University of Nicosia, Cyprus

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

Objectives of the Course:

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 Contents:

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/Reading:

Authors	Title	Publisher	Year	ISBN
Michael Negnevitsky	Artificial Intelligence A Guide to intelligent system	Addison Wesley	2004	0321204662

Recommended Textbooks/Reading:

Authors	Title	Publisher	Year	ISBN
Robert Callan	The Essence of Neural Networks	Prentice-Hall	1999	0139087732x
Adam Blum	Neural Networks in C++	Wiley	1996	0471552011
Bart Kosko	Neural Network and Fuzzy Systems: A Dynamic System Approach to Machine Intelligence	Prentice-Hall	1998	0136114350