PARTIAL DIFFERENTIAL EQUATIONS IN FINANCIAL MATHEMATICS MTH 890–002 FALL 2012

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Lectures: Monday, Wednesday 8:30-9:50, A216 Wells Hall.

Office hours: My office is at the Mathematics Department in the Wells Hall, Room D310. I have office hours on Mondays, and Wednesdays from 10:15 AM–11:15 AM, or by appointments.

Course description: In 1997 the Nobel Prize in Economics was awarded to Robert Merton and Myron Scholes for developing a new method to determine the value of financial derivatives. Merton and Scholes have, in collaboration with the late Fischer Black, developed a pioneering formula, known as the Black-Scholes formula, for the valuation of option on stocks. The goal of the course is to give a graduate level introduction to their work, and to the field of financial mathematics. Financial mathematics is a very influential, vibrant, and very exciting area of mathematics! We will discuss the Black-Scholes method, Brownian motion, stochastic differential equations, parabolic equations, the Black-Scholes partial differential equations, European options, American option as a free boundary value problem, exotic options, barrier options, path-dependent options, Asian options. If we will have time we will also discuss some aspects of portfolio optimization, dynamic programing, Hamilton-Jacobi-Bellman equations.

The goal of the course is to introduce the students to those aspects of partial differential equations that are most relevant for financial mathematics. The course will also concentrate on the applications of partial differential equations in modern financial mathematics.

Outline of the major topics: (1) Partial differential equations: Linear parabolic equations, fundamental solution, boundary value problems, maximum principle, Fourier transformation method, free boundary value problems. Dynamic programing and optimal control, Hamilton-Jacobi-Bellman equations. (2) Application to financial mathematics: Black-Scholes partial differential equations, European and American options, boundary conditions, free boundary conditions. Exotic options, barrier options, path-dependent options, Asian options. Portfolio optimization.

Textbooks:

[1] Wilmott, Howison, Dewynne: The Mathematics of Financial Derivatives: a Student Introduction, Cambridge University Press, 1995.

[2] S. Shreve, Stochastic Calculus for Finance II, Springer, 2004.

Recommended Textbooks:

[3] R.L. McDonald, Derivatives Markets, Addison Wesley, 2nd edition, 2006.

[4] J.C. Hull, Options, Futures and Derivatives, Prentice Hall, 7th edition, 2008.

[5] L.C. Evans, An introduction to stochastic differential equations (online).

Grading will be based on homework assignments.