

quantitative Finance

for Technology-Driven Investment Decisions



Syllabus

V 2025.01.25

Professor:

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Description

An introduction to the most important concepts used in quantitative finance. Students will learn to build practical financial models using MS Excel spreadsheets. Investment banks, hedge funds, and money managers make buy and sell decisions based on computational models. Computers can and do execute buy and sell orders in a completely automated fashion based on pre-programmed parameters. This course starts with the most basic, and most important, portfolio and investment models used to evaluate risk and identify profit opportunities. Using Excel, students will learn how to build these models themselves, and to understand the decision-making inputs used by professional investors. The course has a practical focus - how to analyze prices of stocks, bonds, options and other financial instruments using the types of computationally sophisticated tools in wide and use today.

Learning Objectives:

1. Attain and practice fluency with basic terms and concepts used in the financial industry, including: return metrics, interest rates, asset classes, market terms, and more.
2. Gain a design-level understanding of Markowitz Portfolio Theory (MPT), the Capital Assets Pricing Model (CAPM) and their underlying assumptions. Be able to apply these models to balance financial portfolios.
3. Familiarity with equity put and call options, their relationships to stocks, and their uses in hedging. Be able to translate a belief about the market into a structure of options positions. Understand the underlying assumptions of the Black-Scholes model, the “Greeks”, and be able to calculate Black-Scholes parameters for options contracts.
4. Apply the binomial model to price volatile assets
5. Attain hands-on practice and fluency with trading, market terms, and market behavior through the use of the Interactive Brokers Paper Trader system, which allows a class of students to participate in a simulated stock market.
6. Understand the following instruments and be able to use them to construct risk-optimal positions based on a well-engineered thesis:
 - a. Stocks
 - b. Bonds
 - c. Futures
 - d. Options
 - e. Alternate Asset Classes
7. Gain familiarity with alternate asset classes and financial transactions such as leveraged buyouts, bankruptcy, and mergers & acquisitions.
8. Understand fundamental concepts, behavior, and pricing of stocks, bonds, put & call options, and futures contracts.
9. Be able to understand and apply basic Information Theory (IT) to calculate doubling rate of wealth for a trading strategy that uses Kelly betting.
10. Express the value added (or *destroyed*) by machine learning in terms of information and dollars.

Problem Sets:

Problem sets are submitted in the form of Excel spreadsheets uploaded to Sakai before the start of the class when they are due. Because we discuss answers in class, late problem sets *will not* be graded.

Optional Textbook:

You don't need to buy this textbook but if you want a nice presentation of these concepts in book form, the text below has been helpful in years past:

Simon A. Benninga, *Principles of Finance with Excel*, 3rd Edition (2017)

The 2nd edition can be used for the course as well because most of the information is the same, although some of the chapters are numbered differently.

Excel skills are addressed in Benninga Chapters 24-29. You will be responsible throughout the course for the Excel material in Benninga Chapters 24, 26, and 28. Study any material that is new to you in those Chapters at the beginning of the semester.

Labs / Office Hours:

While there is no official lab for this course, office hours will be determined at the beginning of each semester. Students who wish to attend will receive guidance on problem sets, projects, or general financial questions / discussion.

Grading:

30% class participation and 5 problem sets

30% Midterm Exam

40% Final Exam

Tentative Course Schedule:

CLASS 1	<u>Introduction and Profitability Metrics</u>
CLASS 2	<u>Risk Metrics</u>
CLASS 3	<u>Data, Dividends, Splits, Risk-adjusted Return and the Sharpe Ratio, Capital Market Line & the Efficient Frontier, Alpha & Beta, the Efficient Market Hypothesis</u>
CLASS 4	<u>Continuation of topics + Bonds, Credit Ratings & Credit Risk</u>
CLASS 5	<i>Midterm Review</i>
CLASS 6	<i>Midterm Exam</i>
CLASS 7	<u>Trading Day: Execution Systems, Data Sources, Market Making, Strategies</u>
CLASS 8	<u>Introduction to Derivatives / No-Arbitrage Pricing Models</u>
CLASS 9	<u>The Black-Scholes Option Pricing Model</u>
CLASS 10	<u>Intro to Hedging & Binomial Option Pricing Model</u>
CLASS 11	<u>Trading Options Structures</u>
CLASS 12	<u>Alternative Assets</u>
CLASS 13	<u>Special Topics: Currently Information Theory & Kelly Betting, subject to change based on interest</u>

OPTIONAL CLASS

Final Exam Review (optional, as classes are officially ended at this point)

FINAL

FINAL EXAM, date & time as posted in DukeHub