EENG582 : Artificial Neural Networks

Department:
Electrical and Electronic Engineering

Program Name: **Electrical and Electronic Engineering**	**Program Code:** 27
Course Number: EENG582	**Credits:** 3

☒ Required Course ☐ Elective Course (click and check the appropriate box)

Prerequisite(s): - None

Catalog Description:
EENG 582 Artificial Neural Networks
Neural Network Concepts: what is a neural network? biological neuron, artificial neuron, neural network topologies. Learning in Neural Networks: types of learning, learning rules, error correction learning, Hebbian learning, competitive learning, Boltzmann learning. Application Tasks: function approximation, classification, association, application examples. Feedforward Networks: perceptron, multi-layer perceptron, radial basis function network, self-organizing map. Feedback Networks: Hopfield network, Boltzmann machine, real-time recurrent network.

Course Web Page: https://opencourses.emu.edu.tr/course/view.php?id=619#section-0

Textbook(s):
1) Neural Networks a Comprehensive-Foundation, 2nd Ed. By Simon-Haykin, 2005
2) Neural Networks and Learning Machines - S.Hykin.3ed.2009

Indicative Basic Reading List:
1)

Course Outline:
CONTENTS

1. BIOLOGICAL AND ARTIFICIAL NEURAL NETWORKS
1.1. Intrtoduction to Artificial Neural Networks
1.2. The Human Brain
1.3. Models of a Neuron
1.4. Neural Network Viewed as a Dirtected Graph
1.5. Neural Network Architectures
1.6. Knowledge Representation
1.7. Artificial Intelligence and Neural Networks
1.8. Modelling Neurons
1.9. Tutorial with Selected Problems

2. LEARNING PROCESS
2.1. The Learning Process
2.2. Error Correction Learning
2.3. Memory Based Learning
2.4. Hebbian Learning
2.5. Competitive Learning
2.6. Boltzmann Learning
2.7. Credit Assignment Problem
2.8. Learning with a Teacher
2.9. Learning without a Teacher
2.10. Statistical Learning
2.11. Tutorial with Selected Problems

3. SINGLE LAYER PERCEPTRON, ADAPTIVE FILTERING AND OPTIMIZATİON
3.1. Single Layer Perceptron
3.2. Adaptive Filtering
3.3. Optimization

3.4. Unconstraint Optimization Techniques
3.5. Linear Least-Squares Filters
3.6. Least-Mean-Square Algorithm
3.7. Learning Curves
3.8. Learning Rate Annealing Techniques
3.9. Perceptron
3.10. Perceptron Convergence Theorem
3.11. Relation Between the Perceptron and Bayes
3.12. Tutorial with Selected Problems

4. MULTILAYER PERCEPTRON
4.1. Introduction
4.2. Multilayer Perceptron Architecture
4.3. Back-Propagation Algorithm
4.4. Summary of the Back-propagation Algorithm
4.5. XOR Problem
4.6. Heuristics for Making the Back -Propagation Algorithm Perfol'm Better
4.7. Output Representation and Decision Rule
4.8. Computer Experiment
4.9. Feature Detection
4.10. Back-Propagation and Differentiation
4.11. Hessian Matrix
4.12. Generalization
4.13. Approximations of Functions
4.14. Cross-Validation
4.15. Network Pruning Techniques
4.16. Virtues and Limitations of Back-Propagation Learning
4.17. Convolutional Neural Networks
4.18. Nonlinear Filtering
4.19. Small-scale Versus Large-scale Learning Problems

Course Learning Outcomes:
On successful completion of this course, all students will have developed **knowledge** and **understanding** of:

a) the concept and working principles of Biological Neural Networks.
b) the concept and working principles of Artificial Neural Networks.
c) the process of learning.
d) the concept of Single Layer Perceptron and Adaptive Filtering
e) the concept of Optimization
f) the concept of Multilayer Perceptron and Back Propagation Algorithm
g) employing Artificial Neural Networks to solve real life problems using computer aided design and analysis tools (i.e. Matlab and Python).

Class Schedule:
3 hrs of lectures per week on Friday mornings

	Method	**Percentage**
Assessment	Midterm Exam(s)	30 %
	Term Project	20 %
	Homework (White paper about the project)	10 %
	Quizes	10 %
	Final Examination	30 %

Contribution of Course to Criterion 5
Credit Hours for:
Mathematics & Basic Science: 2
Engineering Design: 2
General Education: 0

Relationship of Course to Student Outcomes
The course has been designed to contribute to the following student outcomes:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
3. an ability to communicate effectively with a range of audiences,
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives,
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

	Contribution of Course Learning Outcomes to Student Outcomes						
Course Learning Outcome	**1**	**2**	**3**	**4**	**5**	**6**	**7**
a) the concept and working principles of Biological Neural Networks.	•		•		•	•	•
b) the concept and working principles of Artificial Neural Networks.	•		•		•	•	•
c) the process of learning.							•
d) the concept of Single Layer Perceptron and Adaptive Filtering	•		•		•	•	•
e) the concept of Optimization	•						
f) the concept of Multilayer Perceptron and Back Propagation Algorithm	•					•	•
Date Prepared: 20 April 2021							