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A First Course in Stochastic Calculus
By Louis-Pierre Arguin
(AMSTEXT/53, 2022)

Stochastic Calculus is a beautiful mathematical theory developed in the mid-twentieth century that extends methods of calculus from an analysis of deterministic functions to random functions, or stochastic processes, such as Brownian motion. The field plays a pivotal role in mathematics, statistics, and probability theory and has applications in myriad areas, such as in theoretical physics, data science, and financial mathematics, where random processes play a central role.

In A First Course in Stochastic Calculus, Arguin brings together the essentials of the theory in a friendly, concise way with a focus on building an intuitive, rigorous, and practical understanding. In the first half of his book, he develops the foundations of stochastic calculus with a presentation of Brownian motion, Martingale and Markov processes, Itô’s calculus, methods of random sampling, and the Monte-Carlo method. Along the way, he builds geometric intuition, for example, emphasizing the spaces of random variables, and promotes practical understanding and facility with useful tools by providing plentiful examples, numerical experiments, and computer-based exercises. Chapters 7–10 deal with applications that are particularly relevant to the field of financial mathematics.

The book requires only a basic background in probability and statistics, linear algebra, and multivariable calculus, and reviews some of the necessary material on measure theory. It can be used either as the textbook for an advanced undergraduate introduction to stochastic calculus, or as the text for a masters-level course for financial engineers. Financial professionals wanting to enhance their understanding of the mathematical underpinnings behind commonly used tools in financial modeling and options pricing will also find this book useful.

Partial Differential Equations: A First Course
By Rustom Choksi
(AMSTEXT/54, 2022)

Partial Differential Equations taught at the undergraduate level can attract students with diverse goals and motivations. Those interested in pure mathematics may focus on theorems and proofs and how they connect with other mathematical subjects; those in applied math may prefer to delve into the behavior and properties of PDE that are useful in modeling; and those in mathematics-related majors may desire direct methods to obtain concrete, numerical solutions to specific problems.

Choksi finds an approach in Partial Differential Equations: A First Course that brings together the subject in a way that will appeal to and be useful for all three kinds of students. He does this by focusing his exposition around seven core concepts: first order equations and the notion of characteristic; wave propagation and the second order wave equation; the Fourier transform; the nature of diffusion and the diffusion equation; harmonic functions and PDEs involving the Laplacian; the fundamental solution of the Laplacian and Green’s function; and finally Fourier series and the Separation of Variables Algorithm. Each concept is preceded by ample motivation and followed by reflections.

A unifying theme throughout is the importance of the Dirac delta function.

The preface contains a thorough discussion of how the book may be adapted by instructors to suit a variety of curricular requirements. While the book is long, at 600+ pages, it is a pleasure to read and easy to use because of its clearly presented over-arching narrative, and its organization into short self-contained chapters. The book is rich with physical motivations and interpretations and can be also used for continued self-study and reference beyond the classroom.