UNIVERSITY of NICOSIA

Course Syllabus

Course Code	Course Title	ECTS Credits
ECE-434	Neural Networks and Fuzzy Systems	6
Prerequisites	**Department**	**Semester**
MATH-191, COMP-111	Engineering	Fall or Spring
Type of Course	**Field**	**Language of Instruction**
Elective	Engineering	English
Level of Course	**Lecturer(s)**	**Year of Study**
1st Cycle	George Tsolaki	4th
Mode of Delivery	**Work Placement**	**Co-requisites**
Face-to-face	N/A	None

Course Objectives:

The main objectives of this course are to:

- Introduce students to the various neural network and fuzzy systems models.
- Reveal different applications of these models to solve engineering and other problems.
- Introduce the theory and applications of artificial neural network and fuzzy systems to engineering applications with emphasis on image processing and control.
- Discuss neural networks and fuzzy systems, architectures, algorithms and applications, including Back-propagation, BAM, Hopfield network, Competitive Learning, ART, SOFM, Fuzzy inference methods and expert systems.

Learning Outcomes:

After completion of the course students are expected to:

- Identify different neural network architectures, their limitations and appropriate learning rules for each of the architectures.
- Select appropriate neural network architectures for a given application (i.e. they shall recognize the class of applications and relate it to specific architectures).
- Design and implement a neural network simulation (with two modes of operation: learning and processing) using a high-level language C++.
- Demonstrate knowledge and understanding of fuzzy system as they apply in engineering and science.

- Assess the power and usefulness of artificial neural networks in several applications including speech synthesis, diagnostic problems, business and finance, robotic control, signal processing, computer vision and many other problems that fall under the category of pattern recognition.
- Develop models for different applications using fuzzy system and Matlab.

Course Content:

Object-Oriented Framework.

Class-objects, Virtual functions and Abstract classes, Polymorphism, Vector class, Matrix class and Neural net class.

Fundamental Concepts in Neural Networks

Learning paradigms, Perceptron learning, Multi-Layer Perceptron,

Hebb Net, Perceptron, Adaline, Training algorithms for pattern association.

Neural Net Models and Applications

Derivation of Back-propagation Algorithms

Clustering, Kohonen Self-Organizing Maps

Counterpropagation

Adaptive Reasoning Theory (ART)

Bidirectional Associative Memory system (BAM)

Pattern Classification

The self-organizing feature map, Clustering patterns, SOFM Algorithm,

Pattern association, Hopfield Network

Fuzzy Set Theory and Fuzzy Logic Control

Sets, linguistic variables and fuzzy rules

Mamdani and Sugeno-style inference

Fuzzy Expert Systems

FAM system architectures

BIOFAM application (Inverted Pendulum)

Fuzzy and neural control systems

Image transform coding with adaptive fuzzy systems

Lab sessions:

The followings are planned to be included as simulation examples in this course.

1. Simulating systems using the simulator: *Fuzzy Logic Controller*
2. Matlab/Simulink and Real Time Workshop
3. System analysis using MATLAB

Experiments:

1. Bidirectional Associative Memory (BAM)
2. Competitive Learning-Differential Competitive Learning
3. Back propagation
4. FAM-ABAMA-CUBICALC working models
5. Fuzzy Logic and Knowledge Based Systems
6. Self-organizing feature maps and Hopfield networks
7. The Matlab package and the Fuzzy Logic Toolbox. Part I,II
8. Build a Fuzzy System in Matlab using FIS. Part I,II,III
9. Define a Fuzzy Logic System using the command line. Part 1,II

Learning Activities and Teaching Methods:

Lectures, in-class examples and exercises

Assessment Methods:

Homework, Lab-experiments, mid-term exam, final exam

Required Textbooks / Readings:

Title	Author(s)	Publisher	Year	ISBN
Artificial Intelligence A Guide to intelligent system	Michael Negnevitsky	Addison Wesley	2017	9781408225745
The Essence of Neural Networks	Robert Callan	Prentice-Hall	1999	0139087732x

Neural Network and Fuzzy Systems: A Dynamic System Approach to Machine Intelligence	Bart Kosko	Prentice-Hall	1991	9780136114352

Recommended Textbooks / Readings:

Title	Author(s)	Publisher	Year	ISBN
Neural Networks in C++	Adam Blum	Wiley	1992	0471552011