Boston University
College of Engineering
Division of Systems Engineering

EK 500: *PROBABILITY AND STATISTICAL METHODS*

FALL 2024

(4 credits)

Professor Christos G. Cassandras

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• Organization: Lectures: M,W 2:30-4:15, EMB 105

• Prerequisites: Elementary Linear Algebra and Differential Equations; A course on elementary Probability Theory would help, but is not required

• Requirements:

1. Weekly Homework Assignments	25%
2. Midterm Exam	35%
3. Second Midterm	40%

• Objectives:

1. Develop a solid foundation in probability theory and random processes.

2. Learn fundamental modeling and statistical analysis techniques for stochastic systems so you can use them in applications found in various Engineering disciplines, Operations Research, Management, and Computer Science.

3. Develop the ability to read technical journals and learn more advanced material based on random processes.

• Office Hours: W: 12:30-1:30 pm.

• Books:

Required: *Lecture notes* (provided)

Recommended but not required:
Probability, Random Variables, and Stochastic Processes, A. Papoulis, McGraw-Hill (out of print)

Bertsekas, D, and Tsitsiklis, J., *Introduction to Probability*, Athena Scientific, 2008 (http://athenasc.com/probbook.html)

• COURSE OUTLINE •

1. FOUNDATIONS OF PROBABILITY THEORY.

1.1. Basic concepts (sample space, event space, probability space)

1.2. Probability measures and probability functions

1.3. Discrete and continuous probability spaces

1.4. Dependent and independent events, conditional probability

2. RANDOM VARIABLES.

2.1. Definitions

2.2. Probability distribution and density functions

2.3. Functions of random variables

2.4. Expectation, moments, characteristic functions

2.5. Sequences of random variables, convergence, laws of large numbers and central limit theorem

3. RANDOM PROCESSES.

3.1. Definitions

3.2. Random process properties (stationarity, ergodicity, correlation)

3.3. Spectral analysis, random process transformations

3.4. Special random processes used in modeling:

Gaussian, Poisson, Markov; applications

3.5. Introduction to Estimation

• ADDITIONAL REFERENCES •

Consult bibliographies in the recommended textbooks, especially books by **Davenport and Root**, **Drake**, **Feller**, **Parzen, and Wong**.

Some suggestions depending on your interests:

- If you need a refresher on **basic probability theory**:

  Clarke, A. B., and Disney, R. L., *Probability and Random Processes*, Wiley, 1985.

- If you are interested in **performance evaluation, discrete event systems, computer simulation, computer engineering** applications:

Cassandras, C.G., and Lafortune, S., *Introduction to Discrete Event Systems*, 3rd Edition, Springer, 2021.

Law, A.M., and Kelton, W.D., *Simulation Modeling and Analysis*, McGraw-Hill, New York, 1991.

Trivedi, K.S., *Probability and Statistics with Reliability, Queuing and Computer Science Applications*, Prentice-Hall, 1982.

- If you are interested in **signal processing and communication** applications:

Stark, H., and Woods, J.W., *Probability, Random Processes, and Estimation Theory for Engineers*, Prentice Hall, 1986.

Schwartz, M., and Shaw, L., *Signal Processing*, McGraw Hill, 1983.

Proakis, J., *Introduction to Digital Communications*, McGraw Hill,, 1983.

- If you are interested in **more advanced theoretical material** on random processes:

Asmussen, S., *Applied Probability and Queues*, Wiley, 1987.

Parzen, E., *Stochastic Processes*, Holden-Day, 1962.

Wong, E., and Hajek, B.*Stochastic Processes in Engineering Systems*, Springer-Verlag, 1971.