

EC 500: FOUNDATIONS OF PROBABILISTIC ML

Fall 2024 Syllabus
Boston University

Department of Electrical & Computer Engineering
<https://learn.bu.edu/>

COURSE STAFF

Lecturer: Prof. Archana Venkataraman

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GENERAL INFORMATION

Lecture Schedule: M/W 2:30 – 4:15pm, EPC 206

Discussion Sections: Thursdays, 6:30 – 8:00pm & Fridays, 10:00 – 11:30am

- The class will work through a past exam problem that emphasizes the topics from lecture. Students will spend the first 30 minutes of class sketching out a solution either independently or in small groups. They will then take turns solving sub-parts of the problem on the board, as moderated by the graduate course assistants.

Required Textbook

- *H. Stark and J.W. Woods*, Probability, Statistics and Random Processes for Engineers (4th Edition)
Amazon e-Book; A copy will be held in reserve by the BU Libraries
- MIT Course Notes (posted on Blackboard)

Problem Sets

- Problem sets will be assigned every 1–2 weeks and due on Monday. They are intended for you to clear up any confusion with the material, develop proficiency through practice, and internalize the concepts.
- HW assignments are due at **2:30pm on the specified date**. There is an automatic 50% deduction for assignments turned in between 2:31–11:59pm on the specified date. No credit will be given after this.
- Each multi-part question will be graded on the following coarse scale:
 - 0 – No attempt
 - 1 – Partially complete and/or major errors
 - 2 – All parts completed but with minor mistakes
 - 3 – All parts done correctly
- Some problems may require coding. We recommend MATLAB for this course but will accept Python code.
- **All assignments should be uploaded electronically to Blackboard.**

Examinations

- **In-Class Quiz 1:** Wednesday, October 9th
- **In-Class Quiz 2:** Wednesday, November 6th
- **Final Exam:** Scheduled by Registrar
- Students may bring two 8.5×11 " double-sided formula sheets to each in-class quiz and four 8.5×11 " double-sided formula sheets to the final exam. Otherwise, the exams are closed book and closed notes.

Grading

- The final score for the course will be computed as follows:
 - Homework:** 15%
 - In-Class Quiz 1:** 20%
 - In-Class Quiz 2:** 20%
 - Final Exam:** 35%
 - Class Participation:** 10%
- Final grades will be adjusted based on the overall class performance.

COURSE POLICIES

Academic Misconduct

- The student handbook defines Academic Misconduct as follows: “Academic misconduct occurs when a student intentionally misrepresents his or her academic accomplishments or impedes other students’ chances of being judged fairly for their academic work. Knowingly allowing others to represent your work as theirs is as serious an offense as submitting another’s work as your own.” This basic definition applies to EC401. If you are ever in doubt as to the legitimacy of an action, please contact me immediately.

Make-Up Exams

- There will be no make-up exams. If you have a legitimate excuse, as confirmed by BU student services, then the scores of your other exams will be weighted more highly to compensate for the missed exam. If you do not have a legitimate excuse, you will be given a grade of zero for any missed exam.

Incomplete Grades

- Incompletes will not be given to students who wish to improve their grade by taking the course in a subsequent semester. An incomplete grade will only be given if accompanied by an official accommodation request from BU student services. Students will not be given an opportunity to improve their grade by doing “extra work”.

COURSE OBJECTIVES

This course is designed to provide students with

- A thorough understanding (and appreciation!) of probabilistic models for detection, inference, and learning, along with their applications in data analysis
- An understanding of hypothesis testing, parameter estimation, and posterior inference
- **ABET #1:** An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- **ABET #6:** An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
- **ABET #7:** An ability to acquire and apply new knowledge as needed, using appropriate learning strategies

SYLLABUS

The following table outlines the topic progression and HW deadlines. While the content pacing is subject to change during the semester, the HW assignments will always be released and due as noted below.

Date	Topic	Reading	HW Out	HW Due
9/2	LABOR DAY - NO CLASS	—		
9/4	Introduction; Probability Review	S&W: Ch. 1	1	
9/6	—	—		
9/9	Random Variables	S&W: Ch. 2		
9/11	Functions of Random Variables	S&W: Ch. 3		
9/13	Discussion: General Probability I	—		
9/16	Moment Generating Functions	S&W: Ch. 4	2	1
9/18	Random Vectors	S&W: Ch. 5		
9/20	Discussion: General Probability II	—		
9/23	Bayesian Hypothesis Testing	6.437: Sec. 2	3	2
9/25	NonBayesian Hypothesis Testing	6.437: Sec. 3-4		
9/27	Discussion: Hypothesis Testing I	—		
9/30	Minmax Decision Theory	6.437: Sec. 5	4	3
10/2	Bayesian Parameter Estimation	6.437: Sec. 6		
10/4	Discussion: Hypothesis Testing II	—		
10/7	Linear Least Squares Estimation	6.437: Sec. 7	5	4*
10/9	In-Class Quiz 1	Through Hypothesis Testing		
10/11	Discussion: Parameter Estimation I	—		
10/15	NonBayesian Parameter Estimation	6.437: Sec. 8		
10/16	Vector Parameters	6.437: Sec. 8		
10/18	Discussion: Parameter Estimation II	—		
10/21	Exponential Families	6.437: Sec. 9	6	5
10/23	Directed Graphical Models	6.438: Sec. 2, MJ: Ch. 2		
10/25	Discussion: Complex Models	—		
10/28	Mixture Models	MJ: Ch. 10	7	6
10/30	EM Algorithm	6.437: Sec. 12, 6.438: Sec. 22		
11/1	Discussion Mixture Model	—		
11/4	Deterministic Approximations	6.437: Sec. 20	8	7*
11/6	In-Class Quiz 2	Through Mixture Models		
11/8	Discussion: EM Algorithm	—		
11/11	Stochastic Approximations	6.437: Sec. 20		
11/13	Approximations Continued	6.437: Sec. 20		
11/15	Discussion: Inference Strategies	—		
11/18	Markov Chains and HMMs	S&W: Ch. 8	9	8
11/20	HMMs Continued	6.438: Sec. 9, MJ: Ch. 12		
11/22	Discussion: Hidden Markov Models	—		
11/25	Conjugate Priors	6.437: Sec. 18, MJ: Ch. 9	10	9
11/27	THANKSGIVING	—		
11/29	BREAK	—		
12/2	Dirichlet Process Priors	Paisley Tutorial		
12/4	Gaussian Processes	MacKay Introduction		
12/6	Discussion: Nonparametrics	—		
12/9	Course Wrap-up	—		10
TBD	Final Exam	Comprehensive		

* Late submissions are not allowed for HW 4 and HW 7.