

Industrial and Applied Mathematics

Priti Kumar Roy

# Mathematical Models for Therapeutic Approaches to Control HIV Disease Transmission



 Springer

# Mathematical Therapeutic Approaches Transmission Mathematics

**Priti Kumar Roy, Xianbing Cao, Xue-Zhi  
Li, Pratulananda Das, Satya Deo**

## **Mathematical Therapeutic Approaches Transmission Mathematics:**

Mathematical Models for Therapeutic Approaches to Control HIV Disease Transmission Priti Kumar Roy, 2015-12-08 The book discusses different therapeutic approaches based on different mathematical models to control the HIV AIDS disease transmission. It uses clinical data collected from different cited sources to formulate the deterministic as well as stochastic mathematical models of HIV AIDS. It provides complementary approaches from deterministic and stochastic points of view to optimal control strategy with perfect drug adherence and also tries to seek viewpoints of the same issue from different angles with various mathematical models to computer simulations. The book presents essential methods and techniques for students who are interested in designing epidemiological models on HIV AIDS. It also guides research scientists working in the periphery of mathematical modeling and helps them to explore a hypothetical method by examining its consequences in the form of a mathematical modelling and making some scientific predictions. The model equations, mathematical analysis, and several numerical simulations that are presented in the book would serve to reveal the consequences of the logical structure of the disease transmission quantitatively as well as qualitatively. One of the chapters introduces the optimal control approach towards the mathematical models describing the optimal drug dosage process that is discussed with the basic deterministic models dealing with stability analysis. Another one chapter deals with the mathematical analysis for the perfect drug adherence for different drug dynamics during the treatment management. The last chapter of the book consists the stochastic approach to the disease dynamics on HIV AIDS. This method helps to move the disease HIV AIDS to extinction as the time to increase. This book will appeal to undergraduate and postgraduate students as well as researchers who are studying and working in the field of bio mathematical modelling on infectious diseases, applied mathematics, health informatics, applied statistics, and qualitative public health etc. Social workers who are working in the field of HIV will also find the book useful for complements.

**Mathematical Models for Therapeutic Approaches to Control Psoriasis** Priti Kumar Roy, Abhirup Datta, 2019-07-18 This book discusses several mathematical models highlighting the disease dynamics of psoriasis and its control. It explains the control of keratinocyte concentration through a negative feedback mechanism and the effect of including a realistic time delay in that system. The effect of cytokine release is described in a mathematical model of psoriasis and further elucidated in two different mathematical pathways: the ordinary differential equation model system and the fractional order differential equation model system. The book also identifies the role of CD8 T cells in psoriasis by investigating the interaction between dendritic cells and CD8 T cells. Presenting an approach to control the fractional order system to prevent excess production of keratinocyte cell population, the book is intended for researchers and scientists in the field of applied mathematics, health informatics, applied statistics, and qualitative public health as well as bio mathematicians interested in the mathematical modeling of autoimmune diseases like psoriasis.

**Mathematical Analysis and Applications in Modeling** Priti Kumar Roy, Xianbing Cao, Xue-Zhi Li, Pratulananda Das, Satya Deo, 2020-03-10 This book

collects select papers presented at the International Conference on Mathematical Analysis and Application in Modeling held at Jadavpur University Kolkata India on 9-12 January 2018. It discusses new results in cutting edge areas of several branches of mathematics and applications including analysis topology dynamical systems nonlinear topological mathematical modeling optimization and mathematical biology. The conference has emerged as a powerful forum bringing together leading academics industry experts and researchers and offering them a venue to discuss interact and collaborate in order to stimulate the advancement of mathematics and its industrial applications.

**Mathematics of Planet Earth** Hans G. Kaper, Fred S. Roberts, 2019-11-01. Since its inception in 2013, Mathematics of Planet Earth (MPE) focuses on mathematical issues arising in the study of our planet. Interested in the impact of human activities on the Earth's system, this multidisciplinary field considers the planet not only as a physical system but also as a system supporting life, a system organized by humans, and a system at risk. The articles collected in this volume demonstrate the breadth of techniques and tools from mathematics, statistics, and operations research used in MPE. Topics include climate modeling, the spread of infectious diseases, stability of ecosystems, ecosystem services, biodiversity, infrastructure restoration after an extreme event, urban environments, food security, and food safety. Demonstrating the mathematical sciences in action, this book presents real world challenges for the mathematical sciences, highlighting applications to issues of current concern to society. Arranged into three topical sections: Geo and Physical Sciences, Life Sciences, Ecology and Evolution, Socio-economics, and Infrastructure, thirteen chapters address questions such as: how to measure biodiversity, what mathematics can say about the sixth mass extinction, how to optimize the long term human use of natural capital, and the impact of data on infrastructure management. The book also treats the subject of infectious diseases with new examples and presents an introduction to the mathematics of food systems and food security. Each chapter functions as an introduction that can be studied independently, offering source material for graduate student seminars and self study. The range of featured research topics provides mathematical scientists with starting points for the study of our planet and the impact of human activities. At the same time, it offers application scientists a plethora of modern mathematical tools and techniques to address the various topics in practice. Including hundreds of references to the vast literature associated with each topic, this book serves as an inspiration for further research.

Mathematical and Computational Approaches in Advancing Modern Science and Engineering Jacques Bélair, Ian A. Frigaard, Herb Kunze, Roman Makarov, Roderick Melnik, Raymond J. Spiteri, 2016-08-10. Focusing on five main groups of interdisciplinary problems, this book covers a wide range of topics in mathematical modeling, computational science, and applied mathematics. It presents a wealth of new results in the development of modeling theories and methods, advancing diverse areas of applications and promoting interdisciplinary interactions between mathematicians, scientists, engineers, and representatives from other disciplines. The book offers a valuable source of methods, ideas, and tools developed for a variety of disciplines, including the natural and social sciences, medicine, engineering, and technology. Original results are presented on

both the fundamental and applied level accompanied by an ample number of real world problems and examples emphasizing the interdisciplinary nature and universality of mathematical modeling and providing an excellent outline of today's challenges Mathematical modeling with applied and computational methods and tools plays a fundamental role in modern science and engineering It provides a primary and ubiquitous tool in the context making new discoveries as well as in the development of new theories and techniques for solving key problems arising in scientific and engineering applications The contributions which are the product of two highly successful meetings held jointly in Waterloo Ontario Canada on the main campus of Wilfrid Laurier University in June 2015 i e the International Conference on Applied Mathematics Modeling and Computational Science and the Annual Meeting of the Canadian Applied and Industrial Mathematics CAIMS make the book a valuable resource for any reader interested in a broader overview of the methods ideas and tools involved in mathematical and computational approaches developed for other disciplines including the natural and social sciences engineering and technology

**Mathematical Analysis and Applications in Biological Phenomena through Modelling** Priti Kumar Roy,Xianbing Cao,Xue-Zhi Li,Arindam Bhattacharya,2025-02-01 This volume presents a comprehensive compilation of chapters whose topics were presented at the 2nd International Conference on Mathematical Analysis and Application in Modeling CMAAM 2023 held at the Department of Mathematics the Center for Mathematical Biology and Ecology Jadavpur University Kolkata West Bengal India from 9 11 October 2023 It encompasses groundbreaking research on cutting edge developments across various branches of mathematics and its applications in diverse disciplines In the realm of epidemiology the book delves into the utilization of advanced tools such as fractional calculus optimal control therapy and impulse therapeutic approaches These tools integrated with mathematical models offer innovative solutions for managing various diseases and optimizing drug dose regimens Beyond the scope of epidemiology the book also incorporates chapters elucidating fundamental concepts in pure mathematics These include explorations of topological phenomena and diverse algebraic concepts This dual focus on applied mathematics and pure mathematical principles enhances the book's usability catering to a broad audience of researchers and scholars The book primarily targets young researchers engaged in the specified areas of study By bridging the gap between theoretical mathematics and real world applications it serves a valuable resource providing insights and methodologies that contribute to advancements in research and application across multiple disciplines

**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

Advances in data-driven approaches and modeling of complex systems Mohd Hafiz Mohd,Joel M. Addawe,Hirohide Haga,Junpyo Park,Tri Nguyen-Huu,2023-06-27 Harris' Developmental Neuropsychiatry James C. Harris,Joseph T. Coyle,2024 Harris Developmental Neuropsychiatry provides updated information to the first edition which defined the field of developmental neuropsychiatry and is the most recent comprehensive textbook in the field **Methods and**

**Applications of Statistics in the Life and Health Sciences** Narayanaswamy Balakrishnan,2009-12-02 Inspired by the Encyclopedia of Statistical Sciences Second Edition this volume outlines the statistical tools for successfully working with modern life and health sciences research Data collection holds an essential part in dictating the future of health sciences and public health as the compilation of statistics allows researchers and medical practitioners to monitor trends in health status identify health problems and evaluate the impact of health policies and programs Methods and Applications of Statistics in the Life and Health Sciences serves as a single one of a kind resource on the wide range of statistical methods techniques and applications that are applied in modern life and health sciences in research Specially designed to present encyclopedic content in an accessible and self contained format this book outlines thorough coverage of the underlying theory and standard applications to research in related disciplines such as biology epidemiology clinical trials and public health Uniquely combining established literature with cutting edge research this book contains classical works and more than twenty five new articles and completely revised contributions from the acclaimed Encyclopedia of Statistical Sciences Second Edition The result is a compilation of more than eighty articles that explores classic methodology and new topics including Sequential methods in biomedical research Statistical measures of human quality of life Change point methods in genetics Sample size determination for clinical trials Mixed effects regression models for predicting pre clinical disease Probabilistic and statistical models for conception Statistical methods are explored and applied to population growth disease detection and treatment genetic and genomic research drug development clinical trials screening and prevention and the assessment of rehabilitation recovery and quality of life These topics are explored in contributions written by more than 100 leading academics researchers and practitioners who utilize various statistical practices such as election bias survival analysis missing data techniques and cluster analysis for handling the wide array of modern issues in the life and health sciences With its combination of traditional methodology and newly developed research Methods and Applications of Statistics in the Life and Health Sciences has everything students academics and researchers in the life and health sciences need to build and apply their knowledge of statistical methods and applications **Mathematical and Statistical Modeling for Emerging**

**and Re-emerging Infectious Diseases** Gerardo Chowell, James M. Hyman, 2016-07-27 The contributions by epidemic modeling experts describe how mathematical models and statistical forecasting are created to capture the most important aspects of an emerging epidemic. Readers will discover a broad range of approaches to address questions such as: Can we control Ebola via ring vaccination strategies? How quickly should we detect Ebola cases to ensure epidemic control? What is the likelihood that an Ebola epidemic in West Africa leads to secondary outbreaks in other parts of the world? When does it matter to incorporate the role of disease induced mortality on epidemic models? What is the role of behavior changes on Ebola dynamics? How can we better understand the control of cholera or Ebola using optimal control theory? How should a population be structured in order to mimic the transmission dynamics of diseases such as chlamydia, Ebola or cholera? How can we objectively determine the end of an epidemic? How can we use metapopulation models to understand the role of movement restrictions and migration patterns on the spread of infectious diseases? How can we capture the impact of household transmission using compartmental epidemic models? How could behavior dependent vaccination affect the dynamical outcomes of epidemic models? The derivation and analysis of the mathematical models addressing these questions provides a wide ranging overview of the new approaches being created to better forecast and mitigate emerging epidemics. This book will be of interest to researchers in the field of mathematical epidemiology as well as public health workers.

**Mathematics of Public Health** Jummy David, Jianhong Wu, 2023-12-30 This volume addresses SDG 3 from a mathematical standpoint, sharing novel perspectives of existing communicable disease modelling technologies of the next generation and disseminating new developments in modelling methodologies and simulation techniques. These methodologies are important for training and research in communicable diseases and can be applied to other threats to human health. The contributions contained in this collection book cover a range of modelling techniques that have been and may be used to support decision making on critical health related issues such as: Resource allocation, Impact of climate change on communicable diseases, Interaction of human behaviour change and disease spread, Disease outbreak trajectories projection, Public health interventions evaluation, Preparedness and mitigation of emerging and re-emerging infectious diseases outbreaks, Development of vaccines and decisions around vaccine allocation and optimization. The diseases and public health issues in this volume include but are not limited to COVID-19, HIV, Influenza, antimicrobial resistance, AMR, the opioid epidemic, Lyme Disease, Zika and Malaria. In addition, this volume compares compartmental models, agent based models, machine learning and network. Readers have an opportunity to learn from the next generation perspective of evolving methodologies and algorithms in modelling infectious diseases, the mathematics behind them, the motivation for them and some applications to supporting critical decisions on prevention and control of communicable diseases. This volume was compiled from the weekly seminar series organized by the Mathematics for Public Health (MfPH) Next Generation Network. This network brings together the next generation of modellers from across Canada and the world, developing the latest

mathematical models modeling methodologies and analytical and simulation tools for communicable diseases of global public health concerns The weekly seminar series provides a unique forum for this network and their invited guest speakers to share their perspectives on the status and future directions of mathematics of public health

**Studying Virtual Math Teams** Gerry Stahl, 2010-05-03 Studying Virtual Math Teams centers on detailed empirical studies of how students in small online groups make sense of math issues and how they solve problems by making meaning together These studies are woven together with materials that describe the online environment and pedagogical orientation as well as reflections on the theoretical implications of the findings in the studies The nature of group cognition and shared meaning making in collaborative learning is a foundational research issue in CSCL More generally the theme of sense making is a central topic in information science While many authors allude to these topics few have provided this kind of detailed analysis of the mechanisms of intersubjective meaning making This book presents a coherent research agenda that has been pursued by the author and his research group The book opens with descriptions of the project and its methodology as well as situating this research in the past and present context of the CSCL research field The core research team then presents five concrete analyses of group interactions in different phases of the Virtual Math Teams research project These chapters are followed by several studies by international collaborators discussing the group discourse the software affordances and alternative representations of the interaction all using data from the VMT project The concluding chapters address implications for the theory of group cognition and for the methodology of the learning sciences In addition to substantial introductory and concluding chapters this important new book includes analyses based upon the author's previous research thereby providing smooth continuity and an engaging flow that follows the progression of the research The VMT project has dual goals a to provide a source of experience and data for practical and theoretical explorations of group knowledge building and b to develop an effective online environment and educational service for collaborative learning of mathematics Studying Virtual Math Teams reflects these twin orientations reviewing the intertwined aims and development of a rigorous science of small group cognition and a Web 2.0 educational math service It documents the kinds of interactional methods that small groups use to explore math issues and provides a glimpse into the potential of online interaction to promote productive math discourse

**Justified Modeling Frameworks and Novel Interpretations of Ecological and Epidemiological Systems** Bapan Ghosh, Salih Djilali, Asep K. Supriatna, 2024-01-12 The Lotka Volterra and the Kermack McKendrick models are well celebrated and widely recognized in the field of ecology and epidemiology Several modified ordinary differential equation models have been proposed over the last many decades to rationalize complex biological phenomena In the current century researchers have paid much attention to developing new modeling frameworks with delay differential equations difference equations fractional order systems stochastic differential equations etc No doubt these models have emerged many new bifurcations theory and methods which have equally contributed to the advances of Mathematics and interdisciplinary



research It is argued that these new modeling frameworks perform more effectively in analyzing and interpreting results compared to the conventional modeling frameworks with ordinary differential equations However implications of emerged bifurcations from new modeling approaches are often less interpreted from a biological viewpoint Even there is also a lack of understanding of how a fractional order model for instance displays a more realistic scenario to analyze a biological process Therefore a more serious justification is essential while modeling any biological event

*Mathematical Methods in Medical and Biological Sciences* Harendra Singh, Hari M Srivastava, 2024-11-05 Mathematical Methods in Medical and Biological Sciences presents mathematical methods for computational models arising in the medical and biological sciences The book presents several real life medical and biological models such as infectious and non infectious diseases that can be modeled mathematically to accomplish profound research in virtual environments when the cost of laboratory expenses is relatively high It focuses on mathematical techniques that provide global solutions for models arising in medical and biological sciences by considering their long term benefits In addition the book provides leading edge developments and insights for a range of applications including epidemiological modeling of pandemic dynamics viral infection developments cancer developments blood oxygen dynamics HIV infection spread reaction diffusion models polio infection spread and chaos modeling with fractional order derivatives Presents the mathematical treatment of a wide range of real life medical and biological models including both infectious and non infectious diseases Provides in depth analysis of the spread of Covid 19 polio and HIV including discussion of computational methods and applications Includes computational modeling methods along with their practical applications providing the basis for further exploration and research in epidemiology and applied biomedical sciences

**HIV Transmission** D. M. Basavarajaiah, Bhamidipati Narasimha Murthy, 2019-11-29 This book presents models describing HIV transmission rates at population level discussing the main statistical methods and analytical interventions It also assesses the practical applicability of the various modelling techniques offering readers insights into what methods are available and more importantly when they should be used to address HIV transmission at global level The book includes realistic simulation models fitted to clarify the rate of HIV mother to child transmission HIV MTCT and substantiates the conclusions that can be drawn as well as the appropriate time for making global level clinical decisions concerning people living with HIV AIDS PLHIVs Intended for students academics and researchers the book offers more than just an introduction to the topic it also features in depth yet easy to understand descriptions of a new mathematical statistical HIV mother to child transmission model making it a useful resource for clinicians public health workers and policymakers involved in implementing HIV prevention programmes at national global level

**Encyclopedia of Statistical Sciences, Volume 1**, 2005-12-16 Countless professionals and students who use statistics in their work rely on the multi volume Encyclopedia of Statistical Sciences as a superior and unique source of information on statistical theory methods and applications This new edition available in both print and on line versions is designed to bring the encyclopedia in line with the latest topics and

advances made in statistical science over the past decade in areas such as computer intensive statistical methodology genetics medicine the environment and other applications Written by over 600 world renowned experts including the editors the entries are self contained and easily understood by readers with a limited statistical background With the publication of this second edition in 16 printed volumes the Encyclopedia of Statistical Sciences retains its position as a cutting edge reference of choice for those working in statistics biostatistics quality control economics sociology engineering probability theory computer science biomedicine psychology and many other areas

**Soft Computing Applications and Techniques in Healthcare** Ashish Mishra,G. Suseendran,Trung-Nghia Phung,2020-10-09 This book provides insights into contemporary issues and challenges in soft computing applications and techniques in healthcare It will be a useful guide to identify categorise and assess the role of different soft computing techniques for disease diagnosis and prediction due to technological advancements The book explores applications in soft computing and covers empirical properties of artificial neural network ANN evolutionary computing fuzzy logic and statistical techniques It presents basic and advanced concepts to help beginners and industry professionals get up to speed on the latest developments in soft computing and healthcare systems It incorporates the latest methodologies and challenges facing soft computing examines descriptive predictive and social network techniques and discusses analytics tools and their role in providing effective solutions for science and technology The primary users for the book include researchers academicians postgraduate students specialists and practitioners Dr Ashish Mishra is a professor in the Department of Computer Science and Engineering Gyan Ganga Institute of Technology and Sciences Jabalpur Madhya Pradesh India He has contributed in organising the INSPIRE Science Internship Camp He is a member of the Institute of Electrical and Electronics Engineers and is a life member of the Computer Society of India His research interests include the Internet of Things data mining cloud computing image processing and knowledge based systems He holds nine patents in Intellectual Property India He has authored four books in the areas of data mining image processing and LaTeX Dr G Suseendran is an assistant professor Department of Information Technology School of Computing Sciences Vels Institute of Science Technology Advanced Studies VISTAS Chennai Tamil Nadu India His research interests include ad hoc networks the Internet of Things data mining cloud computing image processing knowledge based systems and Web information exploration He has published more than 75 research papers in various international journals such as Science Citation Index Springer Book Chapter Scopus IEEE Access and UGC referred journals Prof Trung Nghia Phung is an associate professor and Head of Academic Affairs Thai Nguyen University of Information and Communication Technology ICTU He has published more than 60 research papers His main research interest lies in the field of speech audio and biomedical signal processing He serves as a technical committee program member track chair session chair and reviewer of many international conferences and journals He was a co Chair of the International Conference on Advances in Information and Communication Technology 2016 ICTA 2016 and a Session Chair of

the 4th International Conference on Information System Design and Intelligent Applications INDIA 2017

Mathematics for Healthcare Krasimira Tsaneva-Atanasova, Vanessa Diaz-Zuccarini, 2018-09-28 In 1996 and with extraordinary prescience Panfilov and Holden had highlighted in their seminal book Computational Biology of the Heart that biology was potentially the most mathematical of all sciences Fast forward 20 years and we have seen an explosion of applications of mathematics in not only biology but healthcare that has already produced significant breakthroughs not imaginable more than 20 years ago Great strides have been made in explaining through quantitative methods the underlying mechanisms of human disease not without considerable ingenuity and effort Biological mechanisms are bewildering complex ever evolving multi scale variable difficult to fully access and understand This poses immense challenges to the computational physiology community that nevertheless has developed an impressive arsenal of tools and methods in a vertiginous race to combat disease with the tall order of improving human healthcare Mechanistic models are now contending with the advent of machine learning in healthcare and the hope is that both approaches will be used synergistically since the complexity of human pathophysiology and the difficulty of acquiring human datasets will require both deductive and inductive methods This Research Topic presents work that is currently at the frontier in computational physiology with a striking range of applications from diabetes to graft failure and using a multitude of mathematical tools This collection of articles represents a snapshot in a field that is moving a dizzying speed bringing understanding of fundamental mechanism and solutions to healthcare problems experienced by healthcare systems all over the world

**Analysis of Infectious Disease Problems (Covid-19) and Their Global Impact** Praveen Agarwal, Juan J. Nieto, Michael Ruzhansky, Delfim F. M. Torres, 2021-09-29 This edited volume is a collection of selected research articles discussing the analysis of infectious diseases by using mathematical modelling in recent times Divided into two parts the book gives a general and country wise analysis of Covid 19 Analytical and numerical techniques for virus models are presented along with the application of mathematical modelling in the analysis of their spreading rates and treatments The book also includes applications of fractional differential equations as well as ordinary partial and integrodifferential equations with optimization methods Probability distribution and their bio mathematical applications have also been studied This book is a valuable resource for researchers scholars biomathematicians and medical experts

## Adopting the Tune of Expression: An Mental Symphony within **Mathematical Therapeutic Approaches Transmission Mathematics**

In a world consumed by screens and the ceaseless chatter of instant transmission, the melodic beauty and mental symphony developed by the published word frequently diminish in to the background, eclipsed by the persistent sound and distractions that permeate our lives. But, nestled within the pages of **Mathematical Therapeutic Approaches Transmission Mathematics** a wonderful fictional prize filled with organic thoughts, lies an immersive symphony waiting to be embraced. Constructed by an elegant composer of language, this fascinating masterpiece conducts visitors on a psychological trip, well unraveling the hidden melodies and profound influence resonating within each cautiously constructed phrase. Within the depths with this poignant review, we can examine the book is central harmonies, analyze its enthralling writing model, and surrender ourselves to the profound resonance that echoes in the depths of readers souls.

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