MTH 490/590 — Mathematical Models in Finance
Fall Semester 2006

Time and Place: MW 3:00-4:15pm, SC 306
Instructor: Dr. Ruihua Liu
Office: SC 105C
Phone: 229-1021
Email: Ruihua.Liu@notes.udayton.edu
Web Page: http://academic.udayton.edu/ruihuailiu/
Office Hours: MTWF 10:00-11:50am, walk-ins or appointments

Course Description: Mathematical models have been playing an increasingly important role in finance. Quantitative analysis based on mathematical models produces accuracy and rigor to financial market and is becoming an indispensable part in modern finance. As the pace of financial innovation increases, the need for well trained people in this field intensifies.

This course is intended for those junior/senior and graduate students who have a solid mathematical background and are interested in learning mathematical models in finance. It provides an introduction to commonly used mathematical models and computational methods associated with these models. The topics covered include stock price models, interest rate models, bond pricing, option pricing, optimal portfolio selection and/or credit risk models.

Course Objectives: (1) well understand the models, both mathematically and financially; (2) be able to use computer to compute quantities based on the models; (3) get experience of using market data to fit models; (4) gain confidence in the ability of handling more complicated problems in the future; (5) be encouraged to pursue further study by tackling more advanced subjects, from both practical and theoretical perspectives.

Prerequisite: Intended students should have solid background on calculus and on probability (successfully completed the calculus sequence (MTH 168, 169, 218) and a probability/statistics course). Knowledge in differential equations and linear algebra are also needed. Since computer is used for most computation, the students must know at least one of the following computer languages: Excel/VBA, MatLab, C, C++, Java. Knowledge of finance is definitely a plus.

Methodology: This course is run by a combination of lecture, discussion, presentation, self-studying and projects. Being willing to face challenge and being active are very important in this course.

Textbook: No specific textbook is used. In addition to lectures, research papers and excerpts from reference books are distributed for studying. Students are also asked to search through internet, library, or other resources for related materials.

Reference Books:
- Options, Futures, and Other Derivatives, John C. Hull (most recent edition: 6th), Prentice Hall.
- Investments, Bodie, Kane & Marcus, (most recent edition: 6th), McGraw-Hill.
Plan of Topics:

**Part 1. Stock Price Model**
- Fundamental: discrete tree model, continuous-time constant Geometric Brownian Motion (GBM) model.
- Advanced: models including stochastic jumps and/or stochastic volatility.

**Part 2. Bond Pricing and Interest Rate Model**
- Fundamental: bond pricing, yield curve, one-factor interest rate models.
- Advanced: Heath-Jarrow-Morton (HJM) model and Multi-factor interest rate models.

**Part 3. Option Pricing**
- Fundamental: option pricing based on the constant GBM model (Black-Scholes-Merton formula, trees, Monte-carlo simulation, finite difference method.)
- Advanced: option pricing based on advanced models, bond option pricing.

**Part 4. Optimal Portfolio Selection**
- Fundamental: Markowitz’s method.
- Advanced: open

**Part 5 (optional). Introduction to Credit Risk Models**

**Evaluation:** Four projects will be assigned during the semester. A project may consist of mathematical derivation, data collection and computer computation. Students are required to submit a report for each project. They are also required to give a presentation to the end of the semester (Topic of the presentation can be based on either a project or a research article). Evaluation is based on the projects and the presentation. There is no written examination.

**Grading:** 92% — Four projects, 23% for each; 8% — Presentation.

\[
90 \leq A \leq 100, \quad 75 \leq B < 90, \quad 60 \leq C < 75, \quad F < 60.
\]

Finally, if you have any thoughts, new ideas or questions about this course, feel free to talk to me. This is a new course offered for the first time in this semester. I am expecting to use this wonderful opportunity to work with you on the challenging but very interesting topics in financial mathematics.

Subject to change