4EE65: ARTIFICIAL INTELLIGENCE (AI) APPLICATIONS TO ELECTRICAL ENGINEERING

CREDITS - 4(LTP: 3, 0, 1)

Course Objective:
To familiarize with the concept of Artificial Intelligence, fuzzy logic, artificial neural networks, optimization, machine learning and its applications in electrical engineering.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	150
3	0	2	4	60	40	20	30	

Details of Assessment Instruments under CE Practical Component:

Hands-on and computational experiments related to the course contents. Exposure to Artificial Neural Networks and Machine Learning toolboxes using MATLAB and /or SCILAB

Term work [15]	Allied Evaluation [15]
Attendance/report/Assignment	Performance/Attitude-Aptitude/Quiz/ Questions & Answers/ Discussion

Course Contents:

Unit No.	Topics	Teaching Hours
1.	**Introduction to Artificial Intelligence and Fuzzy Systems:** Artificial Intelligence: Definition, significance, scope and applications. Fuzzy Systems: Fuzzy sets and operations, membership functions, Fuzzification and Defuzzification, rule base, introduction to Fuzzy Logic Control, architecture of Mamdani and Takagi-Sugeno Fuzzy Models, implementation in Electric Drives, Industrial Automation, Renewable Energy Systems, Electric Vehicles, Smart Grids etc.	10
2.	**Artificial Neural Networks:** Introduction to Artificial Neural Networks, Biological Neuron, Artificial Neuron, Activation functions of Artificial Neuron, Structure of Artificial Neural Network, feed forward and recurrent Artificial Neural Networks, training of Artificial Neural Networks, Learning Methods, Back Propagation Algorithm, Implementation in Electric Drives, Industrial Automation, Renewable Energy Systems, Electric Vehicles, Smart Grids etc.	10

Unit No.	Topics	Teaching Hours
3.	**Random Search Optimization:** Modelling of the Optimization Problems, 1-D Optimization Algorithms (Bisection Method and Newton–Raphson Method), of operation, guided random search methods (Genetic Algorithm, Simulated Annealing, Particle Swarm Optimization), Implementation in Electric Drives, Industrial Automation, Renewable Energy Systems, Electric Vehicles, Smart Grids etc.	10
4.	**Machine Learning:** Introduction to Machine Learning (ML), Types of ML (Supervised Learning, Unsupervised Learning, Reinforcement Learning & Evolutionary Learning), support vector regression, Support Vector Machine (SVM), Kernel SVM, Application in Electric Drives, Industrial Automation, Renewable Energy Systems, Electric Vehicles, Smart Grids etc.	10
	Total	**40**

List of Experiments:

Sr. No.	Suggested List of Experiments
1.	Introduction to Artificial Neural Networks toolbox in MATLAB/SCILAB
2.	Programming practice for Fitting a Function using ANN toolbox
3.	Programming practice for Network Models, Network Architectures, Training Styles and Data structures using ANN toolbox
4.	Programming practice for Multi-layer networks and Back-propagation training using ANN toolbox
5.	Programming practice for Dynamic Networks using ANN toolbox
6.	Programming practice for Control Systems using ANN toolbox
7.	Programming practice for Descriptive Statistics and Visualization using Statistics and Machine Learning toolbox in MATLAB/SCILAB
8.	Programming practice for Probability Distribution using Statistics and Machine Learning toolbox in MATLAB/SCILAB
9.	Programming practice for Cluster Analysis using Statistics and Machine Learning toolbox in MATLAB/SCILAB
10.	Programming practice for Regression using Statistics and Machine Learning toolbox in MATLAB/SCILAB
11.	Programming practice for Regression using Support Vector Machine (SVM) in Statistics and Machine Learning toolbox in MATLAB/SCILAB
12.	Application of Artificial Intelligence Techniques for the Control of the Asynchronous Machine using MATLAB

List of References:

1. Saifullah Khalid, "Applications of Artificial Intelligence in Electrical Engineering, "Business Science Reference, 2020.
2. T.J.Ross, "Fuzzy Logic with Engineering Applications," 3rd edition, Wiley, 2011.
3. Simon S. Haykin, "Neural Networks – A Comprehensive Foundation," Pearson Education, 1997.
4. Thomas Weise, "Global Optimization Algorithms Theory and Application," 2nd Edition, Institute of Applied Optimization.
5. Rajesh Kumar Arora, "Optimization Algorithms and Applications," CRC Press, 2015.
6. EthemAlpaydin, "Introduction to Machine Learning," MIT press, 2010.
7. Stephen Marsland, "Machine Learning: An Algorithmic Perspective," CRC Press, 2015.

Lab Resources:

1. Mark Hudson BealeMartin T. HaganHoward B. Demuth, "Neural Network Toolbox™ 7 User's Guide", Mathworks Inc.
2. Primoz Potocnik , "Neural Networks: MATLAB examples", Available at: http://lab.fs.uni-lj.si/lasin/wp/IMIT_files/neural/NN-examples.pdf
3. Heikki N. Koivo, "Neural Networks: Basics using MATLAB Neural Network Toolbox", Available at: http://staff.ttu.ee/~jmajak/Neural_networks_basics_.pdf
4. Documentation and Examples on Statistics and Machine Learning Toolbox in MATLAB, Available at: https://in.mathworks.com/help/stats/index.html
5. Tutorial on Support Vector Machine in MATLAB, Available at: https://in.mathworks.com/discovery/support-vector-machine.html
6. F. Khammar and N. E. Debbache, "Application of Artificial Intelligence Techniques for the Control of the Asynchronous Machine", Journal of Electrical and Computer Engineering, available at: https://www.hindawi.com/journals/jece/2016/8052027/

Course Outcomes (COs):

At the end of this course students will be able to …

1. Recognize the idea of Artificial Intelligence and its applications in various sectors.
2. Demonstrate the understanding of fuzzy system and fuzzy controller to various electrical systems.
3. Understand and implement artificial neural networks in various domains of electrical systems.
4. Appreciate the concepts and different types of Machine Learning Algorithms.