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Mathematical Modeling in Optical Science Springer

This book introduces mathematicians to real applications from physiology. Using mathematics to analyze physiological systems, the authors focus on models reflecting current research in cardiovascular and pulmonary physiology. In particular, they present models describing blood flow in the heart and the cardiovascular system, as well as the transport of oxygen and carbon dioxide through the respiratory system and a model for baroreceptor regulation.

Academic Press

Mathematical Models and Algorithms for Power System Optimization helps readers build a thorough understanding of new technologies and world-class practices developed by the State Grid Corporation of China, the organization responsible for the world's largest power distribution network. This reference covers three areas: power operation planning, electric grid investment and operational planning and power system control. It introduces economic dispatching, generator maintenance scheduling, power flow, optimal load flow, reactive power planning, load frequency control and transient stability, using mathematic models including optimization, dynamic, differential and difference equations. Provides insights on the development of new mathematical models of power system optimization Analyzes power systems comprehensively to create novel mathematic models and algorithms for issues related to the planning operation of power systems Includes research on the optimization of power systems and related practical research projects carried out since 1981

Topics in Mathematical Modeling CRC Press

Mathematical Modeling for Business Analytics is written for decision makers at all levels. This book presents the latest tools and techniques available to help in the decision process. The interpretation and explanation of the results are crucial to understanding the strengths and limitations of modeling. This book emphasizes and focuses on the aspects of constructing a useful model formulation, as well as building the skills required for decision analysis. The book also focuses on sensitivity analysis. The author encourages readers to formally think about solving problems by using a thorough process. Many scenarios and illustrative examples are provided to help solve problems. Each chapter is also comprehensively arranged so that readers gain an in-depth understanding of the subject which includes introductions, background information and analysis. Both undergraduate and graduate students taking methods courses in methods and discrete mathematical modeling courses will greatly benefit from using this book. Boasts many illustrative examples to help solve problems Provides many solutions for each chapter Emphasizes model formulation and helps create model building skills for decision analysis Provides the tools to support analysis and interpretation

Mathematical Modeling for Business Analytics SIAM

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 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 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 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 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 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 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.

The Nature of Mathematical Modeling SIAM

This volume addresses recent developments in mathematical modeling in three areas of optical science: diffractive optics, photonic band gap structures, and waveguides. Particular emphasis is on the formulation of mathematical models and the design and analysis of new computational approaches. The book contains cutting-edge discourses on emerging technology in optics that provides significant challenges and opportunities for applied mathematicians, researchers, and engineers. Each of the three topics is presented through a series of survey papers to provide a broad overview focusing on the mathematical models. Chapters present model problems, physical principles, mathematical and computational approaches, and engineering applications corresponding to each of the three areas. Although some of the subject matter is classical, the topics presented are new and represent the latest developments in their respective fields.

Mathematical Modeling using Differential Equations, and Network Theory SIAM

Methods of Mathematical Modeling: Infectious Diseases presents computational methods related to biological systems and their numerical treatment via mathematical tools and techniques. Edited by renowned experts in the field, Dr. Hari Mohan Srivastava, Dr. Dumitru Baleanu, and Dr. Harendra Singh, the book examines advanced numerical methods to provide global solutions for biological models. These results are important for medical professionals, biomedical engineers, mathematicians, scientists and researchers working on biological models with real-life applications. The authors deal

with methods as well as applications, including stability analysis of biological models, bifurcation scenarios, chaotic dynamics, and non-linear differential equations arising in biology. The book focuses primarily on infectious disease modeling and computational modeling of other real-world medical issues, including COVID-19, smoking, cancer and diabetes. The book provides the solution of these models so as to provide actual remedies. Includes mathematical modeling for a variety of infectious diseases and disease processes, including SIR/SIRA, COVID-19, cancer, smoking and diabetes Offers a complete and foundational understanding of modeling algorithms and techniques such as stability analysis, bifurcation scenarios, chaotic dynamics, and non-linear differential equations Provides readers with datasets for applied learning of the various algorithms and modeling techniques

Exploring Mathematical Modeling with Young Learners Academic Press

This book explores what it means to teach modeling. In part I, the authors discuss mathematical modeling broadly and allow you to explore the student practices and perspectives involved, how modeling can empower students, and classroom communities that support modeling. In part II, the authors launch you on your journey of becoming a teacher of modeling by illustrating features of modeling that are evident in the classrooms of teacher who engage their students in modeling and by sharing specific strategies for making modeling a part of your own classroom practices. In part III, they examine the complementary perspectives of mathematical and statistical models, the role of modeling in the secondary mathematics curriculum, and the role of technology in supporting modeling. Finally, they share wisdom from other teachers who have engaged in this journey and invite you to join in the modeling community.

Engineering Design and Mathematical Modelling SIAM

This book covers an interdisciplinary approach for understanding mathematical modeling by offering a collection of models, solved problems related to the models, the methodologies employed, and the results using projects and case studies with insight into the operation of substantial real-time systems. The book covers a broad scope in the areas of statistical science, probability, stochastic processes, fluid dynamics, supply chain, optimization, and applications. It discusses advanced topics and the latest research findings, uses an interdisciplinary approach for real-time systems, offers a platform for integrated research, and identifies the gaps in the field for further research. The book is for researchers, students, and teachers that share a goal of learning advanced topics and the latest research in mathematical modeling.

Isogeometric Analysis SIAM

This is the only book that teaches all aspects of modern mathematical modeling and that is specifically designed to introduce undergraduate students to problem solving in the context of biology. Included is an integrated package of theoretical modeling and analysis tools, computational modeling techniques, and parameter estimation and model validation methods, with a focus on integrating analytical and computational tools in the modeling of biological processes. Divided into three parts, it covers basic analytical modeling techniques; introduces computational tools used in the modeling of biological problems; and includes various problems from epidemiology, ecology, and physiology. All chapters include realistic biological examples, including many exercises related to biological questions. In addition, 25 open-ended research projects are provided, suitable for students. An accompanying Web site contains solutions and a tutorial for the implementation of the computational modeling techniques. Calculations can be done in modern computing languages such as Maple, Mathematica, and MATLAB.

Mathematical Modeling and Computation of Real-Time Problems Princeton University Press

Designed for classroom use, this book contains short, self-contained mathematical models of problems in the physical, mathematical, and biological sciences first published in the Classroom Notes section of the SIAM Review from 1975-1985. The problems provide an ideal way to make complex subject matter more accessible to the student through the use of concrete applications. Each section has extensive supplementary references provided by the editor from his years of experience with mathematical modelling.

Mathematical Modeling and Simulation Springer Science & Business Media

Topics in Mathematical Modeling is an introductory textbook on mathematical modeling. The book teaches how simple mathematics can help formulate and solve real problems of current research interest in a wide range of fields, including biology, ecology, computer science, geophysics, engineering, and the social sciences. Yet the prerequisites are minimal: calculus and elementary differential equations. Among the many topics addressed are HIV; plant phyllotaxis; global warming; the World Wide Web; plant and animal vascular networks; social networks; chaos and fractals; marriage and divorce; and El Niño. Traditional modeling topics such as predator-prey interaction, harvesting, and wars of attrition are also included. Most chapters begin with the history of a problem, follow with a demonstration of how it can be modeled using various mathematical tools, and close with a discussion of its remaining unsolved aspects. Designed for a one-semester course, the book progresses from problems that can be solved with relatively simple mathematics to ones that require more sophisticated methods. The math techniques are taught as needed to solve the problem being addressed, and each chapter is designed to be largely independent to give teachers flexibility. The book, which can be used as an overview and introduction to applied mathematics, is particularly suitable for sophomore, junior, and senior students in math, science, and engineering.

Mathematical Modeling in Continuum Mechanics Cambridge University Press

Multivariate statistics and mathematical models provide flexible and powerful tools essential in most disciplines. Nevertheless, many practicing researchers lack an adequate knowledge of these techniques, or did once know the techniques, but have not been able to keep abreast of new developments. The Handbook of Applied Multivariate Statistics and Mathematical Modeling explains the appropriate uses of multivariate procedures and mathematical modeling techniques, and prescribe practices that enable applied researchers to use these procedures effectively without needing to concern themselves with the mathematical basis. The Handbook emphasizes using models and statistics as tools. The objective of the book is to inform readers about which tool to use to accomplish which task. Each chapter begins with a discussion of what kinds of questions a particular technique can and cannot answer. As multivariate statistics and modeling techniques are useful across disciplines, these examples include issues of concern in biological and social sciences as well as the humanities.

A Primer in Mathematical Models in Biology CRC Press

An important resource that provides an overview of mathematical modelling Mathematical Modelling offers a comprehensive guide to both analytical and computational aspects of mathematical modelling that encompasses a wide range of subjects. The authors provide an overview of the basic concepts of mathematical modelling and review the relevant topics from differential equations and linear algebra. The text explores the various types of mathematical models, and includes a range of examples that help to describe a variety of techniques from dynamical systems theory. The book's analytical techniques examine compartmental modelling, stability, bifurcation, discretization, and fixed-point analysis. The theoretical analyses involve systems of ordinary differential equations for deterministic models. The text also contains information on concepts of probability and random variables as the requirements of stochastic processes. In addition, the authors describe algorithms for computer simulation of both deterministic and stochastic

models, and review a number of well-known models that illustrate their application in different fields of study. This important resource: Includes a broad spectrum of models that fall under deterministic and stochastic classes and discusses them in both continuous and discrete forms Demonstrates the wide spectrum of problems that can be addressed through mathematical modelling based on fundamental tools and techniques in applied mathematics and statistics Contains an appendix that reveals the overall approach that can be taken to solve exercises in different chapters Offers many exercises to help better understand the modelling process Written for graduate students in applied mathematics, instructors, and professionals using mathematical modelling for research and training purposes, *Mathematical Modelling: A Graduate Textbook* covers a broad range of analytical and computational aspects of mathematical modelling.

Progress in Applied Mathematical Modeling Springer Nature

This book provides a readable and informative introduction to the development and application of mathematical models in science and engineering. The first half of the book begins with a clearly defined set of modeling principles, and then introduces a set of foundational tools (dimensional analysis, scaling techniques, and approximation and validation techniques). The second half then applies these foundational tools to a broad variety of subjects, including exponential growth and decay in fields ranging from biology to economics, traffic flow, free and forced vibration of mechanical and other systems, and optimization problems in biology, structures, and social decision making. An extensive collection of more than 360 problems offer ample opportunity in both a formal course and for the individual reader. (Midwest).

Handbook of Applied Multivariate Statistics and Mathematical Modeling Mdpi AG

Thirty years ago, biologists could get by with a rudimentary grasp of mathematics and modeling. Not so today. In seeking to answer 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, 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 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 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 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 theories and models themselves. This innovative book will be an indispensable guide to the world of mathematical models for the next generation of biologists. A how-to guide for developing new mathematical models in biology Provides step-by-step recipes for constructing and analyzing models Interesting biological applications Explores classical models in ecology and evolution Questions at the end of every chapter Primers cover important mathematical topics Exercises with answers Appendixes summarize useful rules Labs and advanced material available

Mathematical Modeling in Chemistry SIAM

One cannot watch or read about the news these days without hearing about the models for COVID-19 or the testing that must occur to approve vaccines or treatments for the disease. The purpose of *Mathematical Modeling in the Age of a Pandemic* is to shed some light on the meaning and interpretations of many of the types of models that are or might be used in the presentation of analysis. Understanding the concepts presented is essential in the entire modeling process of a pandemic. From the virus itself and its infectious rates and deaths rates to explain the process for testing a vaccine or eventually a cure, the author builds, presents, and shows model testing. This book is an attempt, based on available data, to add some validity to the models developed and used, showing how close to reality the models are to predicting "results" from previous pandemics such as the Spanish flu in 1918 and more recently the Hong Kong flu. Then the author applies those same models to Italy, New York City, and the United States as a whole. Modeling is a process. It is essential to understand that there are many assumptions that go into the modeling of each type of model. The assumptions influence the interpretation of the results. Regardless of the modeling approach the results generally indicate approximately the same results. This book reveals how these interesting results are obtained.

Mathematical Modeling and Computational Methods MDPI

Nature-Inspired Optimization Algorithms provides a systematic introduction to all major nature-inspired algorithms for optimization. The book's unified approach, balancing algorithm introduction, theoretical background and practical implementation, complements extensive literature with well-chosen case studies to illustrate how these algorithms work. Topics include particle swarm optimization, ant and bee algorithms, simulated annealing, cuckoo search, firefly algorithm, bat algorithm, flower algorithm, harmony search, algorithm analysis, constraint handling, hybrid methods, parameter tuning and control, as well as multi-objective optimization. This book can serve as an introductory book for graduates, doctoral students and lecturers in computer science, engineering and natural sciences. It can also serve a source of inspiration for new applications. Researchers and engineers as well as experienced experts will also find it a handy reference. Discusses and summarizes the latest developments in nature-inspired algorithms with comprehensive, timely literature Provides a theoretical understanding as well as practical implementation hints Provides a step-by-step introduction to each algorithm

Principles of Mathematical Modeling Academic Press

Features mathematical modeling techniques and real-world processes with applications in diverse fields *Mathematical Modeling with Multidisciplinary Applications* details the interdisciplinary nature of mathematical modeling and numerical algorithms. The book combines a variety of applications from diverse fields to illustrate how the methods can be used to model physical processes, design new products, find solutions to challenging problems, and increase competitiveness in international markets. Written by leading scholars and international experts in the field, the book presents new and emerging topics in areas including finance and economics, theoretical and applied mathematics, engineering and machine learning, physics, chemistry, ecology, and social science. In addition, the book thoroughly summarizes widely used mathematical and numerical methods in mathematical modeling and features: Diverse topics such as partial differential equations (PDEs), fractional calculus, inverse problems by ordinary differential equations (ODEs), semigroups, decision theory, risk analysis, Bayesian estimation, nonlinear PDEs in financial engineering, perturbation analysis, and dynamic system modeling Case studies and real-world applications that are widely used for current mathematical modeling courses, such as the green house effect and Stokes flow estimation Comprehensive coverage of a wide range of contemporary topics, such as game theory, statistical models, and analytical solutions to numerical methods Examples, exercises with select solutions, and detailed references to the latest literature to solidify comprehensive learning New techniques and applications with balanced coverage of PDEs, discrete models, statistics, fractional calculus, and more *Mathematical Modeling with Multidisciplinary Applications* is an excellent book for courses on mathematical modeling and applied mathematics at the upper-undergraduate and graduate levels. The book also serves as a valuable reference for research scientists, mathematicians, and engineers who would like to develop further insights into essential mathematical tools.

Mathematical Models in Biology John Wiley & Sons

Mathematical modelling in biomedicine is a rapidly developing scientific discipline at the intersection of medicine, biology, mathematics, physics, and computer science. Its progress is stimulated by

fundamental scientific questions and by the applications to public health. This book represents a collection of papers devoted to mathematical modelling of various physiological problems in normal and pathological conditions. It covers a broad range of topics including cardiovascular system and diseases, heart and brain modelling, tumor growth, viral infections, and immune response. Computational models of blood circulation are used to study the influence of heart arrhythmias on coronary blood flow and on operating modes for left-ventricle-assisted devices. Wave propagation in the cardiac tissue is investigated in order to show the influence of tissue heterogeneity and fibrosis. The models of tumor growth are used to determine optimal protocols of antiangiogenic and radiotherapy. The models of viral hepatitis kinetics are considered for the parameter identification, and the evolution of viral quasi-species is investigated. The book presents the state-of-the-art in mathematical modelling in biomedicine and opens new perspectives in this passionate field of research.

Semi-empirical Neural Network Modeling and Digital Twins Development International Journal of Mathematical Modeling, Simulation and Applications

A self-contained and comprehensive guide to the mathematical modeling of disease transmission, appropriate for graduate students.