# EEE 560: Mathematical Foundations of Machine Learning
## Spring 2023 Course Information

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**Note**

Versions of this class were offered in Spring 2019, Fall 2019, and Fall 2020 as a special topics course under the title: *EEE 598: Statisticam Machine Learning: From Theory to Algorithms* taught by Gautam Dasarathy.
The class now has a permanent number (EEE 560) and will be offered regularly in ECEE.

**Instructor:** Gautam Dasarathy
**Contact Info:** e-mail: `gautamd@asu.edu` web: `http://gautamdasarathy.com`
Office: GWC 324 Tel: 480-865-5035
**Class Meetings:** T TH 9:00 am - 10:15am @ COOR 184
**Office Hours:** T TH 10:15 am - 12pm, or by appointment

**Course Description:** This course will serve as a primer in statistical learning theory and in the mathematical foundations of machine learning. It will serve as a platform for exploring emerging algorithms and theory in large scale data analytics. This study is at the intersection of information processing, statistical theory, and computational sciences. The class will contain a healthy mix of topics from all of these disciplines.

**Prerequisites:** EEE 554 (Random Signal Theory) or an equivalent course. Background in probability, statistics, linear algebra, and applied mathematics will be assumed. More importantly, this class will require some mathematical maturity. Some facility in a programming language like Python, R, or Matlab will be assumed.

**Topics:** A tentative list of topics that we will cover:
1. Introduction [motivation, definitions, terminology, probability, statistics, and linear algebra tools]
2. Concentration of measure and Empirical Risk Minimization
3. Vapnik-Chervonenkis Theory and binary classification
4. Structural risk minimization
5. Support Vector Machines
6. Ensemble methods [weak and strong learning, boosting, Adaboost]
7. Convex Losses and Radamacher Complexity
8. Logistic regression and LASSO
9. Johnson-Lindenstrauss Lemma, Sparsity, and Compressed Sensing
10. Graphical Models: Inference, Structure Learning, and applications
11. Clustering [k-means, k-means++, hierarchical, spectral]
12. Stochastic Gradient Descent (SGD) and Large Scale Optimization
13. Multi-armed Bandits, Active Learning
14. Online Learning
15. Ranking
16. Minimax lower bounds

**Grading:** Grades will be based on class participation, quizzes, homework assignments, presentations and/or project reports.

**Textbooks:** A textbook will not be followed in this course. A collection of notes, relevant papers and materials will be prepared and distributed.
The prospective student may want to consult the following excellent textbook to get an idea about the kind of material we will cover in this class:
`https://www.cs.huji.ac.il/~shais/UnderstandingMachineLearning/`

**Academic Integrity:** Absolute professionalism in matters of academic integrity is expected. The minimum penalty for collaboration on an examination in this class will be a grade of E for the class. Other forms of academic misconduct will also incur harsh penalties. You are urged to review the ABOR Student Code of Conduct and disciplinary procedures.
`http://students.asu.edu/files/StudentCodeofConduct.pdf`
`http://students.asu.edu/files/StudentDisciplinaryProceduresChapter5.pdf`