

Probability Theory for Financial Applications

The Pre-MFE Program at Baruch College

January 31 - March 27, 2012

The seminar addresses fundamental concepts of (calculus based) undergraduate probability that are most relevant for a smooth transition to Baruch MFE program. Special attention will be paid to (1) probabilistic ideas, language, and notation; (2) examples and models that are relevant to financial engineering.

Probabilistic topics (selected):

- Discrete Distributions.
- Continuous Distributions.
- Computation of Expectations, Variances, and Generating Functions.
- Joint distributions.
- Conditional Distributions and Conditional Expectations.
- Laws of Large Numbers.
- Central Limit Theorem.

Financial topics (selected):

- Binomial Asset Pricing Model.
- Risk and Expected Return of a Portfolio.
- Black-Scholes Model.
- Risk-Neutral Probabilities.
- Options Pricing.
- Monte-Carlo Simulation.

Dates and Times:

Lectures: January 31, February 7, 14, 21, 28, and March 6, 13, 20, 6-10pm

Final Exam: Tuesday, March 27, 7-9pm

Instructor: Elena Kosygina, Faculty, Baruch College Financial Engineering Program

Tuition: \$1,450

Attending the seminar on Probability and passing the final exam meets the probability prerequisite for the Baruch MFE Program. Upon request, recommendation letters reflecting performance in the seminar will also be provided.

Registration: To register or to receive more information about the Pre-MFE Probability Seminar, send an email to baruch.mfe@gmail.com

Textbooks:

- Instructor's Notes
- *A Natural Introduction to Probability Theory* by Ronald Meester, Birkhauser, 2nd Edition, ISBN 978-3-7643-8723-5.

Prerequisites: Multivariable calculus and some previous exposure to probability (for example, a probability or statistics course previously taken).

Students should read in advance the following sections from the textbook:
Chapter 1, Sections 1.1 - 1.3 and do all exercises within the text for these sections and exercises 1.7.1-1.7.3 from Section 1.7.

Detailed Syllabus

Session 1:

- Random experiments. Events and Operations with them.
- Counting and Combinatorics.
- Probability Measure and its Properties.
- Conditional Probabilities.
- Independence of Events.

Financial Applications:

- Binomial Asset Pricing Model.
- Market Probabilities versus Risk-Neutral Probabilities.

Textbook Sections: Chapter 1 and Instructor's notes.

Session 2:

- Discrete Random Variables.
- Independence of Random Variables.
- Expectation. Variance. Generating Functions.

Financial Applications:

- Derivatives Pricing (Binomial Model).
- CreditRisk+ model.

Textbook Sections: Sections 2.1-2.3 and Instructor's notes.

Session 3:

- Random Vectors (discrete case).
- Covariance and Correlation.
- Conditional Distributions and Expectations (discrete case).

Financial Applications:

- Risk and Expected Return of a Portfolio.
- American Put Option.

Textbook Sections: Sections 2.4-2.6 and Instructor's notes.

Session 4:

- Random Walk and Counting.
- First Passage Times.
- Reflection Principle.

Financial Applications:

- Path-Dependent options.

- Binomial Model for Interest Rates.

Textbook Sections: Chapter 3 and Instructor’s notes.

Session 5:

- Probability density functions.
- Continuous Random Variables.
- Expectation.
- Random Vectors and Independence.
- Functions of Random Variables and Vectors.

Financial Applications:

- Most frequently used Continuous Distributions.
- Geometric Brownian Motion and Black-Scholes Model.

Textbook Sections: Sections 5.1-5.6 and Instructor’s notes.

Session 6:

- Distributions of the Sum, Minimum, and Maximum of several Random Variables.
- More about Expectation. Variance. Covariance and Correlation.
- Conditional Distributions and Expectations.
- Random Variables, which are neither Discrete nor Continuous (time permitting).

Financial Applications:

- Order Statistics.
- What are “fat tails” and where do they appear in practice?

Textbook Sections: Sections 5.7-5.10 and Instructor’s notes.

Session 7:

- Infinitely Many Repetitions. Sequences of i.i.d. Random Variables.
- Laws of Large Numbers.
- Central Limit Theorem.

Financial Applications:

- Monte-Carlo Simulation.
- Black-Scholes Model as a Limit of Binomial Models.

Textbook Sections: Chapter 4, Section 5.11, Sections 6.1-6.4, and Instructor’s notes.

Session 8:

- Random Number Generation.
- Simulation: Inverse Transformation Method.
- Simulation: Acceptance-Rejection Method.

Financial Applications:

- Sampling from Frequently Used Distributions.
- Pricing of Path-Dependent Options by Monte-Carlo Simulation.

Textbook Sections: Instructor’s notes.