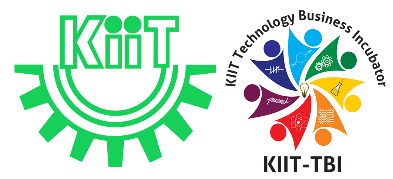
****

**School of Computer Engineering**

**Kalinga Institute of Industrial Technology (KIIT)**

**Deemed to be University**

**Bhubaneswar-751024**

**Semester: 5th**

**Session: Autumn 2024**

**Course Plan**

**Course Code : CS 30011**

**Course Title : Computational Intelligence**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **L** | **T** | **P** | **Total** | **Credit** |
| **3** | **0** | **0** | **3** | **3** |

**LTP Structure :**

**Instructor:**

**Name :** Dipti Dash

**Chamber :** F-09, Block-A, Campus-15

**Email :** dipti.dashfcs@kiit,.ac.in

**Contact Number** : 7978996718

**Course Objective**

This is an elective course, open to 3rd year B.Tech (CS, CSCE, and IT) students. Computational Intelligence (Soft Computing) is a new concept for advanced information processing. The objective of Computational Intelligence approaches is to introduce a new approach for analyzing and creating flexible information processing of humans such as sensing, understanding, learning, recognizing, and thinking. Our aim is to realize three main methodologies of Computational Intelligence and their hybridization in the first few classes. Following this, we discuss in details the three methodologies which are biologically and linguistically motivated computational paradigms such as Neural Networks, Fuzzy Systems, Evolutionary Computation and Hybrid Neuro-Fuzzy Models. Finally, students will be acquainted with designing intelligent systems and provide them with a working knowledge for building these systems.

**Course Outcomes**

|  |  |
| --- | --- |
| CO1: | Identify the basic concepts and characteristics of soft computing and its associated methodologies. |
| CO2: | Assess concepts of artificial neural networks and apply neural networks to various classification problems. |
| CO3: | Apply various set theoretic operations in fuzzy sets. |
| CO4: | Analyze fuzzy rules, fuzzy reasoning and various fuzzy and neuro-fuzzy inference systems. |
| CO5: | Understand derivative free optimization and apply genetic algorithms to optimization problems. |
| CO6: | Apply and evaluate swarm-based optimization techniques in real-world problem solving. |

****

**Course Contents**

|  |  |  |
| --- | --- | --- |
| **Topics** | **No. of lectures** | **Course Outcome** |
| **Introduction to Soft Computing and Neuro-Fuzzy System**   * Introduction to Concept of computing * "Soft" computing versus "Hard" computing * Conventional AI * Constituents of Soft Computing * Neuro-Fuzzy Systems | 3  (1-3) | CO1 |
| **Artificial Neural Networks (ANN)**   * Introduction to ANN * Adaline and Madaline * Learning algorithms * Perceptron * Multilayer Perceptron (MLP) and Backpropagation (BP) algorithm * Radial Basis Function Networks (RBF) | 15  (4 -18) | CO2 |
| **Fuzzy Set Theory**   * Fuzzy sets, Basic Definition and Terminology * Member Function Formulation and Parameterization * Set-theoretic Operations and Fuzzy sets operations (Union, Intersection and Complement) | 6  (19 - 24) | CO3 |
| **Fuzzy Rules, Fuzzy Reasoning and Fuzzy Inference Systems**   * Extension Principle and Fuzzy Relations * Fuzzy If-Then Rules and Fuzzy Reasoning * Fuzzy Inference Systems: Mamdani Fuzzy Models, Sugeno Fuzzy Models, Tsukamoto Fuzzy Models * Adaptive Neuro Fuzzy Inference Systems (ANFIS) | 7  (25 - 31) | CO4 |
| **Optimization**   * Derivative-based Optimization and Derivative-free Optimization * Genetic Algorithms (GA) * Differential Evolution (DE) | 3  (32 - 34) | CO5 |
| **Swarm Intelligence**   * Particle Swarm Optimization * Ant Colony Optimization * Artificial Bee Colony Optimization | 5  (35 - 39) | CO6 |

**Day-wise Lesson Plan**

|  |  |  |  |
| --- | --- | --- | --- |
| **Week** | **Lecture No.** | **Topics** | |
| **Week - 1** | 1 | Introduction to Soft Computing, Techniques, Applications, Advantages, Disadvantages | |
| 2 | Constituents of Soft Computing | |
| 3 | Neuro-Fuzzy Systems | |
| **Week - 2** | 4 | Introduction to Artificial Neural Networks, Biological Model Vs Mathematical Model | |
| 5 | ANN architecture, ANN Building Blocks | |
| 6 | Adaline and Madaline | |
| **Activity - 1** | | | |
| **Week – 3** | 7 | Supervised vs Unsupervised Learning, Gradient descent method | |
| 8 | McCulloch Pitts Model, Modelling logic gates, limitations | |
| 9 | Linear separability, Single Layer Perceptron, Learning Rule & Model | |
| **Week - 4** | 10 | Multilayer Perceptron and its applications in real world | |
| 11 | Back propagation Algorithm - 1 | |
| 12 | Back propagation Algorithm - 2 | |
| **Activity - 2** | | | |
| **Week - 5** | 13 | | Factors affecting back propagation training, Advantages and Disadvantages |
| 14 | | Introduction to Radial Basis Function Networks (RBFN) |
| 15 | | RBFN Learning Algorithms |
| **Week - 6** | 16 | | XOR – Problem Solving using RBFN |
| 17 | | Problem solving on real world applications |
| 18 | | Basics of third-generation neural networks |
| **Activity - 3** | | | |
| **Mid-Semester Examination** | | | |
| **Week - 7** | 19 | | Crisp and Fuzzy sets |
| 20 | | Basic Definition and Terminology |
| 21 | | Member Functions Formulation and Parameterization - 1 |
| **Week - 8** | 22 | | Member Functions Formulation and Parameterization - 2 |
| 23 | | Set-theoretic operations and Fussy sets operations |
| 24 | | Fuzzy sets operations, T-norm and T-conorm |
| **Activity - 4** | | | |
| **Week - 9** | 25 | | Extension Principle and Fuzzy Relations |
| 26 | | Fuzzy systems-quantifiers, fuzzy inference |
| 27 | | Fuzzy If-Then Rules |
| **Week - 10** | 28 | | Fuzzy Reasoning |
| 29 | | Fuzzy Inference Systems: Mamdani Fuzzy Models |
| 30 | | Sugeno Fuzzy Models, Tsukamoto Fuzzy Models |
| **Activity - 5** | | | |
| **Week - 11** | 31 | | Adaptive Neuro Fuzzy Inference Systems (ANFIS) architecture |
| 32 | | Derivative-based Optimization and Derivative-free Optimization |
| 33 | | Concept of Genetic Algorithms (GA), GA Operators |
| **Week - 12** | 34 | | Differential Evolution (DE) as modified GA, Problem solving |
| 35 | | Swarm Intelligence concept, examples, applications |
| 36 | | Particle Swarm Optimization (PSO) model, velocity and position update equations, problem solving |
| **Week - 13** | 37 | | PSO variants, Binary PSO |
| 38 | | Ant Colony Optimization concepts and applications |
| 39 | | Artificial Bee Colony Optimization concepts and applications |
| **Activity - 6** | | | |
| **End-Semester Examination** | | | |

**Text books:**

1. Neuro-Fuzzy and Soft Computing, Jang, Sun, Mizutani, PHI/Pearson Education

**Reference books:**

1. Neural Network Design, M. T. Hagan, H. B. Demuth, Mark Beale, Thomson Learning, Vikash Publishing House
2. Genetic Algorithms: Search, Optimization and Machine Learning, Davis E. Goldberg, Addison Wesley, N.Y., 1989
3. Swarm Intelligence Algorithms: A Tutorial, Adam Slowik, Ed: CRC Press, 2020
4. Introduction to Soft Computing, Roy and Chakraborty, Pearson Education
5. Fuzzy Logic with Engineering Applications, Timothy J. Ross, McGraw-Hill, 1997
6. Neural Networks: A Comprehensive Foundation, Simon Haykin, Prentice Hall
7. Neural Networks, Fuzzy Logic and Genetic Algorithms, S. Rajasekaran and G.A.V. Pai, PHI, 2003

**Assessment plan for activity-based teaching**

Considering the guidelines circulated and after discussing with the faculty members, following activity-based teaching and learning is proposed to have the uniformity of subject delivery in all sections.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sr #** | **Assessment Component** | **Time** | **Weightage/ Marks** | **Schedule** |
|
| 1 | Mid-Semester Examination | 1.5 Hours | 20 | Refer Details in Student Handbook |
| 2 | Activity based Teaching and Learning: Quiz, Assignment, Class Test, Viva, and/or Mini-project | Based on activities | 30 | Throughout semester |
| 3 | End-Semester Examination | 2.5 Hours | 50 | Refer Details in Student Handbook |

**There will be a minimum of 5 short activities (quizzes/assignments/class test/viva/mini project) over the semester, at the end of every unit.**