Partial Differential Equations for Finance
G63.2706, Spring 2011
Some Relevant Books

The following books may be helpful. Note that some are more advanced than this class, and many cover lots of material that's not in this class. Some books exist in more than one edition; in those cases, an old edition is just as good as a new one.

Stochastic calculus, backward and forward Kolmogorov eqns

- C.W. Gardiner, *Handbook of Stochastic Methods for Physics, Chemistry, and the Natural Sciences*, Springer-Verlag. No financial applications here – the book is aimed at applications in the physical sciences. But its heuristic, not-overly-rigorous style is a lot like this course, making it a useful reference for stochastic differential equations, backward and forward Kolmogorov equations, and their applications.

- S. Neftci, *An introduction to the mathematics of financial derivatives*, Academic Press. Includes the stochastic calculus prerequisites for this class, presented in an accessible non-rigorous fashion.

- B.K. Oksendal, *Stochastic differential equations: an introduction with applications*, Springer-Verlag. A PhD-level discussion of SDE (much deeper than this class). In discussing the backward and forward Kolmogorov equations, optimal stopping, etc, I will sometimes give watered-down versions of material from this book.

- S. Shreve, *Stochastic Calculus for Finance II: Continuous Time Models*, Springer-Verlag. An integrated treatment of stochastic calculus and option pricing. The mathematical level is deeper than this class. Includes jump processes, but not stochastic control.

- J. Michael Steele, *Stochastic Calculus and Financial Applications*, Springer-Verlag. Deeper than this class but more accessible than Oksendal. Uses measure-theoretic probability, but always explains the main idea before addressing the nitty-gritty details – making the book delightful reading for those with sufficient background. The short chapter on diffusion equations (Chapter 11) is independent of the rest of the book and about at the level of the PDE part of this class.

Partial differential equations

- L.C. Evans, *Partial Differential Equations*, American Math Society. This is a standard graduate text on partial differential equations. But be warned: the parts relevant to this class – concerning the linear heat equation, and concerning Hamilton-Jacobi equations – are just a small portion of the book.

- F. John, *Partial differential equations*, Springer-Verlag. Another standard graduate-level text on PDE's. Same caveat as above: the part relevant to this class (on the linear heat equation) is just a small portion of the book.

- W. Strauss, *Partial Differential Equations; an Introduction*, John Wiley & Sons. This is a standard undergraduate text on partial differential equations. More basic than Evans or John, but same caveat: the material on the linear heat eqn accounts for just a small part of the book.

- P. Wilmott, S. Howison, and J. Dewynne, *The mathematics of financial derivatives: a student introduction*, Cambridge Univ Press. This book avoids almost all discussion of diffusion processes associated with option pricing, focusing instead as much as possible on the associated PDE's. Relatively easy to read; it goes much further than this class on numerical approximation schemes, American options, and some other PDE-related topics.

Stochastic control

- D. Bertsekas, *Dynamic Programming and Optimal Control*, Athena Scientific. Mainly discrete-time dynamic programming. There's little finance here, but lots of perspective on the power and scope of this method.

- F.-R. Chang, *Stochastic Optimization in Continuous Time*, Cambridge University Press. Correlates well with the stochastic control part of this class. Also includes a good introduction to stochastic calculus.

- R. Korn and E. Korn, *Option Pricing and Portfolio Optimization: Modern Methods of Financial Mathematics*, American Mathematical Society. An integrated discussion of stochastic control and option pricing. The mathematical level is more advanced than this class.

- R.C. Merton, *Continuous Time Finance*, Blackwell. Our discussions of several topics (especially options on underlyings with jumps, and portfolio optimization) will draw on Merton's classic work.