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Charles S. Peskin

Modeling and Simulation in Medicine and the Life Sciences

Second Edition

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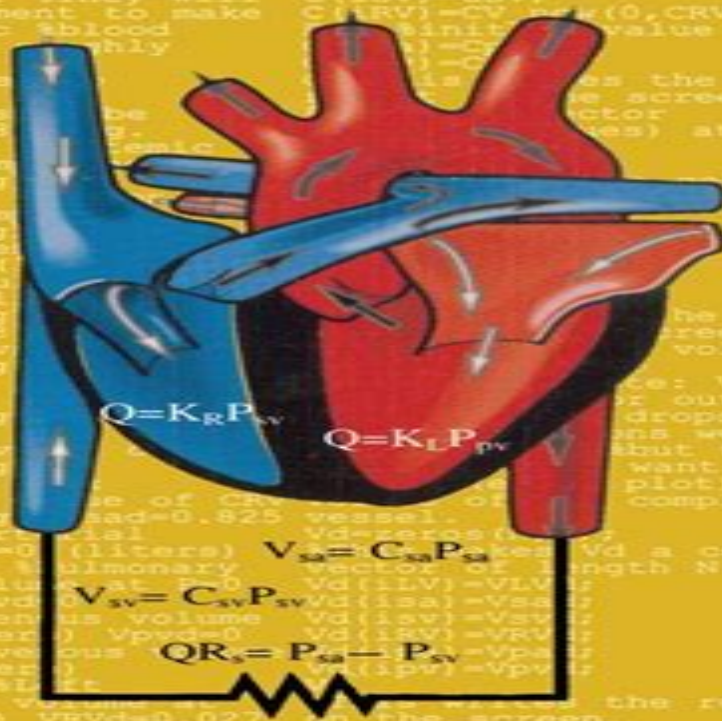
Mathematics And Simulation In Medicine And The Life Sciences

Kristine K. Fowler

Mathematics And Simulation In Medicine And The Life Sciences:

Modeling and Simulation in Medicine and the Life Sciences Frank C. Hoppensteadt,Charles S. Peskin,2012-12-06 Mathematics in Medicine and the Life Sciences grew from lectures given by the authors at New York University the University of Utah and Michigan State University The material is written for students who have had but one term of calculus but it contains material that can be used in modeling courses in applied mathematics at all levels through early graduate courses Numerous exercises are given as well and solutions to selected exercises are included Numerous illustrations depict physiological processes population biology phenomena models of them and the results of computer simulations Mathematical models and methods are becoming increasingly important in medicine and the life sciences This book provides an introduction to a wide diversity of problems ranging from population phenomena to demographics genetics epidemics and dispersal in physiological processes including the circulation gas exchange in the lungs control of cell volume the renal counter current multiplier mechanism and muscle mechanics to mechanisms of neural control Each chapter is graded in difficulty so a reading of the first parts of each provides an elementary introduction to the processes and their models Materials that deal with the same topics but in greater depth are included later Finally exercises and some solutions are given to test the reader on important parts of the material in the text or to lead the reader to the discovery of interesting extensions of that material   *Mathematics in Medicine and the Life Sciences* Frank C. Hoppensteadt,Charles S. Peskin,2013-03-09 The aim of this book is to introduce the subject of mathematical modeling in the life sciences It is intended for students of mathematics the physical sciences and engineering who are curious about biology Additionally it will be useful to students of the life sciences and medicine who are unsatisfied with mere description and who seek an understanding of biological mechanism and dynamics through the use of mathematics The book will be particularly useful to premedical students because it will introduce them not only to a collection of mathematical methods but also to an assortment of phenomena involving genetics epidemics and the physiology of the heart lung and kidney Because of its introductory character mathematical prerequisites are kept to a minimum they involve only what is usually covered in the first semester of a calculus sequence The authors have drawn on their extensive experience as modelers to select examples which are simple enough to be understood at this elementary level and yet realistic enough to capture the essence of significant biological phenomena drawn from the areas of population dynamics and physiology Because the models presented are realistic the book can serve not only as an introduction to mathematical methods but also as a mathematical introduction to the biological material itself For the student who enjoys mathematics such an introduction will be far more stimulating and satisfying than the purely descriptive approach that is traditional in the biological sciences   *Modeling and Simulation in Medicine and the Life Sciences* Frank C Hoppensteadt,Charles S Peskin,2001-10-05   *Mathematics in Medicine and the Life Sciences* Frank C. Hoppensteadt,Charles Peskin,2014-01-15   *Using the Mathematics Literature* Kristine K. Fowler,2004-05-25 This

reference serves as a reader friendly guide to every basic tool and skill required in the mathematical library and helps mathematicians find resources in any format in the mathematics literature It lists a wide range of standard texts journals review articles newsgroups and Internet and database tools for every major subfield in mathematics and details methods of access to primary literature sources of new research applications results and techniques Using the Mathematics Literature is the most comprehensive and up to date resource on mathematics literature in both print and electronic formats presenting time saving strategies for retrieval of the latest information **Mathematical Methods for Analysis of a Complex Disease** F. C. Hoppensteadt,2011-09-23 Complex diseases involve most aspects of population biology including genetics demographics epidemiology and ecology Mathematical methods including differential difference and integral equations numerical analysis and random processes have been used effectively in all of these areas The aim of this book is to provide sufficient background in such mathematical and computational methods to enable the reader to better understand complex systems in biology medicine and the life sciences It introduces concepts in mathematics to study population phenomena with the goal of describing complicated aspects of a disease such as malaria involving several species The book is based on a graduate course in computational biology and applied mathematics taught at the Courant Institute of Mathematical Sciences in fall 2010 The mathematical level is kept to essentially advanced undergraduate mathematics and the results in the book are intended to provide readers with tools for performing more in depth analysis of population phenomena **A Comprehensive Physically Based Approach to Modeling in Bioengineering and Life Sciences** Riccardo Sacco,Giovanna Guidoboni,Aurelio Giancarlo Mauri,2019-07-18 A Comprehensive Physically Based Approach to Modeling in Bioengineering and Life Sciences provides a systematic methodology to the formulation of problems in biomedical engineering and the life sciences through the adoption of mathematical models based on physical principles such as the conservation of mass electric charge momentum and energy It then teaches how to translate the mathematical formulation into a numerical algorithm that is implementable on a computer The book employs computational models as synthesized tools for the investigation quantification verification and comparison of different conjectures or scenarios of the behavior of a given compartment of the human body under physiological and pathological conditions Presents theoretical modeling biological experimental and computational simulation perspectives Features examples exercises and MATLAB codes for further reader involvement Covers basic and advanced functional and computational techniques throughout the book **An Introduction to the Mathematics of Neurons** Frank C. Hoppensteadt,F. C. Hoppensteadt,1997-06-28 This book describes the signal processing aspects of neural networks It begins with a presentation of the necessary background material in electronic circuits mathematical modeling and analysis signal processing and neurosciences and then proceeds to applications These applications include small networks of neurons such as those used in control of warm up and flight in moths and control of respiration during exercise in humans Next a theory of mnemonic surfaces is developed and studied and

material on pattern formation and cellular automata is presented Finally large networks are studied such as the thalamus reticular complex circuit believed to be involved in focusing attention and the development of connections in the visual cortex Additional material is also provided about nonlinear wave propagation in networks This book will serve as an excellent text for advanced undergraduates and graduates in the physical sciences mathematics engineering medicine and life sciences

Physics of the Human Body Irving P. Herman,2016-01-09 This book comprehensively addresses the physics and engineering aspects of human physiology by using and building on first year college physics and mathematics Topics include the mechanics of the static body and the body in motion the mechanical properties of the body muscles in the body the energetics of body metabolism fluid flow in the cardiovascular and respiratory systems the acoustics of sound waves in speaking and hearing vision and the optics of the eye the electrical properties of the body and the basic engineering principles of feedback and control in regulating all aspects of function The goal of this text is to clearly explain the physics issues concerning the human body in part by developing and then using simple and subsequently more refined models of the macrophysics of the human body Many chapters include a brief review of the underlying physics There are problems at the end of each chapter solutions to selected problems are also provided This second edition enhances the treatments of the physics of motion sports and diseases and disorders and integrates discussions of these topics as they appear throughout the book Also it briefly addresses physical measurements of and in the body and offers a broader selection of problems which as in the first edition are geared to a range of student levels This text is geared to undergraduates interested in physics medical applications of physics quantitative physiology medicine and biomedical engineering **Visualization in Medicine and Life Sciences III** Lars Linsen,Bernd Hamann,Hans-Christian Hege,2016-05-21 The book discusses novel visualization techniques driven by the needs in medicine and life sciences as well as new application areas and challenges for visualization within these fields It presents ideas and concepts for visual analysis of data from scientific studies of living organs or to the delivery of healthcare Target scientific domains include the entire field of biology at all scales from genes and proteins to organs and populations as well as interdisciplinary research based on technological advances such as bioinformatics biomedicine biochemistry or biophysics Moreover they comprise the field of medicine and the application of science and technology to healthcare problems This book does not only present basic research pushing the state of the art in the field of visualization but it also documents the impact in the fields of medicine and life sciences *Mathematical Modeling in the Social and Life Sciences* Michael Olinick,2014-05-05 The goal of this book is to encourage the teaching and learning of mathematical model building relatively early in the undergraduate program The text introduces the student to a number of important mathematical topics and to a variety of models in the social sciences life sciences and humanities *Partial Differential Equations with Numerical Methods* Stig Larsson,Vidar Thomee,2008-11-19 The main theme is the integration of the theory of linear PDE and the theory of finite difference and finite element methods For each type of PDE elliptic parabolic

and hyperbolic the text contains one chapter on the mathematical theory of the differential equation followed by one chapter on finite difference methods and one on finite element methods The chapters on elliptic equations are preceded by a chapter on the two point boundary value problem for ordinary differential equations Similarly the chapters on time dependent problems are preceded by a chapter on the initial value problem for ordinary differential equations There is also one chapter on the elliptic eigenvalue problem and eigenfunction expansion The presentation does not presume a deep knowledge of mathematical and functional analysis The required background on linear functional analysis and Sobolev spaces is reviewed in an appendix The book is suitable for advanced undergraduate and beginning graduate students of applied mathematics and engineering   *Introduction to Modeling in Physiology and Medicine* Claudio Cobelli,Ewart Carson,2019-08-01 Introduction to Modeling in Physiology and Medicine Second Edition develops a clear understanding of the fundamental principles of good modeling methodology Sections show how to create valid mathematical models that are fit for a range of purposes These models are supported by detailed explanation extensive case studies examples and applications This updated edition includes clearer guidance on the mathematical prerequisites needed to achieve the maximum benefit from the material a greater detail regarding basic approaches to modeling and discussions on non linear and stochastic modeling The range of case study material has been substantially extended with examples drawn from recent research experience Key examples include a cellular model of insulin secretion and its extension to the whole body level a model of insulin action during a meal oral glucose tolerance test a large scale simulation model of type 1 diabetes and its use in in silico clinical trials and drug trials Covers the underlying principles of good quantitative modeling methodology with applied biomedical engineering and bioscience examples to ensure relevance to students current research and clinical practice Includes modeling data modeling systems linear and non linear systems model identification parametric and non parametric models and model validation Presents clear step by step working plus examples and extensive case studies that relate concepts to real world applications Provides end of chapter exercises and assignments to reinforce learning   Mathematical Studies on Human Disease Dynamics Abba B. Gumel,Carlos Castillo-Chávez,Ronald E. Mickens,Dominic P. Clemence,2006 This volume contains the proceedings of the AMS SIAM IMS Joint Summer Research Conference on Modeling the Dynamics of Human Diseases Emerging Paradigms and Challenges held in Snowbird Utah July 17 21 2005 The goal of the conference was to bring together leading and upcoming researchers to discuss the latest advances and challenges associated with the modeling of the dynamics of emerging and re emerging diseases and to explore various control strategies The articles included in this book are devoted to some of the significant recent advances trends and challenges associated with the mathematical modeling and analysis of the dynamics and control of some diseases of public health importance In addition to illustrating many of the diverse prevailing epidemiological challenges together with the diversity of mathematical approaches needed to address them this book provides insights on a number of topical modeling issues such as the modeling and control of

mosquito borne diseases respiratory diseases animal diseases such as foot and mouth disease cancer and tumor growth modeling influenza HIV HPV rotavirus etc This book also touches upon other important topics such as the use of modeling i

Visualization in Medicine and Life Sciences II Lars Linsen,Hans Hagen,Bernd Hamann,Hans-Christian Hege,2012-01-11 For some time medicine has been an important driver for the development of data processing and visualization techniques Improved technology offers the capacity to generate larger and more complex data sets related to imaging and simulation This in turn creates the need for more effective visualization tools for medical practitioners to interpret and utilize data in meaningful ways The first edition of Visualization in Medicine and Life Sciences VMLS emerged from a workshop convened to explore the significant data visualization challenges created by emerging technologies in the life sciences The workshop and the book addressed questions of whether medical data visualization approaches can be devised or improved to meet these challenges with the promise of ultimately being adopted by medical experts Visualization in Medicine and Life Sciences II follows the second international VMLS workshop held in Bremerhaven Germany in July 2009 Internationally renowned experts from the visualization and driving application areas came together for this second workshop The book presents peer reviewed research and survey papers which document and discuss the progress made explore new approaches to data visualization and assess new challenges and research directions **Complex Systems and Population Health** Yorghos Apostolopoulos,Kristen Hassmiller Lich,Michael K. Lemke,2020-05-29 Currently population health science is an integral part of global academic curricula For over a century the principles of the reductionist paradigm have guided population health curricula training research and action Researchers continue to draw upon these principles when theorizing conceptualizing designing studies analyzing and devising interventions to tackle complex population health problems However unresolved impasses in addressing pressing population health challenges have catalyzed calls for the integration of complex systems science grounded approaches into population health science Mounting evidence denotes that a complex systems paradigm can bring about dramatic multipronged changes for education and training and lead to innovative research interventions and policies Despite the large and untapped promise of complex systems the haphazard knowledge base from which academics researchers students policymakers and practitioners can draw has slowed their integration into the population health sciences This volume fulfils this growing need by providing the knowledge base necessary to introduce a holistic complex systems paradigm in population health science As such it is the first comprehensive book in population health science that meaningfully integrates complex systems theory methodology modeling computational simulation and real world applications while incorporating current population health theoretical methodological and analytical perspectives It is intended as a programmatic primer across a broad spectrum of population health stakeholders from university professors and graduate students to researchers policymakers and practitioners **Digital Human Modeling and Medicine** Gunther Paul,Mohamed H. Doweidar,2022-12-04 Digital Human Modeling and Medicine The Digital Twin explores the body of

knowledge and state of the art in Digital Human Modeling DHM and its applications in medicine DHM is the science of representing humans with their physical properties characteristics and behaviors in computerized virtual models These models can be used standalone or integrated with other computerized object design systems to both design or study designs of medical devices or medical device products and their relationship with humans They serve as fast and cost efficient computer based tools for the assessment of human functional systems and human system interaction This book provides an industry first introductory and practitioner focused overview of human simulation tools with detailed chapters describing body functional elements and organs organ interactions and fields of application Thus DHM tools and a specific scientific practical problem functional study of the human body are linked in a coherent framework Eventually the book shows how DHM interfaces with common physical devices in medical practice answering to a gap in literature and a common practitioner question Case studies provide the applied knowledge for practitioners to make informed decisions A non specialist level up to date overview and introduction to all medically relevant DHM systems to inform trialing procurement decisions and initial application Includes user level examples and case studies of DHM applications in various medical fields Clearly structured and focused compendium that is easy to access read and understand   MacArthur Fellows ,2005

  Mathematics for Life Science and Medicine Yasuhiro Takeuchi,Yoh Iwasa,Kazunori Sato,2007-01-25 Dynamical systems theory in mathematical biology has attracted much attention from many scientific directions The purpose of this volume is to present and discuss the many rich properties of the dynamical systems that appear in life science and medicine The main topics include cancer treatment dynamics of paroxysmal tachycardia vector disease model epidemic diseases and metapopulations immune systems pathogen competition and coexistence and the evolution of virulence and the rapid evolution of viruses within a host Each chapter will serve to introduce students and scholars to the state of the art in an exciting area to present new results and to inspire future contributions to mathematical modeling in life science and medicine   National Library of Medicine Current Catalog National Library of Medicine (U.S.),

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