SOFT COMPUTING (404211)

Teaching Scheme:
Lectures: 3 Hrs/ Week

Examination Scheme:
In Semester Assessment:
Phase I : 30
End Semester Examination:
Phase II: 70

Course Objectives:

- Introduce a relatively new computing paradigm for creating intelligent machines useful for solving complex real world problems.
- Insight into the tools that make up the soft computing technique: fuzzy logic, artificial neural networks and hybrid systems Techniques.
- To create awareness of the application areas of soft computing technique
- Provide alternative solutions to the conventional problem solving techniques in image/signal processing, pattern recognition/classification, control system

Course Outcomes:

Having successfully completing the course students will be able to

- use a new tool /tools to solve a wide variety of real world problems
- find an alternate solution , which may offer more adaptability, resilience and optimization
- Identify the suitable antenna for a given communication system
- Gain knowledge of soft computing domain which opens up a whole new career option
- Tackle real world research problems

Unit I : Artificial Neural Network -I 8L

Biological neuron, Artificial neuron model, concept of bias and threshold , Mc Culloch-Pits Neuron Model , implementation of logical AND, OR, XOR functions Soft Topologies of neural networks, learning paradigms: supervised, unsupervised, reinforcement, Linear neuron model : concept of error energy , gradient descent algorithm and application of linear neuron for linear regression, Activation functions : binary , bipolar (linear, signup, log sigmoid, tan-sigmoid) Learning mechanisms: Hebbian, Delta Rule o Perceptron and its limitations Draft

Unit II : Artificial Neural Network-II 8L

Multilayer perceptron (MLP) and back propagation algorithm, Application of MLP for classification and regression, Self-organizing Feature Maps, k-means clustering, Learning vector quantization
Radial Basis Function networks: Cover's theorem, mapping functions (Gaussian, Multi-quadrics, Inverse multi quadrics), Application of RBFN for classification and regression, Hopfield network, associative memories.

Unit III : Fuzzy Logic -I 6L

Concept of Fuzzy number, fuzzy set theory (continuous, discrete), Operations on fuzzy sets, Fuzzy membership functions (core, boundary, support), primary and composite linguistic terms, Concept of fuzzy relation, composition operation (T-norm, T-conorm), Fuzzy if-then rules.

Unit IV : Fuzzy Logic -II 6L

Fuzzification, Membership Value Assignment techniques, De-fuzzification (Max membership principle, Centroid method, Weighted average method), Concept of fuzzy inference, Implication rules- Dienes-Rescher Implication, Mamdani Implication, Zadeh Implication, Fuzzy Inference systems -Mamdani fuzzy model, Sugeno fuzzy model, Tsukamoto fuzzy model, Implementation of a simple two-input single output FIS employing Mamdani model Computing.

Unit V : Fuzzy Control Systems 6L

CONTROL SYSTEM DESIGN PROBLEM 1.5, Control (Decision) Surface, Assumptions in a Fuzzy Control System Design V, Fuzzy Logic Controllers Soft o Comparison with traditional PID control, advantages of FLC, Architecture of a FLC: Mamdani Type, Example Aircraft landing control problem.

Unit VI : Adaptive Neuro-Fuzzy Inference Systems (ANFIS) 6L

ANFIS architecture, Hybrid Learning Algorithm, Advantages and Limitations of ANFIS Application of ANFIS/CANFIS for regression

Text Books

1. Fundamentals of Neural Networks: Architectures, Algorithms And Applications, Laurene Fausett, Pearson Education, Inc, 2008 .
2. Fuzzy Logic With Engineering Applications, Third Edition Thomas, Timothy Ross, John Wiley & Sons,2010
3. Neuro- Fuzzy and Soft Computing, J.S. Jang, C.T. Sun, E. Mizutani, PHI Learning Private Limited.
4. Principles of Soft Computing , S. N. Sivanandam, S. N. Deepa, John Wiley & Sons, 2007

Reference Books

1. Introduction to the theory of neural computation, John Hertz, Anders Krogh, Richard Palmer, Addison –Wesley Publishing Company, 1991
2. Neural Networks A comprehensive foundation,, Simon Haykin,Prentice Hall International Inc-1999
3. Neural and Adaptive Systems: Fundamentals through Simulations, José C. Principe Neil R.

Euliano , W. Curt Lefebvre, John-Wiley & Sons, 2000
4. Pattern Classification, Peter E. Hart, David G. Stork Richard O.Duda,Second Edition,2000
5. Pattern Recognition, Sergios Theodoridis , Konstantinos Koutroumbas, Fourth Edition, Academic Press, 2008
6. A First Course in Fuzzy Logic, Third Edition, Hung T. Nguyen, Elbert A. Walker, Taylor & Francis Group, LLC, 2008
7. Introduction to Fuzzy Logic using MATLAB, S. N. Sivanandam , S.Sumathi, S. N. Deepa, Springer Verlag, 2007

Practical Sessions: (Use MATLAB/OCTAVE/SCILAB base code only)

1. Implement simple logic network using MP neuron model
2. Implement a simple linear regressor with a single neuron model
3. Implement and test MLP trained with backpropagation algorithm
4. Implement and test RBF network
5. Implement SOFM for character recognition
6. Implement fuzzy membership functions (triangular, trapezoidal, gbell, PI, Gamma, Gaussian)
7. Implement defuzzyfication (Max-membership principle, Centroid method, Weighted average method)
8. Implement FIS with Mamdaniinferencing mechanism
9. A small project: may include classification or regression problem , using any soft computing technique studied earlier