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Mathematical Modeling, Third Edition
is a general introduction to an
increasingly crucial topic for today's

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mathematicians. Unlike textbooks focused on one kind of mathematical model, this book covers the broad spectrum of modeling problems, from optimization to dynamical systems to stochastic processes. Mathematical modeling is the link between mathematics and the rest of the world.

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Meerschaert shows how to refine a question, phrasing it in precise mathematical terms. Then he encourages students to reverse the process, translating the mathematical solution back into a comprehensible, useful answer to the original question. This textbook mirrors the process

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professionals must follow in solving complex problems. Each chapter in this book is followed by a set of challenging exercises. These exercises require significant effort on the part of the student, as well as a certain amount of creativity.

Meerschaert did not invent the

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problems in this book--they are real problems, not designed to illustrate the use of any particular mathematical technique. Meerschaert's emphasis on principles and general techniques offers students the mathematical background they need to model problems in a wide range of

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disciplines. Increased support for
instructors, including MATLAB material
New sections on time series analysis
and diffusion models Additional
problems with international focus such
as whale and dolphin populations, plus
updated optimization problems
The study of the theory of games was

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started in Von Neumann (1928), but the development of the theory of games was accelerated after the publication of the classical book "Theory of games and economic behavior" by Von Neumann and Morgenstern (1944). As an initial step, the theory of games aims to put

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situations of conflict and cooperation into mathematical models. In the second and final step, the resulting models are analysed on the basis of equitable and mathematical reasonings. The conflict and/or cooperative situation in question is generally due to the interaction

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between two or more individuals (players). Their interaction may lead up to several potential payoffs over which each player has his own preferences. Any player attempts to achieve his largest possible payoff, but the other players may also exert their influence on the realization of some

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potential payoff. As already mentioned, the theory of games consists of two parts, a modelling part and a solution part. Concerning the modelling part, the mathematical models of conflict and cooperative situations are described. The description of the models includes the

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rules, the strategy space of any player, potential payoffs to the players, the preferences of each player over the set of all potential payoffs, etc.

According to the rules, it is either permitted or forbidden that the players communicate with one another in order to make binding agreements

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regarding their mutual actions.

A unique textbook for an undergraduate course on mathematical modeling, Differential Equations with MATLAB: Exploration, Applications, and Theory provides students with an understanding of the practical and theoretical aspects of

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mathematical models involving ordinary and partial differential equations (ODEs and PDEs). The text presents a unifying picture inherent to the study and analysis of more than 20 distinct models spanning disciplines such as physics, engineering, and finance. The first part of the book

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presents systems of linear ODEs. The text develops mathematical models from ten disparate fields, including pharmacokinetics, chemistry, classical mechanics, neural networks, physiology, and electrical circuits. Focusing on linear PDEs, the second part covers PDEs that arise in the

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mathematical modeling of phenomena in ten other areas, including heat conduction, wave propagation, fluid flow through fissured rocks, pattern formation, and financial mathematics. The authors engage students by posing questions of all types throughout, including verifying details,

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proving conjectures of actual results, analyzing broad strokes that occur within the development of the theory, and applying the theory to specific models. The authors' accessible style encourages students to actively work through the material and answer these questions. In addition, the extensive

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use of MATLAB® GUIs allows students to discover patterns and make conjectures.

Many phenomena in social, natural and engineering fields are governed by wave, potential, parabolic heat-conduction, hyperbolic heat-conduction and dual-phase-lagging

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heat-conduction equations. This monograph examines these equations: their solution structures, methods of finding their solutions under various supplementary conditions, as well as the physical implication and applications of their solutions.

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Unit 10 (RES)

An Introduction to Mathematical
Modeling

Modeling and Data Analysis: An
Introduction with Environmental
Applications

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Answer Key Units 1-10 (RES)

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College Algebra

Using R for Item Response Theory
Model Applications

This book highlights the
mathematical models and
solutions of the generalized
dynamics of soft-matter

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quasicrystals (SMQ) and introduces possible applications of the theory and methods. Based on the theory of quasiperiodic symmetry and symmetry breaking, the book treats the dynamics of individual

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quasicrystal systems by reducing them to nonlinear partial differential equations and then provides methods for solving the initial-boundary value problems in these equations. The solutions obtained demonstrate

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the distribution, deformation and motion of SMQ and determine the stress, velocity and displacement fields. The interactions between phonons, phasons and fluid phonons are discussed in some fundamental

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materials samples. The reader benefits from a detailed comparison of the mathematical solutions for both solid and soft-matter quasicrystals, gaining a deeper understanding of the universal properties of SMQ. The

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second edition covers the latest research progress on quasicrystals in topics such as thermodynamic stability, three-dimensional problems and solutions, rupture theory, and the photonic band-gap and its

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applications. These novel chapters make the book an even more useful and comprehensive reference guide for researchers in condensed matter physics, chemistry and materials sciences.

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The book covers nonlinear physical problems and mathematical modeling, including molecular biology, genetics, neurosciences, artificial intelligence with classical problems in mechanics

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and astronomy and physics. The chapters present nonlinear mathematical modeling in life science and physics through nonlinear differential equations, nonlinear discrete equations and hybrid equations. Such modeling

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can be effectively applied to the wide spectrum of nonlinear physical problems, including the KAM (Kolmogorov-Arnold-Moser (KAM)) theory, singular differential equations, impulsive dichotomous linear systems,

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analytical bifurcation trees of periodic motions, and almost or pseudo- almost periodic solutions in nonlinear dynamical systems.

This text makes math fun, approachable, and applicable in

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everyday life. The authors provide algebraic modeling concepts and solutions in non-threatening, easy-to-understand language with numerous step-by-step examples to illustrate ideas. Whether they are going on to

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study early childhood education, graphic arts, automotive technologies, criminal justice, or something else, students will discover that the practical applications of mathematical modeling will continue to be

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useful well after they have finished this course.

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Applications Unit 6 (RES)
Cooperative Games, Solutions
and Applications
Models, Analysis and
Applications
Mathematical Models with
Applications Unit 8 (RES)

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Models and Applications
Mathematical Modeling

As we enter the 21st century, there is an urgent need for new approaches to mathematics education emphasizing its relevance in young learners' futures.

Modeling Students' Mathematical

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Modeling Competencies explores the vital trend toward using real-world problems as a basis for teaching mathematics skills, competencies, and applications. Blending theoretical constructs and practical considerations, the book presents papers from the latest

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conference of the ICTMA, beginning with the basics (Why are models necessary? Where can we find them?) and moving through intricate concepts of how students perceive math, how instructors teach—and how both can become better learners. Dispatches as

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varied as classroom case studies, analyses of math in engineering work, and an in-depth review of modeling-based curricula in the Netherlands illustrate modeling activities on the job, methods of overcoming math resistance, and the movement toward

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replicable models and lifelong engagement. A sampling of topics covered: How students recognize the usefulness of mathematics Creating the modeling-oriented classroom Assessing and evaluating students' modeling capabilities The relationship between

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modeling and problem-solving

Instructor methods for developing their own models of modeling New technologies for modeling in the classroom Modeling Students' Mathematical Modeling Competencies offers welcome clarity and focus to the

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international research and professional community in mathematics, science, and engineering education, as well as those involved in the sciences of teaching and learning these subjects. Accessible text features over 100 reality-based examples pulled from the

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science, engineering and operations research fields. Prerequisites: ordinary differential equations, continuous probability. Numerous references. Includes 27 black-and-white figures. 1978 edition.

Elementary Mathematical Models

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offers instructors an alternative to standard college algebra, quantitative literacy, and liberal arts mathematics courses. Presuming only a background of exposure to high school algebra, the text introduces students to the methodology of mathematical

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modeling, which plays a role in nearly all real applications of mathematics. A course based on this text would have as its primary goal preparing students to be competent consumers of mathematical modeling in their future studies. Such a course would also

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provide students with an understanding of the modeling process and a facility with much of the standard, non-trigonometric, content of college algebra and precalculus. This book builds, successively, a series of growth models defined in terms of simple

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recursive patterns of change corresponding to arithmetic, quadratic, geometric, and logistic growth. Students discover and come to understand linear, polynomial, exponential, and logarithmic functions in the context of analyzing these models of

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intrinsically—and scientifically—interesting phenomena including polar ice extent, antibiotic resistance, and viral internet videos. Students gain a deep appreciation for the power and limitations of mathematical modeling in the physical,

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life, and social sciences as questions of modeling methodology are carefully and constantly addressed. Realistic examples are used consistently throughout the text, and every topic is illustrated with models that are constructed from and compared to real

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data. The text is extremely attractive and the exposition is extraordinarily clear. The lead author of this text is the recipient of nine MAA awards for expository writing including the Ford, Evans, Pólya, and Allendoerfer awards and the Beckenbach Book prize. Great

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care has been taken by accomplished expositors to make the book readable by students. Those students will also benefit from more than 1,000 carefully crafted exercises.

Mathematical Modeling: Models,
Analysis and Applications, Second

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Edition introduces models of both discrete and continuous systems. This book is aimed at newcomers who desires to learn mathematical modeling, especially students taking a first course in the subject. Beginning with the step-by-step guidance of model formulation,

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this book equips the reader about modeling with difference equations (discrete models), ODE's, PDE's, delay and stochastic differential equations (continuous models). This book provides interdisciplinary and integrative overview of mathematical

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modeling, making it a complete textbook for a wide audience. A unique feature of the book is the breadth of coverage of different examples on mathematical modelling, which include population models, economic models, arms race models, combat models,

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learning model, alcohol dynamics model, carbon dating, drug distribution models, mechanical oscillation models, epidemic models, tumor models, traffic flow models, crime flow models, spatial models, football team performance model, breathing model, two neuron

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system model, zombie model and model on love affairs. Common themes such as equilibrium points, stability, phase plane analysis, bifurcations, limit cycles, period doubling and chaos run through several chapters and their interpretations in the context of the

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model have been highlighted. In chapter 3, a section on estimation of system parameters with real life data for model validation has also been discussed. Features Covers discrete, continuous, spatial, delayed and stochastic models. Over 250

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illustrations, 300 examples and exercises with complete solutions. Incorporates MATHEMATICA® and MATLAB®, each chapter contains Mathematica and Matlab codes used to display numerical results (available at CRC website). Separate sections for

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Projects. Several exercise problems can also be used for projects. Presents real life examples of discrete and continuous scenarios. The book is ideal for an introductory course for undergraduate and graduate students, engineers, applied mathematicians and

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researchers working in various areas of natural and applied sciences.

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mathematical modeling is published, so, why another? The answer springs directly from the fact that it is very rare to find a book that covers modeling with all types of differential equations in one volume. Until now.

Mathematical Modeling: Models, Analysis and Applications covers

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modeling with all kinds of differential equations, namely ordinary, partial, delay, and stochastic. The book also contains a chapter on discrete modeling, consisting of differential equations, making it a complete textbook on this important skill needed for the study of science, engineering,

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and social sciences. More than just a textbook, this how-to guide presents tools for mathematical modeling and analysis. It offers a wide-ranging overview of mathematical ideas and techniques that provide a number of effective approaches to problem solving. Topics covered include

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spatial, delayed, and stochastic modeling. The text provides real-life examples of discrete and continuous mathematical modeling scenarios. MATLAB® and Mathematica® are incorporated throughout the text. The examples and exercises in each chapter can be used as problems in a

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project. Since mathematical modeling involves a diverse range of skills and tools, the author focuses on techniques that will be of particular interest to engineers, scientists, and others who use models of discrete and continuous systems. He gives students a foundation for

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understanding and using the mathematics that is the basis of computers, and therefore a foundation for success in engineering and science streams.

"This book began as lecture notes developed in connection with a course of the same name given since 1968 at

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Indiana University. The audience can be loosely grouped as follows: junior and senior mathematics majors, many of whom contemplate graduate work in other fields; undergraduate and graduate students majoring in the social and life sciences and in business; and prospective secondary

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teachers of mathematics. In addition, portions of the material have been used in NSF institutes for mathematics teachers. The goal of the course has been to provide the student with an appreciation for, an understanding of, and a facility in the use of mathematics in other fields. The role of

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mathematical models in explaining and predicting phenomena arising in the real world is the central theme."

--Preface.

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Mathematical Models with Applications
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Proceedings of the International
Conference held in Tucson, Arizona,
11-13 April, 1996

College Algebra provides a

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**comprehensive exploration
of algebraic principles
and meets scope and
sequence requirements for
a typical introductory
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modular approach and**

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richness of content ensure that the book meets the needs of a variety of courses. College Algebra offers a wealth of examples with detailed, conceptual explanations,

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**building a strong
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Scope In determining the
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topics to cover, we engaged dozens of highly experienced instructors with a range of student audiences. The resulting scope and sequence proceeds logically while

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authors recognize that while some institutions may find this material a prerequisite, other institutions have told us that they have a cohort that need the prerequisite

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Prerequisites Chapter 2:
Equations and Inequalities
Chapters 3-6: The
Algebraic Functions
Chapter 3: Functions**

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Functions Chapters 7-9:
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**well-organized guide to
various mathematical
modeling techniques and
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**highly-qualified lecturer
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the author provides a
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problem solving and
evaluation through
mathematical modeling. The
main software presented in
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which is a fast-growing,**

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free program and can be used within numerous areas of mathematics such as algebra, geometry, geometry 3D, functions, statistics, spreadsheet calculations, and symbolic

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algebra. The book provides detailed information on how to use GeoGebra to teach mathematics, as well as a technical guide to using GeoGebra for mathematical modeling.

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Beginning with the basics of GeoGebra, the book introduces specific GeoGebra exercises and additional resources for further study. The book then moves on to

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**comprehensive modeling
examples that correspond
to different levels of
mathematics experience.
Each chapter builds on the
previous chapter's level,
and includes numerous**

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**examples of solved
modeling tasks with at
least one, sometimes
several, solution
suggestions. These
solutions are detailed
both mathematically and in**

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a GeoGebra sense to engage readers with the necessary skills for future problem solving and mathematical modeling. Subsequently, the book addresses how to organize practical work

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and gives examples of various approaches to teaching modeling in the classroom. Finally, the book illustrates the methods for evaluating models, including relative

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**error, correlation, square
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and confidence interval.
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revisiting it based on the results of the test--is critical for learning how to think mathematically. Demonstrating this ability can open up a wide range of educational and

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practical problems by introducing both mathematical and Excel techniques. The book begins with a step-by-step introduction to discrete dynamical systems, which are mathematical models that describe how a quantity changes from one point in time to the next. Readers are taken through the

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process, language, and notation required for the construction of such models as well as their implementation in Excel. The book examines single-compartment models in contexts such as population growth, personal finance, and body weight and provides an introduction to more advanced,

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multi-compartment models via applications in many areas, including military combat, infectious disease epidemics, and ranking methods. Models for Life: An Introduction to Discrete Mathematical Modeling with Microsoft® Office Excel® also features: A modular organization that,

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after the first chapter, allows readers to explore chapters in any order Numerous practical examples and exercises that enable readers to personalize the presented models by using their own data Carefully selected real-world applications that motivate the mathematical material such as

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predicting blood alcohol concentration, ranking sports teams, and tracking credit card debt References throughout the book to disciplinary research on which the presented models and model parameters are based in order to provide authenticity and resources for further study

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sustainable yield, and a drug's therapeutic window A companion website that includes the referenced Excel spreadsheets, select solutions to homework problems, and an instructor's manual with solutions to all homework problems, project ideas, and a test bank

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models—equations of various sorts capturing relationships between variables involved in a complex situation—are fundamental for understanding the potential consequences of choices we make. Extracting insights from the vast amounts of data we are able to collect

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requires analysis methods and statistical reasoning. This book on elementary topics in mathematical modeling and data analysis is intended for an undergraduate “liberal arts mathematics”-type course but with a specific focus on environmental applications. It is suitable for

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introductory courses with no prerequisites beyond high school mathematics. A great variety of exercises extends the discussions of the main text to new situations and/or introduces new real-world examples. Every chapter ends with a section of problems, as well as with an extended

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chapter project which often involves substantial computing work either in spreadsheet software or in the R statistical package.

This book discusses the interplay of stochastics (applied probability theory) and numerical analysis in the field of quantitative finance. The stochastic

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models, numerical valuation techniques, computational aspects, financial products, and risk management applications presented will enable readers to progress in the challenging field of computational finance. When the behavior of financial market participants changes, the

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corresponding stochastic mathematical models describing the prices may also change. Financial regulation may play a role in such changes too. The book thus presents several models for stock prices, interest rates as well as foreign-exchange rates, with increasing

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complexity across the chapters. As is said in the industry, "do not fall in love with your favorite model." The book covers equity models before moving to short-rate and other interest rate models. We cast these models for interest rate into the Heath-Jarrow-Morton framework, show relations

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between the different models, and explain a few interest rate products and their pricing. The chapters are accompanied by exercises. Students can access solutions to selected exercises, while complete solutions are made available to instructors. The MATLAB and Python computer codes

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used for most tables and figures in the book are made available for both print and e-book users. This book will be useful for people working in the financial industry, for those aiming to work there one day, and for anyone interested in quantitative finance. The topics that are discussed are relevant

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for MSc and PhD students, academic researchers, and for quants in the financial industry.

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Applications In order to emphasize the
main concepts of each chapter, Finite
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features plentiful pedagogical elements throughout such as special exercises, end notes, hints, select solutions, biographies of key mathematicians, boxed key principles, a glossary of important terms and topics, and an overview of use of technology. The book encourages the

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modeling of linear programs and their solutions and uses common computer software programs such as LINDO. In addition to extensive chapters on probability and statistics, principles and applications of matrices are included as well as topics for enrichment such as the Monte Carlo

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method, game theory, kinship matrices, and dynamic programming. Supplemented with online instructional support materials, the book features coverage including: Algebra Skills Mathematics of Finance Matrix Algebra Geometric Solutions Simplex Methods Application Models Set and

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Response Theory Model

Applications is a practical guide for students, instructors, practitioners, and applied researchers who want to learn how to properly use R IRT packages to perform IRT model calibrations with their own data.

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This book provides practical line-by-line descriptions of how to use R IRT packages for various IRT models. The scope and coverage of the modeling in the book covers almost all models used in practice and in popular research, including:

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dichotomous response modeling
polytomous response modeling
mixed format data modeling
concurrent multiple group modeling
fixed item parameter calibration
modelling with latent regression to
include person-level covariate(s)

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*simple structure, or between-item,
multidimensional modeling cross-
loading, or within-item,
multidimensional modeling high-
dimensional modeling bifactor
modeling testlet modeling two-tier
modeling For beginners, this book*

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provides a straightforward guide to learn how to use R for IRT applications. For more intermediate learners of IRT or users of R, this book will serve as a great time-saving tool for learning how to create the proper syntax, fit the

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various models, evaluate the models, and interpret the output using popular R IRT packages. Thirty years ago, biologists could get by with a rudimentary grasp of mathematics and modeling. Not so today. In seeking to answer

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fundamental questions about how biological systems function and change over time, the modern biologist is as likely to rely on sophisticated mathematical and computer-based models as traditional fieldwork. In this book,

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Sarah Otto and Troy Day provide biology students with the tools necessary to both interpret models and to build their own. The book starts at an elementary level of mathematical modeling, assuming that the reader has had high school

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mathematics and first-year calculus. Otto and Day then gradually build in depth and complexity, from classic models in ecology and evolution to more intricate class-structured and probabilistic models. The authors

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provide primers with instructive exercises to introduce readers to the more advanced subjects of linear algebra and probability theory. Through examples, they describe how models have been used to understand such topics as

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the spread of HIV, chaos, the age structure of a country, speciation, and extinction. Ecologists and evolutionary biologists today need enough mathematical training to be able to assess the power and limits of biological models and to develop

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*theories and models themselves.
This innovative book will be an
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mathematical models for the next
generation of biologists. A how-to
guide for developing new
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