Intelligent Systems

Course Code: 46332
Course Type: Theoretical
Credits: 3
Course Status: Elective specialized
Prerequisite: Advisor approval

Aim/Scope/Objectives: This course is designed to provide graduate students with the knowledge needed to apply AI in simulation, prediction, identification, and optimization of different complex nonlinear systems. This course also covers complete training of Python programming language.

Course Outline:

1- **Part one: Artificial Neural Networks**
- 1-1- Pattern recognition
- 1-2- Multi-Layered Perceptron (MLP)
- 1-3- Radial Basis Function (RBF)
- 1-4- K-means clustering
- 1-5- Systems identification and modeling
- 1-6- Recurrent Neural Networks (RNN)
- 1-7- Deep Neural Networks (DNN)
- 1-8- Long Short Term Memory (LSTM)
- 1-9- Physics-Informed Neural Networks (PINN)
- 1-10- Graph Neural Networks (GNN)

2- **Part two: Nature Inspired Optimization Algorithms**
- 2-1- Introduction to optimization and applications
- 2-2- Simulated Annealing (SA)
- 2-3- Genetic Algorithms (GA)
- 2-4- Ant Colony Optimization (ACO)
- 2-5- Particle Swarm Optimization (PSO)

Grading: 40% Final exam, 20% Homework by Python, 40% Research Project

References:

- Christopher M. Bishop, “Deep Learning Foundation and Concepts”, Springer, 2024
- Oliver Nelles, “Nonlinear System Identifications, from classical approach to neural networks, fuzzy models, and Gaussian process”, Springer, second edition, 2021.
- William L. Hamilton, “Graph Representation Learning”, Morgan & Claypool, 2020.
- Maxim Labonne, “Hands on Graph Neural Networks using Python”, Packt, 2023.
- R. L. Haupt, S. E. Haupt, “Practical Genetic Algorithms”, John Wily & Sons, 2004.
- Andreas Antoniou, Wu-Sheng Lu, “Practical Optimization: Algorithms and Engineering Applications”, Springer, 2007
- Xavier Vasques, "Machine Learning Theory and Applications Hands-on Use Cases with Python on Classical and Quantum Machines", John Wiley, 2024.