

INTERDISCIPLINARY APPLIED MATHEMATICS

MATHEMATICAL BIOLOGY

Mathematical Physiology

II: Systems Physiology

James Keener
James Sneyd

Second Edition



Mathematical Physiology Ii Systems Physiology Interdisciplinary Applied Mathematics

James Keener, James Sneyd



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Mathematical Physiology James Keener, James Sneyd, 2009-01-06 Divided into two volumes the book begins with a pedagogical presentation of some of the basic theory with chapters on biochemical reactions diffusion excitability wave propagation and cellular homeostasis The second more extensive part discusses particular physiological systems with chapters on calcium dynamics bursting oscillations and secretion cardiac cells muscles intercellular communication the circulatory system the immune system wound healing the respiratory system the visual system hormone physiology renal physiology digestion the visual system and hearing New chapters on Calcium Dynamics Neuroendocrine Cells and Regulation of Cell Function have been included *Mathematical Physiology*

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Callender Highlander, Alex Capaldi, Carrie Diaz Eaton, 2020-02-17 Speaking directly to the growing importance of research experience in undergraduate mathematics programs this volume offers suggestions for undergraduate appropriate research projects in mathematical and computational biology for students and their faculty mentors The aim of each chapter is twofold for faculty to alleviate the challenges of identifying accessible topics and advising students through the research process for students to provide sufficient background additional references and context to excite students in these areas and to enable them to successfully undertake these problems in their research Some of the topics discussed include Oscillatory behaviors present in real world applications from seasonal outbreaks of childhood diseases to action potentials in neurons Simulating bacterial growth competition and resistance with agent based models and laboratory experiments Network structure and the dynamics of biological systems Using neural networks to identify bird species from birdsong samples Modeling fluid flow induced by the motion of pulmonary cilia Aimed at undergraduate mathematics faculty and advanced undergraduate students this unique guide will be a valuable resource for generating fruitful research collaborations between students and faculty

Optimal Trajectory Tracking of Nonlinear Dynamical Systems Jakob Löber, 2016-12-20 By establishing an alternative foundation of control theory this thesis represents a significant advance in the theory of control systems of interest to a broad range of scientists and engineers While common control strategies for dynamical systems center on the system state as the object to be controlled the approach developed here focuses on the state trajectory The concept of precisely realizable trajectories identifies those trajectories that can be accurately achieved by applying appropriate control signals The resulting simple expressions for the control signal lend themselves to immediate application in science and technology The approach permits the generalization of many well known results from the control theory of linear systems e g the Kalman rank condition to nonlinear systems The relationship between controllability optimal control and trajectory tracking are clarified Furthermore the existence of linear structures underlying nonlinear optimal control is revealed enabling the derivation of exact analytical solutions to an entire class of nonlinear optimal trajectory tracking problems The clear and self contained presentation focuses on a general and mathematically rigorous analysis of controlled dynamical systems The concepts developed are visualized with the help of particular dynamical systems motivated by physics and chemistry

Nonlinear Dynamics in Physiology and Medicine Anne Beuter, Leon Glass, Michael C. Mackey, Michele S. Titcombe, 2003-09-12 Introduces concepts from nonlinear dynamics using an almost exclusively biological setting for motivation and includes examples of how these concepts are used in experimental investigations of biological and physiological systems One novel feature of the book is the inclusion of classroom tested computer exercises This book will appeal to students and researchers working in the natural and physical sciences wanting to learn about physiological systems from a mathematical perspective

Biohybrid Systems Ranu Jung, 2012-09-19 The discipline of neurodesign is a highly interdisciplinary one while at the same time in the process of maturing towards real life applications The breakthrough about

to be achieved is to close the loop in communication between neural systems and electronic and mechatronic systems and actually let the nervous system adapt to the feedback from the man made systems To master this loop scientists need a sound understanding of neurology from the cellular to the systems scale of man made systems and how to connect the two These scientists comprise medical scientists neurologists and physiologists engineers as well as biophysicists And they need the topics in a coherently written work with chapters building upon another

Algebraic and Symbolic Computation Methods in Dynamical Systems Alban Quadrat,Eva Zerz,2020-05-30 This book aims at reviewing recent progress in the direction of algebraic and symbolic computation methods for functional systems e g ODE systems differential time delay equations difference equations and integro differential equations In the nineties modern algebraic theories were introduced in mathematical systems theory and in control theory Combined with real algebraic geometry which was previously introduced in control theory the past years have seen a flourishing development of algebraic methods in control theory One of the strengths of algebraic methods lies in their close connections to computations The use of the above mentioned algebraic theories in control theory has been an important source of motivation to develop effective versions of these theories when possible With the development of computer algebra and computer algebra systems symbolic methods for control theory have been developed over the past years The goal of this book is to propose a partial state of the art in this direction To make recent results more easily accessible to a large audience the chapters include materials which survey the main mathematical methods and results and which are illustrated with explicit examples

Progress in Differential-Algebraic Equations II Timo Reis,Sara Grundel,Sebastian Schöps,2020-10-10 This book contains articles presented at the 9th Workshop on Differential Algebraic Equations held in Paderborn Germany from 17-20 March 2019 The workshop brought together more than 40 mathematicians and engineers from various fields such as numerical and functional analysis control theory mechanics and electromagnetic field theory The participants focussed on the theoretical and numerical treatment of descriptor systems i e differential algebraic equations DAEs The book contains 14 contributions and is organized into four parts mathematical analysis numerics and model order reduction control as well as applications It is a useful resource for applied mathematicians with interest in recent developments in the field of differential algebraic equations but also for engineers in particular those interested in modelling of constraint mechanical systems thermal networks or electric circuits

Hemomath Antonio Fasano,Adélia Sequeira,2017-10-30 This book illustrates applications of mathematics to various processes physiological or artificial involving flowing blood including hemorheology microcirculation coagulation kidney filtration and dialysis offering a historical overview of each topic Mathematical models are used to simulate processes normally occurring in flowing blood and to predict the effects of dysfunctions e g bleeding disorders renal failure as well as the effects of therapies with an eye to improving treatments Most of the models have a completely new approach that makes patient specific simulations possible The book is mainly intended for mathematicians interested in medical applications but it

is also useful for clinicians such as hematologists nephrologists cardio surgeons and bioengineers Some parts require no specific knowledge of mathematics The book is a valuable addition to mathematics medical biology and bioengineering libraries

A First Course in Systems Biology Eberhard Voit, Melissa L. Kemp, 2025-01-20 A First Course in Systems Biology Third Edition is an introduction to the growing field of systems biology for advanced undergraduates and graduate students Its focus is the design and analysis of computational models and their applications to diverse biomedical phenomena from simple networks and kinetics to complex pathway systems signal transduction personalized medicine and interacting populations The book begins with the fundamentals of computational modeling then reviews features of the molecular inventories that bring biological systems to life and ends with case studies that reflect some of the frontiers in systems biology In this way the First Course provides the reader with a comprehensive background and with access to methods for executing standard tasks of biomedical systems analysis exposure to the modern literature and a foundation for launching into specialized projects that address biomedical questions with theoretical and computational means This third edition has been thoroughly updated It provides an introduction to agent based and multiscale modeling a deeper account of biological design principles and the optimization of metabolic flux distributions This edition also discusses novel topics of synthetic biology personalized medicine and virtual clinical trials that are just emerging on the horizon of this field

Mathematical Modeling, Computational Intelligence Techniques and Renewable Energy Manoj Sahni, José M. Merigó, Brajesh Kumar Jha, Rajkumar Verma, 2021-02-28 This book presents new knowledge and recent developments in all aspects of computational techniques mathematical modeling energy systems applications of fuzzy sets and intelligent computing The book is a collection of best selected research papers presented at the International Conference on Mathematical Modeling Computational Intelligence Techniques and Renewable Energy organized by the Department of Mathematics Pandit Deendayal Petroleum University in association with Forum for Interdisciplinary Mathematics Institution of Engineers IEI Gujarat and Computer Society of India CSI Ahmedabad The book provides innovative works of researchers academicians and students in the area of interdisciplinary mathematics statistics computational intelligence and renewable energy

Methods in Bioengineering Arul Jayaraman, Juergen Hahn, 2009 This cutting edge volume provides a detailed look at the two main aspects of systems biology the design of sophisticated experimental methods and the development of complex models to analyze the data Focusing on methods that are being used to solve current problems in biomedical science and engineering this comprehensive richly illustrated resource shows you how to design of state of the art methods for analyzing biological systems Implement experimental approaches for investigating cellular behavior in health and disease use algorithms and modeling techniques for quantitatively describing biomedical problems and integrate experimental and computational approaches for a more complete view of biological systems Book Jacket

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Using the Biological Literature Diane Schmidt, 2014-04-14 The biological sciences cover a broad array of literature types from younger fields like molecular biology with its reliance on recent journal articles genomic databases and protocol manuals to classic fields such as taxonomy with its scattered literature found in monographs and journals from the past three centuries *Using the Biological Literature A Practical Guide Fourth Edition* is an annotated guide to selected resources in the biological sciences presenting a wide ranging list of important sources This completely revised edition contains numerous new resources and descriptions of all entries including textbooks The guide emphasizes current materials in the English language and includes retrospective references for historical perspective and to provide access to the taxonomic literature It covers both print and electronic resources including monographs journals databases indexes and abstracting tools websites and associations providing users with listings of authoritative informational resources of both classical and recently published works With chapters devoted to each of the main fields in the basic biological sciences this book offers a guide to the best and most up to date resources in biology It is appropriate for anyone interested in searching the biological literature from undergraduate students to faculty researchers and librarians The guide includes a supplementary website dedicated to keeping URLs of electronic and web based resources up to date a popular feature continued from the third edition

Chaos in Classical and Quantum Mechanics Martin C. Gutzwiller, 2013-11-27 Describes the chaos apparent in simple mechanical systems with the goal of elucidating the connections between classical and quantum

mechanics It develops the relevant ideas of the last two decades via geometric intuition rather than algebraic manipulation The historical and cultural background against which these scientific developments have occurred is depicted and realistic examples are discussed in detail This book enables entry level graduate students to tackle fresh problems in this rich field

Quantitative Systems Pharmacology Davide Manca, 2018-07-18 Quantitative Systems Pharmacology Models and Model Based Systems with Applications Volume 42 provides a quantitative approach to problem solving that is targeted to engineers The book gathers the contributions of doctors pharmacists biologists and chemists who give key information on the elements needed to model a complex machine like the human body It presents information on diagnoses administration and release of therapeutics distribution metabolism and excretion of drugs compartmental pharmacokinetics physiologically based pharmacokinetics pharmacodynamics identifiability of models numerical methods for models identification design of experiments in vitro and in vivo models and more As the pharma community is progressively acknowledging that a quantitative and systematic approach to drug administration release pharmacokinetics and pharmacodynamics is highly recommended to understand the mechanisms and effects of drugs this book is a timely resource Outlines a model based approach based on Process Systems Engineering OSE and Computer Aided Process Engineering CAPE in quantitative pharmacology Explains how therapeutics work in the human body and how anatomy and physiology influences drug efficacy Discusses how drugs are driven to specific targets using nanoparticles Offers insight into how in vitro and in vivo experiments help understand the drug mechanism of action and optimize their performance Includes case studies showing the positive outcome of these methods in personalized therapies therapeutic drug monitoring clinical trials analysis and drug formulation

Applied Stochastic Analysis Weinan E, Tiejun Li, Eric Vanden-Eijnden, 2021-09-22 This is a textbook for advanced undergraduate students and beginning graduate students in applied mathematics It presents the basic mathematical foundations of stochastic analysis probability theory and stochastic processes as well as some important practical tools and applications e g the connection with differential equations numerical methods path integrals random fields statistical physics chemical kinetics and rare events The book strikes a nice balance between mathematical formalism and intuitive arguments a style that is most suited for applied mathematicians Readers can learn both the rigorous treatment of stochastic analysis as well as practical applications in modeling and simulation Numerous exercises nicely supplement the main exposition

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