

# ***MATHEMATICAL FINANCE AND DERIVATIVES (part II, PhD)***

**Lecturer:** Prof. Dr. Marc CHESNEY

**Location:**

**Time:** Mon. 08:00 – 09:45

**First lecture:** 16.02.2009

**Language:** English

## **Contents:**

- Stochastic volatility models and time changed Brownian motions
- Tanaka's Formula and applications to Finance
- Itô's formula and Girsanov theorem for jump-diffusion processes
- The pricing of options in presence of possible discontinuities
- Exotic options
- Real options

## **Description of the course:**

The course focuses on the theoretical foundations of modern derivative pricing. It aims at deriving option pricing models by relying on the main mathematical tools of continuous time finance. A particular focus on jump processes is given. The introduction of possible financial crashes is now essential in some models and a clear understanding of Poisson processes is therefore important. A standard background in stochastic calculus is required.

The last part of the course covers real options. Basic and recent models will be presented. These include the introduction of competition and incomplete information into the real options framework. The use of the Real Options approach in Environmental Finance will also be presented.

**Grades:** The final grades will be based on a written or oral examination.

## **Literature:**

### **BOOKS**

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**Levy Processes**  
Cambridge University press, 2005
2. CONT R. and P. TANKOV  
**Financial Modelling with Jump Processes**  
Chapman & Hall, 2004.
3. DANA, R.A. and M. JEANBLANC  
**Marchés financiers en temps continu, valorisation et équilibre**  
Economica, 1994.
4. DIXIT A. and R. PINDYCK  
**Investment under Uncertainty**  
Princeton University Press, 1994.

5. DUFFIE D.  
**Dynamic Asset Pricing Theory**  
Princeton University Press, 2001
6. DUMAS B. and B. ALLAZ  
**Les Titres Financiers : Equilibre du Marché et Méthodes d'Evaluation**  
P.U.F., 1995.
7. ELLIOTT R. and E. KOPP  
**Mathematics of Financial Markets**  
Springer Finance, 2004.
8. HULL J.  
**Options, Futures and Other Derivative Securities**  
Prentice Hall, 2000.
9. JARROW R.A.  
**Finance Theory**  
Prentice Hall, 1988.
10. KARATZAS I. and S. SHREVE  
**Brownian Motion and Stochastic Calculus**  
Springer Verlag, 1988.
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Chapman & Hall, London, 1996
12. MERTON R.  
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Basic Blackwell, 1990.
13. REVUZ D. and M. YOR  
**Continuous Martingale and Brownian Motion**  
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**Growth Options and Strategy Analysis**  
Erasmus University Rotterdam, 1996.
15. SANDMANN K.  
**Einführung in die Stochastik der Finanzmärkte**  
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16. TRIGEORGIS L.  
**Real Options**  
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**Derivatives : The Theory and Practice of Financial Engineering**  
John Wiley, 2000.

## ARTICLES

1. BARONE-ADESI G. and R. WHALEY,  
**Efficient analytic approximation of American option values**  
*Journal of Finance*, 42:301-320, 1987.
2. BATES D.S.  
**The Crash of 87; was it expected ? The evidence from options markets**  
*The Journal of Finance*, 46:1009-1044, 1991.
3. BELLAMY N. and M. JEANBLANC  
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*Finance and Sto.*, 4:209-222, 1999
4. BRENNAN, M.J. and E.S. SCHWARTZ,  
**Evaluating Natural Resource Investments,**  
*The Journal of Business* 58,  
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5. CARR P., K. ELLIS and V. GUPTA  
**Static hedging of path dependant options**  
*Journal of Finance*, 53:1165-1190, 1998.
6. CARR P., H. GEMAN, D. MADAN and M. YOR  
**Stochastic Volatility for Lévy Processes**  
*Mathematical Finance*, 13:345-380, 2003.
7. CARR P., R. JARROW and R. MYNENI  
**Alternative Characterization of American Put Options**  
*Mathematical Finance*, 2:87-105, 1992.
8. CARR P. and L. WU  
**Time-changed Lévy Processes and Option Pricing**  
*Journal of Financial Economics*, 17:113-141, 2004.
9. CHESNEY M., and L. GAUTHIER  
**American Parisian Options ,**  
*Finance and Stochastics* , 10-475-506, 2006
10. CHESNEY M., and M. JEANBLANC  
**Pricing American Currency Options in an Exponential Lévy Model**  
*Applied Mathematical Finance*, 11: 207-225, 2004

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**The Endogeneous Price Dynamics of Emission Allowances and an Application to CO2 Option Pricing**  
Working paper, University of Zurich, 2008
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*Journal of Political Economy*, 620-638, 1989.
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**Options exotiques**  
*Finance*, 20:49-67, 1999.
17. FEHR, M. and J. HINZ  
**A Quantitative Approach to Carbon price risk modeling**,  
Institute of Operations Research, ETH, Zurich, 2006
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**Foreign Currency Option Values**  
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**On the discounted penalty at ruin in a jump-diffusion and the perpetual put option**  
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28. MERTON R.  
**Option Pricing when underlying stock returns are discontinuous**  
*Journal of Financial Economics*, 3:125-144, 1976.
29. MORDECKI E,  
**Optimal stopping for a diffusion with jumps**  
*Finance and Sto.*, 3:227-236, 1999.
30. PAOLELLA, M. and L. TASCHINI,  
**An Econometric Analysis of Emission Allowances Prices**  
Forthcoming *Journal of Banking and Finance*
31. PAWLINA G. and P. KORT,  
**Real options in an asymmetric duopoly: Who benefits from your competition,**  
*Journal of Economics and Management Strategy*, 15: 1–35, 2006
32. PHAM H.  
**Optimal stopping free boundary and American option in a jump diffusion model**  
*Applied Math. and optim.*, 35:145-164, 1997.
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**The mathematical foundations of barrier option-pricing theory**  
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*Journal of Financial and Quantitative Analysis*, 22:419-438, 1987.
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**Option values under stochastic volatility: theory and empirical estimates**  
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