**Winter 2025**

To: SECS Faculty and ECE 4740/5740 Students

From: Darrin M. Hanna, Ph.D., CFII, MEII, Professor of Engineering

Subject: ECE 4740/5740 – Embedded Artificial Intelligence (AI)

**Course Title**

Embedded Artificial Intelligence (AI)

##### Course Description

Foundations of AI algorithms and implementation of AI in embedded systems (microcontroller or custom hardware). Topics include neural networks, fuzzy logic, decision trees, clustering, reinforcement, and self-organizing methods in applications for low-cost mobile systems with limited processing power and battery life.  The theory, common implementations, and techniques for simplifying calculations and modifying algorithms for implementations in embedded systems will be presented. Students will participate in hands-on exercises in implementing these on targets of microcontrollers or by designing digital circuits for FPGAs.

##### Prerequisites

###### Ability to implement a digital system using either a microcontroller or digital design in VHDL or Verilog.

**Course Emphasis**

This course focuses on implementing artificial intelligence (AI) algorithms on embedded systems, addressing the unique challenges of limited computational power, low energy budgets, and physical size constraints. While cloud platforms like AWS offer high-performance AI computing, embedded systems enable real-time AI processing directly on portable devices. Students will learn classical and modern AI algorithms across various problem domains and techniques for optimizing them for resource-constrained environments. The course will also cover the architectural advantages of embedded systems, including parallel digital design, to maximize efficiency and performance in AI applications.

**Text and Materials**

* There is no required text for this course, course material will be provided in class and on Moodle. Each student must own a suitable digital development board and environment for implementing digital embedded systems in a microcontroller or using an FPGA.
* MATLAB or access to MATLAB through SECS is required. Students may complete exercises using Python, TensorFlow, or other language with AI libraries.

**Class Time**

Classes will be held on Tuesday and Thursday from 7:30 p.m. to 9:17 p.m in 281 EC. Labs with computers, software, and hardware design boards are available in room 562 of the Engineering Center (EC). The lab will be accessible to you 24/7. Most of the work in this course will be completed using MATLAB, Python, and other tools.

**Course Objectives**

By the end of this course a successful student will be able to:

* Describe at least three pattern recognition and machine learning algorithms, strengths and weaknesses, parameters, and types of applications for which they would be appropriate.
* Describe the role that feature extraction and reduction plays in AI
* Identify a practical intelligent method to solve a given problem and derive the appropriate parameters to implement the method
* Use MATLAB to apply AI techniques to solve problems
* Identify algorithm bottlenecks and opportunities for optimizing the intelligent algorithm to execute on an embedded system
* Implement an AI algorithm on a microcontroller or digital hardware on an FPGA

**Homework**

The homework in this class is an integral part of the learning experience. The assignments will challenge students to practice with AI algorithms and toolboxes and work with solving problems using AI targeted to embedded systems. Most of the homework will use tools such as MATLAB, Python, TensorFlow, and other AI platforms. Since this is a cross-listed course, some assignments will not require certain questions for the undergraduate students enrolled in ECE 4740.

**Design Project**

Each student will participate in a group project and demonstrate an original intelligent system using a PowerPoint presentation given to the class and a project report. Students will receive individual project grades.

**Exams**

There will be two exams during the semester.

**Grading**

Grading will be based on the following:

Homework 35 %

Exam 1 20 %

Exam 2 20 %

Design Project – Thursday, April 24th 7:00pm – 10:00pm 25 %

100 %

**Office Hours:** By Appointment via Email or Walk-ins Welcomed

436 Engineering Center

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Class Web Site: <http://moodle.oakland.edu>