

Texts in Applied Mathematics

Fred Brauer
Carlos Castillo-Chavez

Mathematical Models in Population Biology and Epidemiology

Second Edition

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Mathematical Models In Population Biology And Epidemiology Texts In Applied Mathematics

Carlos Castillo-Chavez



Mathematical Models In Population Biology And Epidemiology Texts In Applied Mathematics:

Mathematical Models in Population Biology and Epidemiology Fred Brauer, Carlos Castillo-Chavez, 2013-03-09 As the world population exceeds the six billion mark questions of population explosion of how many people the earth can support and under which conditions become pressing Some of the questions and challenges raised can be addressed through the use of mathematical models but not all The goal of this book is to search for a balance between simple and analyzable models and unsolvable models which are capable of addressing important questions such as these Part I focusses on single species simple models including those which have been used to predict the growth of human and animal population in the past Single population models are in some sense the building blocks of more realistic models the subject of Part II Their role is fundamental to the study of ecological and demographic processes including the role of population structure and spatial heterogeneity the subject of Part III This book which includes both examples and exercises will be useful to practitioners graduate students and scientists working in the field

Mathematical Models in Population Biology and Epidemiology Fred Brauer, Dawn Bies, 2011-11-08 The goal of this book is to search for a balance between simple and analyzable models and unsolvable models which are capable of addressing important questions on population biology Part I focusses on single species simple models including those which have been used to predict the growth of human and animal population in the past Single population models are in some sense the building blocks of more realistic models the subject of Part II Their role is fundamental to the study of ecological and demographic processes including the role of population structure and spatial heterogeneity the subject of Part III This book which will include both examples and exercises is of use to practitioners graduate students and scientists working in the field

Mathematical Approaches for Emerging and Reemerging Infectious Diseases: An Introduction Carlos Castillo-Chavez, 2002-05-02 This book grew out of the discussions and presentations that began during the Workshop on Emerging and Reemerging Diseases May 17 21 1999 sponsored by the Institute for Mathematics and its Application IMA at the University of Minnesota with the support of NIH and NSF The workshop started with a two day tutorial session directed at ecologists epidemiologists immunologists mathematicians and scientists interested in the study of disease dynamics The core of this first volume Volume 125 covers tutorial and research contributions on the use of dynamical systems deterministic discrete delay PDEs and ODEs models and stochastic models in disease dynamics The volume includes the study of cancer HIV pertussis and tuberculosis Beginning graduate students in applied mathematics scientists in the natural social or health sciences or mathematicians who want to enter the fields of mathematical and theoretical epidemiology will find this book useful

Mathematical Models for Communicable Diseases Fred Brauer, Carlos Castillo-Chavez, 2013-02-07 A self contained and comprehensive guide to the mathematical modeling of disease transmission appropriate for graduate students

Introduction to Mathematical Methods in Population Theory Jacek Banasiak, 2024-12-20 This textbook provides an introduction to the mathematical methods used to analyse deterministic

models in life sciences including population dynamics epidemiology and ecology The book covers both discrete and continuous models The presentation emphasises the solvability of the equations appearing in the mathematical modelling of natural phenomena and in the absence of solutions the analysis of their relevant properties Of particular interest are methods that allow for determining the long term behaviour of solutions Thus the book covers a range of techniques from the classical Lyapunov theorems and positivity methods based on the Perron Frobenius theorem to the more modern monotone dynamical system approach The book offers a comprehensive presentation of the Lyapunov theory including the inverse Lyapunov theorems with applications to perturbed equations and Vidyasagar theorem Furthermore it provides a coherent presentation of the foundations of the theory of monotone dynamical systems with its applications to epidemiological models Another feature of the book is the derivation of the McKendrick von Foerster equation from the discrete Leslie model and the analysis of the long term behaviour of its solutions Designed for upper undergraduate courses and beyond this textbook is written for students and researchers looking to master the mathematics of the tools commonly used to analyse life science models It therefore goes somewhat deeper into mathematics than typical books at this level but should be accessible to anyone with a good command of calculus with elements of real and complex analysis and linear algebra the necessary concepts are collected in the appendices

Nonlinear Functional Analysis and Its Applications Radu Precup, 2021-04-14 This book consists of nine papers covering a number of basic ideas concepts and methods of nonlinear analysis as well as some current research problems Thus the reader is introduced to the fascinating theory around Brouwer's fixed point theorem to Granas theory of topological transversality and to some advanced techniques of critical point theory and fixed point theory Other topics include discontinuous differential equations new results of metric fixed point theory robust tracker design problems for various classes of nonlinear systems and periodic solutions in computer virus propagation models

Advances in Discrete Dynamical Systems, Difference Equations and Applications Saber Elaydi, Mustafa R. S. Kulenović, Senada Kalabušić, 2023-03-25 This book comprises selected papers of the 26th International Conference on Difference Equations and Applications ICDEA 2021 held virtually at the University of Sarajevo Bosnia and Herzegovina in July 2021 The book includes the latest and significant research and achievements in difference equations discrete dynamical systems and their applications in various scientific disciplines The book is interesting for Ph D students and researchers who want to keep up to date with the latest research developments and achievements in difference equations discrete dynamical systems and their applications the real world problems

Methods of Mathematical Modelling Thomas Witelski, Mark Bowen, 2015-09-18 This book presents mathematical modelling and the integrated process of formulating sets of equations to describe real world problems It describes methods for obtaining solutions of challenging differential equations stemming from problems in areas such as chemical reactions population dynamics mechanical systems and fluid mechanics Chapters 1 to 4 cover essential topics in ordinary differential equations transport equations and the calculus of variations that are important for formulating

models Chapters 5 to 11 then develop more advanced techniques including similarity solutions matched asymptotic expansions multiple scale analysis long wave models and fast slow dynamical systems Methods of Mathematical Modelling will be useful for advanced undergraduate or beginning graduate students in applied mathematics engineering and other applied sciences *Mathematical Modeling of Biological Systems, Volume II* Andreas Deutsch, Rafael Bravo de la Parra, Rob J. de Boer, Odo Diekmann, Peter Jagers, Eva Kisdi, Mirjam Kretzschmar, Petr Lansky, Hans Metz, 2007-10-12 Volume II of this two volume interdisciplinary work is a unified presentation of a broad range of state of the art topics in the rapidly growing field of mathematical modeling in the biological sciences Highlighted throughout are mathematical and computational approaches to examine central problems in the life sciences ranging from the organization principles of individual cells to the dynamics of large populations The chapters are thematically organized into the following main areas epidemiology evolution and ecology immunology neural systems and the brain and innovative mathematical methods and education The work will be an excellent reference text for a broad audience of researchers practitioners and advanced students in this rapidly growing field at the intersection of applied mathematics experimental biology and medicine computational biology biochemistry computer science and physics **Structured Population Models in Biology and Epidemiology** Pierre Magal, Shigui Ruan, 2008-04-12 In this new century mankind faces ever more challenging environmental and public health problems such as pollution invasion by exotic species the emergence of new diseases or the emergence of diseases into new regions West Nile virus SARS Anthrax etc and the resurgence of existing diseases in uenza malaria TB HIV AIDS etc Mathematical models have been successfully used to study many biological epidemiological and medical problems and nonlinear and complex dynamics have been observed in all of those contexts Mathematical studies have helped us not only to better understand these problems but also to find solutions in some cases such as the prediction and control of SARS outbreaks understanding HIV infection and the investigation of antibiotic resistant infections in hospitals Structured population models distinguish individuals from one another according to characteristics such as age size location status and movement to determine the birth growth and death rates interaction with each other and with environment infectivity etc The goal of structured population models is to understand how these characteristics affect the dynamics of these models and thus the outcomes and consequences of the biological and epidemiological processes There is a very large and growing body of literature on these topics This book deals with the recent and important advances in the study of structured population models in biology and epidemiology There are six chapters in this book written by leading researchers in these areas **Mathematical Epidemiology of Infectious Diseases** O. Diekmann, J. A. P. Heesterbeek, 2000-04-07 *Mathematical Epidemiology of Infectious Diseases Model Building Analysis and Interpretation* O Diekmann University of Utrecht The Netherlands J A P Heesterbeek Centre for Biometry Wageningen The Netherlands The mathematical modelling of epidemics in populations is a vast and important area of study It is about translating biological assumptions into

mathematics about mathematical analysis aided by interpretation and about obtaining insight into epidemic phenomena when translating mathematical results back into population biology Model assumptions are formulated in terms of usually stochastic behaviour of individuals and then the resulting phenomena at the population level are unravelled Conceptual clarity is attained assumptions are stated clearly hidden working hypotheses are attained and mechanistic links between different observables are exposed Features Model construction analysis and interpretation receive detailed attention Uniquely covers both deterministic and stochastic viewpoints Examples of applications given throughout Extensive coverage of the latest research into the mathematical modelling of epidemics of infectious diseases Provides a solid foundation of modelling skills The reader will learn to translate model analyse and interpret with the help of the numerous exercises In literally working through this text the reader acquires modelling skills that are also valuable outside of epidemiology certainly within population dynamics but even beyond that In addition the reader receives training in mathematical argumentation The text is aimed at applied mathematicians with an interest in population biology and epidemiology at theoretical biologists and epidemiologists Previous exposure to epidemic concepts is not required as all background information is given The book is primarily aimed at self study and ideally suited for small discussion groups or for use as a course text

Mathematical Modelling of Population Dynamics Ryszard Rudnicki, 2004 Discrete and Continuous Dynamical Systems, 2006 Mathematical Models in Population Biology Maira Aguiar, 2018-08-15 The aim of this book is to build a fundamental understanding in Mathematical Biology Epidemiology and Ecology Written for biologists mathematicians applied statisticians and physicists Mathematical Models in Population Biology Essential Concepts in Biomathematics provides a coverage of different topics in mathematical biology from vector borne diseases fractional calculus and stochastic differential equations to neuro dynamics illustrating some important models used for real data

Studies in Epidemiology and Social Dynamics Fabio Ariel Sánchez, 2007 **Mathematical Modeling for Epidemiology and Ecology** Glenn Ledder, 2023-04-13 Mathematical Modeling for Epidemiology and Ecology provides readers with the mathematical tools needed to understand and use mathematical models and read advanced mathematical biology books It presents mathematics in biological contexts focusing on the central mathematical ideas and the biological implications with detailed explanations The author assumes no mathematics background beyond elementary differential calculus An introductory chapter on basic principles of mathematical modeling is followed by chapters on empirical modeling and mechanistic modeling These chapters contain a thorough treatment of key ideas and techniques that are often neglected in mathematics books such as the Akaike Information Criterion The second half of the book focuses on analysis of dynamical systems emphasizing tools to simplify analysis such as the Routh Hurwitz conditions and asymptotic analysis Courses can be focused on either half of the book or thematically chosen material from both halves such as a course on mathematical epidemiology The biological content is self contained and includes many topics in epidemiology and ecology Some of this

material appears in case studies that focus on a single detailed example and some is based on recent research by the author on vaccination modeling and scenarios from the COVID 19 pandemic The problem sets feature linked problems where one biological setting appears in multi step problems that are sorted into the appropriate section allowing readers to gradually develop complete investigations of topics such as HIV immunology and harvesting of natural resources Some problems use programs written by the author for Matlab or Octave these combine with more traditional mathematical exercises to give students a full set of tools for model analysis Each chapter contains additional case studies in the form of projects with detailed directions New appendices contain mathematical details on optimization numerical solution of differential equations scaling linearization and sophisticated use of elementary algebra to simplify problems

Discrete Mathematical Models in Population Biology Saber N. Elaydi, Jim M. Cushing, 2025-01-03 This text lays the foundation for understanding the beauty and power of discrete time models It covers rich mathematical modeling landscapes each offering deep insights into the dynamics of biological systems A harmonious balance is achieved between theoretical principles mathematical rigor and practical applications Illustrative examples numerical simulations and empirical case studies are provided to enhance mastery of the subject and facilitate the translation of discrete time mathematical biology into real world challenges Mainly geared to upper undergraduates the text may also be used in graduate courses focusing on discrete time modeling Chapters 1 4 constitute the core of the text Instructors will find the dependence chart quite useful when designing their particular course This invaluable resource begins with an exploration of single species models where frameworks for discrete time modeling are established Competition models and Predator prey interactions are examined next followed by evolutionary models structured population models and models of infectious diseases The consequences of periodic variations seasonal changes and cyclic environmental factors on population dynamics and ecological interactions are investigated within the realm of periodically forced biological models This indispensable resource is structured to support educational settings A first course in biomathematics introducing students to the fundamental mathematical techniques essential for biological research A modeling course with a concentration on developing and analyzing mathematical models that encapsulate biological phenomena An advanced mathematical biology course that offers an in depth exploration of complex models and sophisticated mathematical frameworks designed to tackle advanced problems in biology With its clear exposition and methodical approach this text educates and inspires students and professionals to apply mathematical biology to real world situations While minimal knowledge of calculus is required the reader should have a solid mathematical background in linear algebra

Mathematical Models in Epidemiology Fred Brauer, Carlos Castillo-Chavez, Zhilan Feng, 2019-10-10 The book is a comprehensive self contained introduction to the mathematical modeling and analysis of disease transmission models It includes i an introduction to the main concepts of compartmental models including models with heterogeneous mixing of individuals and models for vector transmitted diseases ii a detailed analysis of models for important specific diseases

including tuberculosis HIV AIDS influenza Ebola virus disease malaria dengue fever and the Zika virus iii an introduction to more advanced mathematical topics including age structure spatial structure and mobility and iv some challenges and opportunities for the future There are exercises of varying degrees of difficulty and projects leading to new research directions For the benefit of public health professionals whose contact with mathematics may not be recent there is an appendix covering the necessary mathematical background There are indications which sections require a strong mathematical background so that the book can be useful for both mathematical modelers and public health professionals

Competition Models in Population Biology Paul Waltman, 1983-01-01 This book uses fundamental ideas in dynamical systems to answer questions of a biologic nature in particular questions about the behavior of populations given a relatively few hypotheses about the nature of their growth and interaction The principal subject treated is that of coexistence under certain parameter ranges while asymptotic methods are used to show competitive exclusion in other parameter ranges Finally some problems in genetics are posed and analyzed as problems in nonlinear ordinary differential equations

Mathematical Population Dynamics and Epidemiology in Temporal and Spatio-Temporal Domains Harkaran Singh, Joydip Dhar, 2018-12-07 Mankind now faces even more challenging environment and health related problems than ever before Readily available transportation systems facilitate the swift spread of diseases as large populations migrate from one part of the world to another Studies on the spread of the communicable diseases are very important This book Mathematical Population Dynamics and Epidemiology in Temporal and Spatio Temporal Domains provides a useful experimental tool for making practical predictions building and testing theories answering specific questions determining sensitivities of the parameters forming control strategies and much more This volume focuses on the study of population dynamics with special emphasis on the migration of populations and the spreading of epidemics among human and animal populations It also provides the background needed to interpret construct and analyze a wide variety of mathematical models Most of the techniques presented in the book can be readily applied to model other phenomena in biology as well as in other disciplines

Embark on a transformative journey with Written by is captivating work, **Mathematical Models In Population Biology And Epidemiology Texts In Applied Mathematics** . This enlightening ebook, available for download in a convenient PDF format PDF Size: , invites you to explore a world of boundless knowledge. Unleash your intellectual curiosity and discover the power of words as you dive into this riveting creation. Download now and elevate your reading experience to new heights .

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