**Code and Name:**

**MAT5990 Mathematical Foundations of Artificial Neural Networks**

**Unit:**

Institute of Science, Department of Mathematics

**Details:**

* **Term:** 2023-2024 Spring
* **Status:** Elective
* **Class Level:** 1
* **Credit Hours:** 3-0-0-3
* **ECTS:** 6
* **Language:** Turkish

**Course Instructors:**

* **Course Coordinator:** ...
* **Assistant Instructor:** ...
  + **Phone:** ...
  + **Email:** ...@firat.edu.tr
  + **Social Accounts:** ...

**Weekly Schedule**

| **Monday** | **Tuesday** | **Wednesday** | **Thursday** | **Friday** | **Saturday** |
| --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |

**Teaching Method:**  
Each weekly hour will include at least 45 minutes of face-to-face teaching.

**Location:**

* **In-person (YY):** Classroom (To be announced)
* **Remote (UE):** -

**Objective:**

This course aims to teach the widely used models and algorithms of Artificial Neural Networks (ANNs), including foundational neuron models, perceptrons, adaptive linear elements, least squares algorithms, Multi-Layer Perceptrons (MLPs), Backpropagation learning algorithms, Radial Basis Function (RBF) networks, self-organizing networks, vector quantization, Support Vector Machines (SVMs), continuous and discrete-time Hopfield networks, classification techniques, and pattern recognition.

**Materials:**

1. S. Haykin, *Neural Networks and Learning Machines*, Pearson Education, 3rd Ed., 2009
2. J.M. Zurada, *Introduction to Artificial Neural Systems*, West Publishing Company, 1992

**Student Responsibilities:**

Students are required to attend at least 70% of the classes.

**Weekly Lesson Plan:**

| **Week** | **Topic** | **Methodology** |
| --- | --- | --- |
| 1 | Introduction to the course and key concepts | Face-to-Face |
| 2 | **General Introduction**: Biological inspiration, historical notes, and applications of ANNs | Face-to-Face |
| 3 | **Algorithms**: Classification of ANN models and learning algorithms | Face-to-Face |
| 4 | General artificial neuron model, discrete-valued perceptron, threshold logic, and limitations | Face-to-Face |
| 5 | **Hebb Rule**: Hopfield networks, weight matrices as outer products of memory pattern vectors | Face-to-Face |
| 6 | **Supervised Learning**: Perceptron learning rule, linear adaptive element, least squares rule | Face-to-Face |
| 7 | **Delta Rule**: Single-layer perceptrons, sigmoidal activation function | Face-to-Face |
| 8 | Gradient descent algorithms, deterministic and stochastic gradient descent | Face-to-Face |
| 9 | **Midterm Exam** | Face-to-Face |
| 10 | **Multi-Layer Perceptrons**: Backpropagation algorithm | Face-to-Face |
| 11 | Overfitting problems, training and test datasets | Face-to-Face |
| 12 | Training and testing networks, pattern recognition | Face-to-Face |
| 13 | **RBF Networks**: Gaussian centers, linear weights, backpropagation algorithm | Face-to-Face |
| 14 | **Applications**: SVMs, kernel representations, Vapnik-Chervonenkis dimension | Face-to-Face |

**Assessment and Evaluation:**

| **Method** | **Quantity** | **Weight** |
| --- | --- | --- |
| **Midterm Exam** | 1 | 50% |
| **Quizzes** | None | - |
| **Assignments** | Pre- and post-midterm activities | - |
| **Projects** | None | - |
| **Final Exam** | 1 | 50% |

**Learning Outcomes:**

1. Understand biological inspiration, historical development, and applications of ANNs.
2. Learn the artificial neuron model, Hebb rule, and supervised learning.
3. Understand the delta rule, gradient descent, MLPs, and overfitting problems.
4. Learn practical aspects of network training and testing.
5. Gain knowledge of RBF networks and SVMs.

**Special Notes:**

* **UE:** Remote Education
* **YY:** Face-to-Face Education