TO: The Faculty of the College of Engineering

FROM: Elmore Family School of Electrical and Computer Engineering

RE: New Graduate Course, ECE 50635 An Introduction To Data Analysis, Design Of Experiment, And Machine Learning

The faculty of the School of Electrical and Computer Engineering has approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

ECE 50635 An Introduction To Data Analysis, Design Of Experiment, And Machine Learning
Sem. 1, Lecture 1, Cr. 1.
Prerequisite by Topic: Calculus, linear algebra, differential equations, probability distribution, programing languages (such as MatLab)

Description: This course will provide the conceptual foundation so that a student can use modern statistical concepts and tools to analyze data generated by experiments or numerical simulations. We will also discuss the principles of the design of experiments so that the data generated by experiments/simulations are statistically relevant and useful. We will conclude with a discussion of analytical tools for machine learning and principal component analysis. At the end of the course, a student will be able to use a broad range of tools embedded in MATLAB and Excel to analyze and interpret their data.

Reason: Some of the ideas are taught in Math (Modern Statistics), ME (Scaling theory), and Data Science Classes (Machine Learning Concepts). However, this course provides an original synthesis of the ideas from a practicing engineer's perspective.

Milind Kulkarni,
Associate Head for Teaching and Learning
Elmore Family School of Electrical and Computer Engineering

ECE 595 Data Analysis, Design of Experiments, and Machine Learning

Course Information

- **Course Name:** ECE 59500 Data Analysis, Design of Experiments, and Machine Learning
- **CRN:** 30278
- **Meeting day(s) and time(s)**: Class :9:00 am - 10:15 am (TR); Stanley Coulter G014, 09/25/2023 – 10/31/2023
- **Instructional Modality:** Lecture
- **Course credit hours:** 1
- **Prerequisites:** Pre-requisites: Grade of B or better in the following courses: ENGR 13200 or ENGR 16200 or ENGR 13300] and [MA 16200 or MA 16600] and MA 261 and [MA 26200 or [MA 26500 and 26600]. Two semesters of calculus; Working knowledge of linear algebra topics such as vectors and matrices; Simple first-order differential equations; Familiarity with the concepts of probability distribution function and cumulative distribution functions; Computer literacy and experience with programming language such as MatLab and spreadsheet programs such as Excel. Instructors' Contact Information

- **Instructor:** Professor Alam
- **Office Location:** WANG 3051
- **Office Phone Number:** +1-765-494-5988
- **Purdue Email Address:** alam@purdue.edu
- **Office Hours:** After class or by email appointment alam@purdue.edu

Course Description

This course will provide the conceptual foundation so that a student can use modern statistical concepts and tools to analyze data generated by experiments or numerical simulations. We will also discuss the principles of the design of experiments so that the data generated by experiments/simulations are statistically relevant and useful. We will conclude with a discussion of analytical tools for machine learning and principle component analysis. At the end of the course, a student will be able to use a broad range of tools embedded in MATLAB and Excel to analyze and interpret their data.

Learning Resources, Technology & Texts

Required Text: None

Recommended References:

- "Applied Statistics and Probability for Engineers", Montgomery and Runger, 3rd Edition, Wiley, 2003.
- "Understanding Robust and Exploratory Data Analysis", D. C. Hoaglin, F. Mosteller, and J.W. Tukey, Wiley Interscience, 1983.
- Video Lectures by Muhammad Alam posted at:
  - https://nanohub.org/resources/28817
- Video Lectures by Stuart Hunter:
  - https://www.youtube.com/watch?v=NoVlRAq0Uxs&list=PL335F9F2DE78A358B

Programming IDE's

- Google Collab
- Jupyter

Programming Libraries

- Scikit Learn
- Numpy
- Matplotlib
- Scipy

Learning Outcomes

A student who successfully fulfills the course requirements will be able to demonstrate:

1. An ability to analyze data taken from variety of sources
2. An ability to design randomized experiments and analyze the results
3. An ability to understand key machine learning algorithms and use them in illustrative examples

Assignments

There will be ***five*** homework assignments and ***one*** final exam for this course (end of the week following Monday)

Assignments	Due	Points
HW 1	10/02/2023	15
HW 2	10/09/2023	15
HW 3	10/16/2023	15
HW 4	10/23/2023	15
HW 5	10/30/2023	15
Final	TDB	25

Each week, the students are assigned homework based on the topics covered in the preceding week. The answers are collected through Brightspace. Some of the questions are auto-graded, others are hand-graded. The students can receive partial points by uploading their work.

Grading Scheme

Grade scheme: A(>85), B(75-85), C(65-75), D(55-65), F(<55)

Course Schedule/Syllabus

Week	Topic & Readings	Assignments
Week 1	Big vs Small Data Collecting and Plotting Data Physical vs Empirical Distributions	*HW 1*
Week 2	Model Selection and Goodness of Fit Design Experiments by Scaling of Equations	*HW 2*
Week 3	Buckingham Pi Scaling Theory Statistical Design of Experiments with Taguchi Array Taguchi Design of Experiments	*HW 3*
Week 4	Principle Component Analysis Basics of Machine Learning Deep learning	*HW 4*
Week 5	Interpretable Physics-Based Machine Learning	*HW 5*

* Schedule and assignments subject to change. Any changes will be posted in the learning management system.

Academic Calendar

Classroom Guidance Regarding Protect Purdue

Any student who has substantial reason to believe that another person is threatening the safety of others by not complying with Protect Purdue protocols is encouraged to report the behavior to and discuss the next steps with their instructor. Students also have the option of reporting the behavior to the Office of the Student Rights and Responsibilities. See also Purdue University Bill of Student Rights and the Violent Behavior Policy under University Resources in Brightspace.

Academic Integrity

Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breaches of this value by either emailing integrity@purdue.edu or by calling 765-494-8778. While information may be submitted anonymously, the more information is submitted the greater the opportunity for the university to investigate the concern. More details are available on our course Brightspace under University Policies.

Purdue's Student Guide for Academic Integrity

Nondiscrimination Statement

Purdue University is committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. A hyperlink to Purdue's full Nondiscrimination Policy Statement is included in our course Brightspace under University Policies.

Mental Health/Wellness Statement

If you find yourself beginning to feel some stress, anxiety and/or feeling slightly overwhelmed, try WellTrack**.** Sign in and find information and tools at your fingertips, available to you at any time.

If you need support and information about options and resources, please contact or see the Office of the Dean of Students. Call 765-494-1747. Hours of operation are M-F, 8 am- 5 pm.

If you find yourself struggling to find a healthy balance between academics, social life, stress, etc., sign up for free one-on-one virtual or in-person sessions with a Purdue Wellness Coach at RecWell. Student coaches can help you navigate through barriers and challenges toward your goals throughout the semester. Sign up is free and can be done on BoilerConnect.

If you're struggling and need mental health services: Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS office on the second floor of the Purdue University Student Health Center (PUSH) during business hours. The CAPS website also offers resources specific to situations such as COVID-19.

Basic Needs Security

Any student who faces challenges securing their food or housing and believes this may affect their performance in the course is urged to contact the Dean of Students for support. There is no appointment needed and Student Support Services is available to serve students 8 a.m.-5 p.m. Monday through Friday. Considering the significant disruptions caused by the current global crisis as it relates to COVID-19, students may submit requests for emergency assistance from the Critical Need Fund

Emergency Preparation

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructors or TAs via email or phone. You are expected to read your @purdue.edu email on a frequent basis.