Partial Differential Equations for Finance
MATH-GA 2706, Spring 2015
Some Relevant Books

The following books may be helpful. They'll all be on reserve in the CIMS library. Note that many of them are more advanced than this class, and most cover lots of material that's not in this class. You need not buy any of them. But if you're considering acquisitions: the two with the strongest correlation to this class (in level and scope) are probably Chang (available for free online) and Guenther & Lee (an inexpensive Dover book).

Stochastic calculus, backward and forward Kolmogorov eqns

- F.-R. Chang, *Stochastic Optimization in Continuous Time*, Cambridge University Press. Excellent book, at about the same level as this class. The first chapters provide a good introduction to stochastic calculus. Downloadable through Bobcat.
- 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. 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.
- 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.

Partial differential equations

- R. Guenther and J. Lee, *Partial Differential Equations of Mathematical Physics and Integral Equations*, Dover, 1996. An excellent text, at about the same level as this class. Also a great value (under $20).
- W. Strauss, *Partial Differential Equations; an Introduction*, John Wiley & Sons. This is a standard undergraduate text on partial differential equations. More basic than Guenther & Lee, and much more expensive.

- L.C. Evans, *Partial Differential Equations*, American Math Society. This is a standard graduate text on partial differential equations. Includes the relationship between optimal control and "viscosity solutions" (a topic that's relevant to this class, but deeper). More advanced than Guenther & Lee, and much more expensive.

- P. Wilmott, S. Howison, and J. Dewynne, *The mathematics of financial derivatives: a student introduction*, Cambridge Univ Press. This book avoids almost entirely the connections between probability, PDE, and option pricing. So its spirit is almost opposite from that of this class. But for those with a PDE background, the book is relatively easy to read. It goes much further than we will on numerical approximation schemes, American options, and some other PDE-related topics.

Stochastic control

- F.-R. Chang, *Stochastic Optimization in Continuous Time*, Cambridge University Press. Already listed under "stochastic calculus," but repeated here since its main focus is stochastic control. This is an excellent book, at about the same level as this class. Includes many examples (though the emphasis is more on economics than finance). Downloadable through Bobcat.

- D. Bertsekas, *Dynamic Programming: Deterministic and Stochastic Models*, Prentice Hall 1987. There's little finance here, but lots of perspective on the power and scope of dynamic programming.

- R. Korn and E. Korn, *Option Pricing and Portfolio Optimization: Modern Methods of Financial Mathematics*, American Mathematical Society. An integrated discussion of portfolio optimization and option pricing. The mathematical level is somewhat 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.

Underlyings with jumps

- Rama Cont and Peter Tankov, *Financial modeling with jump processes*, Chapman and Hall. We'll have time for at most one lecture concerning underlyings with jumps. If you want to learn more, this book provides an accessible survey.