ADVANCED DERIVATIVES (MFE), FALL 2013

Professor:
Anders B. Trolle, anders.trolle@epfl.ch. Office: Extranef 216.

Assistant:
Remy Praz, remy.praz@epfl.ch. Office: Extranef 128.

Office hours: Thursdays 12:00-13:00.

***Content*:**
The course covers a list of advanced topics in derivative securities such as stochastic volatility, jumps, pricing of vanilla options by Fourier inversion techniques, numerical methods including finite difference methods and pricing of American-style options by simulation, exotic derivatives, structured products, volatility derivatives, and term structure modeling with unspanned stochastic volatility.

Prerequisites:
Students must have taken basic derivatives and stochastic calculus courses. There will be an emphasis on implementation of models and numerical methods. Therefore, the course requires familiarity with a software package that can be used for numerical computation. I prefer MATLAB and I will present and distribute various MATLAB programs as we go along. However, students are free to use any software package they prefer.

Course material*:*
The main textbook for the course is: Jim Gatheral, The Volatility Surface, Wiley, 2006.

The first printing of the book contained quite a few typos, a list of which is available here: `http://faculty.baruch.cuny.edu/jgatheral/BookErratum.pdf`.
I believe the second recent printing of the book corrects most of these typos.

In addition, I will use a number of journal articles, which will be posted on the course website. I will also make slides and sample MATLAB programs available on the course website.

Class participation and seating arrangements:
Class participation and discussion are essential to learning. Participation in the class will not be explicitly graded, but I will keep track of who participates and who doesn't, and this information will be used in determining grades in the borderline cases. To help me keep track of who you are, I would like you to sit in the same seat each class. Please choose your preferred seat during the second class session.

Requirements and grading*:*
There will be weekly mandatory assignments, which can be done in groups of up to three people. Two types of assignments are given: 1) Practical assignments that involve implementing models and methods covered in class 2) Theoretical assignments that will help you understand the material and prepare for the final exam. No late assignments will be accepted.

There will also be a final exam, which is closed-book, closed-notes. However, you are permitted to bring a calculator.

In calculating the grade for the course, the combined weight on assignments given during the course will be 40% and the weight on the final exam will be 60%.

***Course website**:*
`http://moodle.epfl.ch/course/view.php?id=6311`. Enrolment key will be provided at the first lecture.

Preliminary course outline:

Lecture 1: Equity derivatives
Properties of asset returns, implied volatility surfaces, the general stochastic volatility setting

Readings: The Volatility Surface chapter 1 (p. 1-7)

Lecture 2: Equity derivatives (cont.)
The Heston model, calibration to volatility surfaces

Readings: The Volatility Surface chapters 2 and 3 (p. 36-42), Heston (1993) A Closed-Form Solution for Options with Stochastic Volatility with Applications to Bond and Currency Options, and Mikhailov and Nogel (2003) Heston's Stochastic Volatility Model Implementation, Calibration and Some Extensions

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Lecture 3: Equity derivatives (cont.)
Adding jumps, the Merton and Bates models

Readings: The Volatility Surface, chapter 5

Lecture 4: Equity derivatives (cont.)
The Carr-Madan approach to pricing, the Fast Fourier Transform, the empirical performance of stochastic volatility jump diffusion models, the SABR model

Readings: The Volatility Surface p. 91-93, Carr and Madan (1999) Option Valuation Using the Fast Fourier Transform, and Broadie, Chernov, and Johannes (2007) Model Specification and Risk Premium. Evidence from Futures Options

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Lecture 5: Equity derivatives (cont.)
Volatility surface asymptotics, local volatility, and implied binomial trees.

Readings: The Volatility Surface chapter 1 (p. 7-14) and 7 (p. 89-94), Derman and Kani (1994) The Volatility Smile and its Implied Tree

Lecture 6: Numerical procedures
Pricing derivatives by simulation

Readings: Boyle, Broadie, and Glasserman (1997) Monte Carlo Methods for Security Pricing and Lord, Koekkoek, and Dijk (2006) A Comparison of Biased Simulation Schemes for Stochastic Volatility Models

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Lecture 7: Numerical procedures (cont.)
Pricing American-style derivatives by simulation

Readings: Longstaff and Schwartz (2001) Valuing American Options by Simulation, A Simple Least-Squares Approach.

Lecture 8: Numerical procedures (cont.)
Finite difference methods

Readings: Munk (2007) Introduction to the Numerical Solution of Partial Differential Equations in Finance

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Lecture 9: Exotic equity derivatives
Structured products, forward starting options, cliquets, reverse cliquets, Napoleons, model risk

Readings: The Volatility Surface chapter 10

Lecture 10: Volatility derivatives
Variance swaps, volatility swaps, options on variance, VIX derivatives, the volatility risk premium

Readings: The Volatility Surface chapter 11 and Carr and Wu (2009) Variance Risk Premia

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Lecture 11: Interest rate derivatives
Unspanned stochastic volatility, pricing of caps and swaptions

Readings: Casassus, Collin-Dufresne, and Goldstein (2005). Unspanned Stochastic Volatility and Fixed Income Derivatives Pricing and Trolle and Schwartz (2013) The Swaption Cube

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Lecture 12: Commodity derivatives
The convenience yield, unspanned stochastic volatility, pricing of futures and options, real options

Readings: Trolle (2013) Efficient Pricing of Energy Derivatives

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Final exam in class