Financial Maths

Integration

$$\int_{\mathbb{R}} e^{-x^2} dx = \sqrt{\pi}$$

Let $I = \int_{\mathbb{R}} e^{-x^2} dx$, then $I^2 = \int_{\mathbb{R}} e^{-x^2} dx \int_{\mathbb{R}} e^{-y^2} dy = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} e^{-(x^2 + y^2)} dx dy$

We then convert into polar coordinates: $x = r\cos(\theta), \; y = r\sin(\theta), \; dxdy = rdrd\theta$

$$I^2 = \int_0^{2\pi} \int_0^{\infty} e^{-r^2} rdrd\theta = \frac{1}{2} \int_0^{2\pi} d\theta = \pi$$

$$\Rightarrow I = \sqrt{\pi}$$

$$\int_0^{\infty} e^{-x^2} dx = \frac{\sqrt{\pi}}{2}$$

$$\int_{-\infty}^{\infty} e^{-ax^2} dx$$

Let $s = \sqrt{a}\,x$ so $ds = \sqrt{a}\,dx$

Hence $\frac{1}{\sqrt{a}} \int_{-\infty}^{\infty} e^{-s^2} ds = \sqrt{\frac{\pi}{a}}$

Error Function

$erf(x) = \frac{2}{\sqrt{\pi}} \int_0^x e^{-t^2} dt$ is the error function

$erfc(x) = \frac{2}{\sqrt{\pi}} \int_x^{\infty} e^{-t^2} dt$ is the complementary error function

$$erf(x) + erfc(x) = \frac{2}{\sqrt{\pi}} \left(\int_0^x + \int_x^{\infty} \right) = \frac{2}{\sqrt{\pi}} \int_0^{\infty} e^{-x^2} dx = 1$$

$$\int_{x_0}^{x_1} e^{-x^2} dx = \int_{x_0}^{0} + \int_0^{x_1} = \int_0^{x_1} - \int_0^{x_0} = \frac{\sqrt{\pi}}{2} \left(\frac{2}{\sqrt{\pi}} \int_0^{x_1} - \frac{2}{\sqrt{\pi}} \int_0^{x_0} \right) = \frac{\sqrt{\pi}}{2} (erf(x_1) - erf(x_0))$$

Taylor Series Expansion (TSE)

We consider the function $f(x)$ and what happens when we consider $f(x + \delta x)$

$$f(x + \delta x) = f(x) + f'(x)\delta x + \frac{1}{2!} f''(x) \delta x^2 + O(\delta x^3)$$

For a general power series $f(x) = \sum_{n=0}^{\infty} a_n(x)(x - x_0)^n$

[Financial Mathematics Lecture Notes](#)

Ioannis Karatzas

Financial Mathematics Lecture Notes:

Lecture Notes on Financial Mathematics Francesca Beccacece,2020 **From Probability to Finance** Ying Jiao,2020-03-20 This volume presents a collection of lecture notes of mini courses taught at BICMR Summer School of Financial Mathematics from May 29 to June 9 2017 Each chapter is self contained and corresponds to one mini course which deals with a distinguished topic such as branching processes enlargement of filtrations Hawkes processes copula models and valuation adjustment analysis whereas the global topics cover a wide range of advanced subjects in financial mathematics from both theoretical and practical points of view The authors include world leading specialists in the domain and also young active researchers This book will be helpful for students and those who work on probability and financial mathematics

Paris-Princeton Lectures on Mathematical Finance 2010 Areski Cousin,Stéphane Crépey,Olivier Guéant,David Hobson,Monique Jeanblanc,Jean-Michel Lasry,Jean-Paul Laurent,Pierre-Louis Lions,Peter Tankov,2011-06-29 The Paris Princeton Lectures in Financial Mathematics of which this is the fourth volume publish cutting edge research in self contained expository articles from outstanding specialists established or on the rise The aim is to produce a series of articles that can serve as an introductory reference source for research in the field The articles are the result of frequent exchanges between the finance and financial mathematics groups in Paris and Princeton The present volume sets standards with five articles by 1 Areski Cousin Monique Jeanblanc and Jean Paul Laurent 2 St phane Cr pey 3 Olivier Gu ant Jean Michel Lasry and Pierre Louis Lions 4 David Hobson and 5 Peter Tankov **Introductory Course On Financial Mathematics** Michael Tretyakov,2013-07-23 This book is an elementary introduction to the basic concepts of financial mathematics with a central focus on discrete models and an aim to demonstrate simple but widely used financial derivatives for managing market risks Only a basic knowledge of probability real analysis ordinary differential equations linear algebra and some common sense are required to understand the concepts considered in this book Financial mathematics is an application of advanced mathematical and statistical methods to financial management and markets with a main objective of quantifying and hedging risks Since the book aims to present the basics of financial mathematics to the reader only essential elements of probability and stochastic analysis are given to explain ideas concerning derivative pricing and hedging To keep the reader intrigued and motivated the book has a sandwich structure probability and stochastics are given in situ where mathematics can be readily illustrated by application to finance The first part of the book introduces one of the main principles in finance no arbitrage pricing It also introduces main financial instruments such as forward and futures contracts bonds and swaps and options The second part deals with pricing and hedging of European and American type options in the discrete time setting In addition the concept of complete and incomplete markets is discussed Elementary probability is briefly revised and discrete time discrete space stochastic processes used in financial modelling are considered The third part introduces the Wiener process Ito integrals and stochastic differential equations but its main focus is the famous Black Scholes formula for

pricing European options Some guidance for further study within this exciting and rapidly changing field is given in the concluding chapter There are approximately 100 exercises interspersed throughout the book and solutions for most problems are provided in the appendices **An Undergraduate Introduction to Financial Mathematics** J. Robert Buchanan,2008 This textbook provides an introduction to financial mathematics and financial engineering for undergraduate students who have completed a three or four semester sequence of calculus courses It introduces the theory of interest random variables and probability stochastic processes arbitrage option pricing hedging and portfolio optimization The student progresses from knowing only elementary calculus to understanding the derivation and solution of the Black Scholes partial differential equation and its solutions This is one of the few books on the subject of financial mathematics which is accessible to undergraduates having only a thorough grounding in elementary calculus It explains the subject matter without hand waving arguments and includes numerous examples Every chapter concludes with a set of exercises which test the chapter s concepts and fill in details of derivations Publisher s description Paris-Princeton Lectures on Mathematical Finance 2003 Tomasz R. Bielecki,Tomas Björk,Monique Jeanblanc,Marek Rutkowski,Jose A. Scheinkman,Wei Xiong,2004-08-30 The Paris Princeton Lectures in Financial Mathematics of which this is the second volume will on an annual basis publish cutting edge research in self contained expository articles from outstanding established or upcoming specialists The aim is to produce a series of articles that can serve as an introductory reference for research in the field It arises as a result of frequent exchanges between the finance and financial mathematics groups in Paris and Princeton This volume presents the following articles Hedging of Defaultable Claims by T Bielecki M Jeanblanc and M Rutkowski On the Geometry of Interest Rate Models by T Bj rk Heterogeneous Beliefs Speculation and Trading in Financial Markets by J A Scheinkman and W Xiong Lectures on the Mathematics of Finance Ioannis Karatzas,1997 In this text the author discusses the main aspects of mathematical finance These include arbitrage hedging and pricing of contingent claims portfolio optimization incomplete and or constrained markets equilibrium and transaction costs The book outlines advances made possible during the last fifteen years due to the methodologies of stochastic analysis and control Readers are presented with current research and open problems are suggested This tutorial survey of the rapidly expanding field of mathematical finance is addressed primarily to graduate students in mathematics Familiarity is assumed with stochastic analysis and parabolic partial differential equations The text makes significant use of students mathematical skills but always in connection with interesting applied problems

Financial Mathematics Bruno Biais,Centro internazionale matematico estivo,1997-03-20 Financial Mathematics is an exciting emerging field of application The five sets of course notes in this book provide a bird s eye view of the current state of the art and directions of research For graduate students it will therefore serve as an introduction to the field while reseachers will find it a compact source of reference The reader is expected to have a good knowledge of the basic mathematical tools corresponding to an introductory graduate level and sufficient familiarity with probabilistic methods in

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result of frequent exchanges between the finance and financial mathematics groups in Paris and Princeton The present volume sets standards with articles by P Bank H F llmer F Baudoin L C G Rogers and M Soner N Touzi   An Introduction to Mathematical Finance with Applications Arlie O. Petters,Xiaoying Dong,2016-06-17 This textbook aims to fill the gap between those that offer a theoretical treatment without many applications and those that present and apply formulas without appropriately deriving them The balance achieved will give readers a fundamental understanding of key financial ideas and tools that form the basis for building realistic models including those that may become proprietary Numerous carefully chosen examples and exercises reinforce the student s conceptual understanding and facility with applications The exercises are divided into conceptual application based and theoretical problems which probe the material deeper The book is aimed toward advanced undergraduates and first year graduate students who are new to finance or want a more rigorous treatment of the mathematical models used within While no background in finance is assumed prerequisite math courses include multivariable calculus probability and linear algebra The authors introduce additional mathematical tools as needed The entire textbook is appropriate for a single year long course on introductory mathematical finance The self contained design of the text allows for instructor flexibility in topics courses and those focusing on financial derivatives Moreover the text is useful for mathematicians physicists and engineers who want to learn finance via an approach that builds their financial intuition and is explicit about model building as well as business school students who want a treatment of finance that is deeper but not overly theoretical   **Financial Mathematics, Volatility and Covariance Modelling** Julien Chevallier,Stéphane Goutte,David Guerreiro,Sophie Saglio,Bilel Sanhaji,2019-06-28 This book provides an up to date series of advanced chapters on applied financial econometric techniques pertaining the various fields of commodities finance mathematics academics and students seeking convenient access to an unfamiliar area It will also be of great interest established researchers seeking a single repository on the current state of knowledge current debates and relevant literature **Commodities, Energy and Environmental Finance** René Aïd,Michael Ludkovski,Ronnie Sircar,2015-06-30 This volume is a collection of chapters covering the latest developments in applications of financial mathematics and statistics to topics in energy commodity financial markets and environmental economics The research presented is based on the presentations and discussions that took place during the Fields Institute Focus Program on Commodities Energy and Environmental Finance in August 2013 The authors include applied mathematicians economists and industry practitioners providing for a multi disciplinary spectrum of perspectives on the subject The volume consists of four sections Electricity Markets Real Options Trading in Commodity Markets and Oligopolistic Models for Energy Production Taken together the chapters give a comprehensive summary of the current state of the art in quantitative analysis of commodities and energy finance The topics covered include structural models of electricity markets financialization of commodities valuation of commodity real options game theory analysis of exhaustible resource management and analysis of commodity ETFs The

volume also includes two survey articles that provide a source for new researchers interested in getting into these topics

   Elementary Stochastic Calculus with Finance in View Thomas Mikosch,1998 Modelling with the Ito integral or stochastic differential equations has become increasingly important in various applied fields including physics biology chemistry and finance However stochastic calculus is based on a deep mathematical theory This book is suitable for the reader without a deep mathematical background It gives an elementary introduction to that area of probability theory without burdening the reader with a great deal of measure theory Applications are taken from stochastic finance In particular the Black Scholes option pricing formula is derived The book can serve as a text for a course on stochastic calculus for non mathematicians or as elementary reading material for anyone who wants to learn about Ito calculus and or stochastic finance   Numerical Solution of Stochastic Differential Equations with Jumps in Finance Eckhard Platen,Nicola Bruti-Liberati,2010-07-23 In financial and actuarial modeling and other areas of application stochastic differential equations with jumps have been employed to describe the dynamics of various state variables The numerical solution of such equations is more complex than that of those only driven by Wiener processes described in Kloeden Platen Numerical Solution of Stochastic Differential Equations 1992 The present monograph builds on the above mentioned work and provides an introduction to stochastic differential equations with jumps in both theory and application emphasizing the numerical methods needed to solve such equations It presents many new results on higher order methods for scenario and Monte Carlo simulation including implicit predictor corrector extrapolation Markov chain and variance reduction methods stressing the importance of their numerical stability Furthermore it includes chapters on exact simulation estimation and filtering Besides serving as a basic text on quantitative methods it offers ready access to a large number of potential research problems in an area that is widely applicable and rapidly expanding Finance is chosen as the area of application because much of the recent research on stochastic numerical methods has been driven by challenges in quantitative finance Moreover the volume introduces readers to the modern benchmark approach that provides a general framework for modeling in finance and insurance beyond the standard risk neutral approach It requires undergraduate background in mathematical or quantitative methods is accessible to a broad readership including those who are only seeking numerical recipes and includes exercises that help the reader develop a deeper understanding of the underlying mathematics   **Machine Learning and Data Sciences for Financial Markets** Agostino Capponi,Charles-Albert Lehalle,2023-06 Learn how cutting edge AI and data science techniques are integrated in financial markets from leading experts in the industry

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