Partial Differential Equations for Finance
G63.2706, Spring 2003
Reserve List

I'm providing two separate lists: first, some books that are more or less at the level of this class; then some that are more advanced than this class. I don't recommend buying *any* of these books for this class alone. But MS-level students of mathematical finance will probably find Merton and Wilmott-Howison-Dewynne well worth owning (both are inexpensive paperbacks).

Except for Dixit and Pindyck, all the books in both lists are on reserve in the CIMS library.

Books roughly at the level of this class.

- C.W. Gardiner, *Handbook of Stochastic Methods for Physics, Chemistry, and the Natural Sciences*, Springer-Verlag 1985. 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.

- R.C. Merton, *Continuous Time Finance*, Blackwell, 1992. Our discussions of several topics (stochastic optimal control, portfolio optimization, options on underlyings with jumps) will draw on Merton's classic work.

- S. Neftci, *An introduction to the mathematics of financial derivatives*, Academic Press, 1996. (A second edition was published recently, it contains everything from the first edition, plus some new material.) Chapters 9-11 cover roughly the stochastic calculus prerequisites to this class. There's relatively little about PDE's here.

- L.C. Evans, *Partial Differential Equations*, American Math Society, 1998. 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 – is just a small part of the book.

- F. John, *Partial differential equations*, 4th edition, Springer-Verlag. Another standard graduate-level text on PDE's. The usual caveat: the part relevant to this class (on the linear heat equation) is just a small portion of the book.

- Jack Macki and Aaron Strauss, *Introduction to optimal control theory*, Springer-Verlag. Discusses deterministic optimal control (not stochastic optimal control), mainly with reference to applications in the physical sciences. Therefore it has only tangential relevance to this class.

- W. Strauss, *Partial Differential Equations; an Introduction*, John Wiley & Sons, 1992. This is a standard undergraduate text on partial differential equations. Same caveat as Evans and John: the part relevant to this class – concerning the linear heat equation – represents just a small portion of the book.

- P. Wilmott, S. Howison, and J. Dewynne, *The mathematics of financial derivatives: a student introduction*, Cambridge Univ Press, 1995. 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.

- P. Wilmott, *Derivatives*, John Wiley & Sons, 1998. Longer and deeper than the Wilmott-Howison-Dewynne book, but it has the same strong bias toward PDE (away from risk-neutral pricing). Just a few relatively short sections are directly relevant to this class.

Books more advanced than this class.

- Dimitri Bertsekas, *Dynamic programming: deterministic and stochastic models*, Prentice-Hall, 1987. No PDE here either, and very little finance. But the early chapters give some enlightening examples of discrete-time dynamic programming.

- A. Dixit and R. Pindyck, *Investment under Uncertainty*, Princeton University Press, 1994. Applies dynamic programming to financial decision-making. The sections on "mathematical background" may be helpful, though this book's focus (mainly economics) is quite different from ours (mainly option pricing and hedging). (Another book on dynamic programming with a focus on economics applications is A. Chiang, *Elements of Dynamic Optimization*, McGraw Hill, 1992.)

- W. Fleming and R. Rishel, *Deterministic and stochastic optimal control*, Springer-Verlag, 1975 (reprinted with corrections recently). A little out of date (e.g. predates viscosity solutions) but still a classic treatment of optimal control.

- I. Karatzas and S. Shreve, *Brownian Motion and Stochastic Calculus*, Springer-Verlag, second edition, 1991. Harder to read than Oksendal, but includes some valuable topics not found there.

- R. Korn and E. Korn, *Option Pricing and Portfolio Optimization: Modern Methods of Financial Mathematics*, American Math. Society. I haven't actually seen this yet, so I can't comment on it.

- B.K. Oksendal, *Stochastic differential equations: an introduction with applications* (5th edition, paper) Springer-Verlag, 1998. A great book, well worth reading if you have the background. Some of my lectures on the backward and forward Kolmogorov equations, optimal stopping, etc. are watered-down versions of material from here.

- J. Michael Steele, *Stochastic Calculus and Financial Applications*, Springer-Verlag, 2001. The most accessible book in this list. Steele uses measure-theoretic probability, with rigorous proofs; but he 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 this class.