Course Description

Financial markets are characterized by continuous innovation, evolving risk management techniques, and increasingly powerful computational capabilities. In this course, we discuss financial models and computational methods that help solve problems which appear every day in the financial markets. Examples of such problems are pricing and hedging techniques for equity derivatives, hedging and risk management, short and long term portfolio optimization, interest rate models and interest rate derivatives, credit sensitive securities, volatility estimation, etc. We use a hands-on approach and apply the financial models and the computational methods to real-world problems. We focus on the context in which the financial models and the computational methods are applicable, and highlight their limitations. We also have a number of distinguished professionals give guest lectures on different aspects of modern day finance, as practiced in leading institutions.

Course Outline (Tentative)

- **Hedging.** Statistical models for risk management and hedging.

- **Single & Multi-Period Portfolio Optimization.** Asset allocation and portfolio optimization over short and long term investment horizons.

- **Treasury Yield Curve.** Statistical analysis and modeling of the evolution of interest rates.

- **Interest-Rate Models.** Models for the pricing of interest-rate sensitive securities, including single factor models (e.g. Ho-Lee, Black-Derman-Toy) and multi-factor models (e.g. Heath-Jarrow-Morton). Model calibration to market data, and applications including the pricing of caps, floors, swaptions, callable bonds, mortgage-backed securities, and other interest-rate sensitive securities.

- **Numerical Option Pricing.** Models and computational techniques for pricing and hedging of equity options in the Black-Scholes framework, including exotic derivatives (e.g. path-dependent options) and, possibly, multi-asset options (e.g. spread, out-performance, and basket options).

- **Beyond Black-Scholes.** Deviations of real markets from the assumptions of the Black-Scholes framework. Extensions of the Black-Scholes framework.

- **Structured Option Portfolios.** Investing in and hedging options portfolios in practice.
• **Pricing Credit-Sensitive Securities.** Introduction to the pricing and hedging of credit sensitive securities (e.g. credit default swaps).

**Recommended Background**

For the discussion of the topics in the course, we assume familiarity with:

(a) probability and statistics (at the level of B6100 Statistics);
(b) elementary optimization and simulation (at the level of B6101 Business Analytics);
(c) basic concepts in fixed income (at the level of B8308 Debt Markets);
(d) basic concepts in options.

Good review reading material for the course may be found in the textbooks:

• J. C. Hull, *Options, Futures, and Other Derivatives*, Prentice Hall;

For the homework assignments (see below), we assume:

(e) proficiency with Excel, including its Solver (the built-in optimizer);
(f) sufficient knowledge, or willingness to acquire sufficient knowledge, of Visual Basic (VBA);
(g) or, working knowledge of any other software environment that allows for financial calculations and completion of the homework assignments.

Links to free VBA books can be found in the Columbia Library Books 24x7. Alternatively, a useful book on VBA is:


**Grading**

The grade for the course is based on homework assignments, a final exam, and in-class participation; there is no mid-term exam. Homework assignments count for 50% of the final grade. The final exam counts for 40% of the final grade. In-class participation counts for 10% of the final grade. There are approximately 4-5 homework assignments. Students may work on the homework assignments in groups of up to three students per group. It is highly recommended that students first work on their own on all the problems in the homework assignments, and then confer with the other members of the group to check results, discuss difficulties, and/or resolve discrepancies. The homework assignments and the final exam are intended to be relevant, applicable and instructive. Students are expected to spend a significant amount of time *outside of the lectures* to digest the material, complete the homework assignments, and prepare for the final exam.