

**OR649 Topics in Operations Research**  
**-- Financial Engineering**  
Spring 2009

George Mason University  
Department of Systems Engineering and Operations Research

Monday 4:30 – 7:10pm,  
Innovation Hall, Room 208

**Instructor:** Yifan Liu

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Office Hour: Wednesday 4:00-6:00pm, or by appointment

**TA:** None

**Course Summary:** This course is an introduction to financial engineering. It will cover the following topics:

1. Different types of Interest rates, Net Present Value of cash flows;
2. Basic types of derivatives, such as forward contract, call and put options;
3. Arbitrage, No-arbitrary theory;
4. Binomial tree and Risk-neutral probability;
5. Brownian motion and Ito's formula;
6. Black-Scholes Equation and Black-Scholes formula;
7. Greek-letter hedging;
8. Exotic Options;
9. Numerical methods for option pricing, such as Binomial tree and Monte Carlo simulation;
10. Volatility Estimation;
11. Interest rate models, such as Hull-White, CIR, Vasicek, etc.

*While mathematics is indispensable in financial engineering, the course will try best to focus on the concepts and ideas of finance, while limiting the math within a scope acceptable to most students in engineering. For example, the famous Girsanov Theorem, which requires strong background in measure theory, will NOT be covered in this course.*

**Prerequisites:** Calculus and Probability Theory at undergrad level, and some basic computer programming skills. Some background in stochastic process would be better, but not required, since the course will cover some basic knowledge of stochastic calculus needed in financial engineering, such as Brownian motion and Ito's formula.

**Textbooks:**

**Required:** None;

**Highly Recommended:**

1. John. C. Hull, "Options, Futures, and Other Derivatives"; 4<sup>th</sup> or later editions;

**Recommended:**

2. Salih N. Neftci, “*Principles of Financial Engineering*”
3. Mark S. Joshi, “*The concepts and practice of mathematical finance*”;
4. David G. Luenberger, “*Investment Science*”;
5. Martin Baxter and Andrew Rennie: “*Financial Calculus: An Introduction to Derivative Pricing*”
6. Steven E. Shreve, “*Stochastic Calculus for Finance II, Continuous-Time Models*”  
(This book is for those with strong math background.)

Detailed lecture notes will be handed out in each lecture, which is basically a simplified version of the related chapters of the recommended books.

**Course Website:** All course material will be posted on <http://courses.gmu.edu>.

**Tentative Course Schedule** (subject to slight change, depending on the pace of the course)

<b>Date</b>	<b>Topic</b>
1/26	Different types of Interest rates, Net Present Value of cash flows;
2/2	Basic types of derivatives, such as forward contract, call and put options;
2/9	Arbitrage, No-arbitrary theory;
2/16	Binomial tree and Risk-neutral probability;
2/23	Brownian motion, Stochastic calculus and Ito's formula;
3/2	More on Stochastic Calculus, Black-Scholes model
3/9	<b><i>Spring Break, No Class</i></b>
3/16	Black-Scholes equation and Black-Scholes formula;
3/23	<b>Midterm Exam</b>
3/30	Greek-letter hedging;
4/6	Exotic Options
4/13	Numerical methods (Binomial tree, Monte Carlo simulation)
4/20	Volatility Estimation;
4/27	Interest rate models (I)
5/4	Interest rate models (II)
5/11	<b>Final Exam</b>

**Grading:**

**Homework: 20%.** There will be 6 homework sets, assigned about once every two weeks. The lowest homework score will be dropped, and the other 5 will each count 4% towards the grading. Homework 5 and 6 will require some computer programming, preferably in Matlab, but other languages are also acceptable.

**Midterm: 40%.** Monday, 3/23, class time, open book, open notes, **NO** computer allowed (calculator OK).

***Final Exam: 40%***. Monday, 5/11, 4:30-7:15pm, open book, open notes, **NO** computer allowed (calculator OK). Final exam will be mainly based on the part not covered in the mid-term, but may use some of the knowledge learned in the first half of the semester.

Make-up exams will only be given for extreme situations (religious reasons, family emergency, sickness, conference or business trips, etc.), and only if the instructor is contacted before the exam is given and full arrangements are established.