# Soft Computing

**Course Code:** PGMTH1E022T

**Semester: I**

**Credits:** 04

**Course Overview**

Soft computing is an emerging approach to computing which parallel the remarkable ability of the human mind to reason and learn in an environment of uncertainty and imprecision. Soft computing is based on some biological inspired methodologies such as genetics, evolution, one's behaviour, particles swarming, human nervous systems, etc. It has enormous applications in many application areas such as medical diagnosis, computer vision, hand written character recondition, pattern recognition, machine intelligence, weather forecasting, network optimization, VLSI design, etc.

**Course Objectives**

- To provide an introduction to the basic principles, techniques, and applications of soft computing.
- The student should be able to choose appropriate soft computing technique and use it to solve a specific problem.
- Students should be able to understand the necessary mathematical abstraction to solve problems.
- Upon successful completion of the course, students will have an understanding of the basic areas of Soft Computing including Artificial Neural Networks, Fuzzy Logic and Genetic Algorithms
- Student should be able to come up with analysis of efficiency.

**Course Outlines**

| Contents | No of Lectures |
|---|---|
| **Unit-I**<br>Soft Computing: Introduction, soft computing vs. hard computing, various types of soft computing techniques, Applications of soft computing techniques, Introduction, Structure and function of a neuron, Biological neuron, artificial neuron, definition of ANN, Taxonomy of neural networks, Difference between ANN and human brain, Characteristics and applications of ANN. | **10** |
| **Unit-II**<br>Learning rules, Thresholds and activation functions, Single layer network, Perceptron and its training algorithm, Linear Separability, XOR problem, ADALINE, MADALINE. Introduction to multilayer layer Perceptron, Back | **10** |

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| propagation neural(BPN) networks, | |
| **Unit-III**<br><br>Counter propagation network,Hopfield/ Recurrent network, Associative memory, Hopfield v/s Boltzman machine, competitive learning, Kohonen's self organizing networks, Adaptive Resonance Theory(ART). | **10** |
| **Unit-IV**<br><br>Introduction to Fuzzy Logic: Classical and Fuzzy Sets: Overview of Classical Sets, Membership Function, Fuzzy rule generation. Operations on Fuzzy Sets: Compliment, Intersections, Unions, Combinations of Operations, Aggregation Operations, Fuzzy Arithmetic: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals & Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations. Fuzzy Logic: FIS, Fuzzification and de-Fuzzification. | **10** |
| **Unit-V**<br><br>Genetic algorithms(GA): Basic concepts, Conventional Vs. GA, Simple, GA working, encoding, fitness function, reproduction, Selection, crossover, mutation, schema analysis, analysis of selection algorithms; convergence; Reproduction, Crossover, and mutation, Mapping objective functions to fitness form, Fitness scaling.<br><br>Meta-heuristic search: Overview of ACO, PCO | **10** |

**Teaching Plan**

| SN | Topic | No. of Lectures | Reference |
|---|---|---|---|
| **Unit-I** | | | |
| **1** | Introduction of soft computing | **1** | T1, T2 |
| **2** | soft computing vs. hard computing | **1** | T1, T2, Chapter 1 |
| **3** | Various types of soft computing technique | **1** | T1, T2: Chapter 1 |
| **4** | Applicationsof soft computing technique | **1** | T1, T2: Chapter 1 |
| **5** | Structure and function of a neuron | **1** | T1, T2, R1: Chapter 2 |
| **6** | Biological neuron, artificial neuron,definition of ANN, | **2** | T1, T2, R1: Chapter 1 |
| **7** | Taxonomy of neural networks | **1** | T1, T2, R1: Chapter 1 |
| **8** | Difference between ANN and human brain, Characteristics and applications of ANN | **2** | T1, T2, R1: Chapter 1 |
| **Unit-II** | | | |

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| **9** | Learning rules | **1** | T1, T2, R1: Chapter 1 |
| **10** | Thresholds and activation functions | **2** | T1, T2, R1: Chapter 1 |
| **11** | Single layer network | **1** | T1, T2, R1: Chapter 1 |
| **12** | Perceptron and its training algorithm | **1** | T1, T2, R1: Chapter 2,3 |
| **13** | Linear Separability,XOR problem | **1** | T1, T2, R1: Chapter 3 |
| **14** | ADALINE | **1** | T1, T2, R1: Chapter 2 |
| **15** | MADALINE | **1** | T1, T2, R1: Chapter 2 |
| **16** | Introduction to multilayer layer Perceptron, Back propagation neural(BPN) networks,. | **2** | T1, T2, R1: Chapter 2 |
| **Unit-III** | | | |
| **17** | Counter propagation network,Hopfield/ Recurrent network | **2** | T1, T2, R1: Chapter 4 |
| **18** | Associative memory | **2** | T1, T2, R1: Chapter 5,6 |
| **19** | Hopfield v/s Boltzman machine | **1** | T1, T2, R1: Chapter 6 |
| **20** | competitive learning | **1** | T1, T2, R1: Chapter 7 |
| **21** | Kohonen's self organizing networks | **2** | T1, T2, R1: Chapter 7 |
| **22** | Adaptive Resonance Theory(ART) | **2** | T1, T2, R1: Chapter 7 |
| **Unit-IV** | | | |
| **23** | Introduction to Fuzzy Logic, Classical and Fuzzy Sets | **1** | T1, R2, R3 |
| **24** | Membership Function | **1** | T1, R2, R3 |
| **25** | Fuzzy rule generation. | **1** | T1, R2, R3 |
| **26** | Operations on Fuzzy Sets: Compliment, Intersections, Unions, Combinations of Operations, Aggregation Operations | **2** | T1, R2, R3 |
| **27** | Fuzzy Arithmetic: Fuzzy Numbers, Linguistic Variables, | **1** | T1, R2, R3 |
| **28** | , Arithmetic Operations on Intervals & Numbers | **1** | T1, R2, R3 |
| **29** | Lattice of Fuzzy Numbers, Fuzzy Equations | **1** | T1, R2, R3 |
| **30** | Fuzzy Logic: FIS, Fuzzification and de-Fuzzification | **2** | T1, R2, R3 |
| **Unit-V** | | | |

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| **31** | Genetic algorithms(GA): Basic concepts, Conventional Vs. GA | **1** | T1, R2 |
| **32** | Simple GA working, encoding, fitness function | **1** | T1,T2 |
| **33** | schema analysis, analysis of selection algorithms; convergence | **2** | T1,T2 |
| **34** | Reproduction,Selection, Crossover, and mutation | **2** | T1,T2 |
| **35** | Mapping objective functions to fitness form, Fitness scaling | **2** | T1,T2 |
| **36** | Meta-heuristic search: Overview of ACO, PCO | **2** | T1,T2 |

**Evaluation Scheme**

| S.No | Exam | Marks | Duration of Exam. | Coverage/Scope of Examination |
|---|---|---|---|---|
| 1 | Mid Term Exam. | 25 | 2Hours | Two to Three Units |
| 2 | End Term Exam. | 50 | 3 Hours | All Five Units |
| 3 | Teachers Continuous Assessment | 25 | Entire Semester | Assignments, Quizzes, Tests, Group projects, Presentations etc. |

**Course Outcomes**

After completion of course, students would be able to learn:

- Identify and describe soft computing techniques and their roles in building intelligent machines
- Apply genetic algorithms to combinatorial optimization problems.
- Evaluate and compare solutions by various soft computing approaches for a given problem.
- Apply fuzzy logic and reasoning to handle uncertainty and solve various engineering problems.

**Text Books**

T1 S, Rajasekaran& G.A. VijayalakshmiPai, Neural Networks, Fuzzy Logic & Genetic Algorithms, Synthesis & applications, PHI Publication 2015.

T2 S.N. Sivanandam& S.N. Deepa, Principles of SoftComputing , Wiley Publications, 2018.

**Reference Books**

R1 Bose, Neural Network fundamental with Graph ,Algo.&Appl, TMH.

R2 Kosko: Neural Network & Fuzzy System, PHI Publication.

R3 Klir&Yuan ,Fuzzy sets & Fuzzy Logic: Theory &Appli.,PHI Pub.