Preface

The book covers several topics in areas like travelling waves, epidemiology, the chemotaxis system, atrial fibrillation, and nerve complexes to provide key ideas and theories, as well as their applications in developing various mathematical models. The works of the chapters have also relevance in fields such as physics, biology, health, and sociology. This book is intended for a wide range of readers, including researchers, professionals, educators, and students interested in applied mathematics for modelling various physical phenomena. There are five chapters in this book, and some major aspects of the chapters are presented below.

The chapter "Travelling waves in nonlinear lattices" discusses some recent results on travelling wave solutions for differential equations on lattices modelled by metamaterials, discrete nonlinear Schrödinger equations, Fermi-Pasta-Ulam models, and fractional differential equations on lattices. Model equations for the propagation of nonlinear electromagnetic waves in metamaterials can be grouped into two classes. The first class assumes that effective metamaterials are homogeneous media with specific physical properties that result in partial differential equations such as coupled short-pulse equations and higher-order nonlinear Schrödinger equations. Metamaterials in the second class are represented by arrays of coupled oscillators, i.e., lattice equations such as a nonlinear Klein-Gordon equation and coupled Klein-Gordon equations. It takes the second approach and considers both local and nonlocal couplings.

The chapter "Dynamics of an SEIR model for infectious diseases in random environments" begins with a review of the original deterministic and autonomous SEIR model, followed by a stochastic SEIR model with white noise. It develops a random SEIR model and demonstrates the fundamental difference between the deterministic and random models. The random SEIR model's well-posedness is established, and it is demonstrated that it has a unique nonnegative and bounded global solution. It also includes preliminaries on canonical noise and random dynamical systems, which are used to investigate the dynamics of solutions to the random SEIR model. Furthermore, numerical simulations for the developed random SEIR model are presented to demonstrate the relevant theoretical results obtained.

The chapter "On a parabolic-ODE chemotaxis system with periodic asymptotic behaviour" presents a system of differential equations that models chemotaxis, which is the ability of some living organisms to move towards a higher concentration of a chemical signal. The system is made up of two differential equations, one parabolic that describes the behaviour of a biological species and the other that models the concentration of a chemical substance. The main results are the existence and uniqueness of global and bounded classical solutions, asymptotic behaviour towards a time-periodic function, solution of the corresponding ODE system associated with

a time-periodic function approaching a given function acting in the reaction term, and some numerical approximations using the generalized finite difference method, which is based on mesfree, Taylor's expansion, and the least squares procedure, producing a convergent result.

The chapter "Atrial fibrillation through strange attractor dynamics" presents an application of the scale relativity theory in the description of the atrial phenomena. Fractalization is achieved through stochasticization, and it employs two procedures to describe the heart dynamics. In the first operating procedure, the diagnosis and evolution of atrial fibrillation by applying the method of nonlinear dynamics, the values of asymmetry and courtesy are in accordance with the pulse frequency distributions in the histograms of the analysed ECG signal. The second procedure involves the reconstruction of EKG signals using harmonic mappings between ordinary and hyperbolic space. It emphasises that the two operational procedures are complementary, with the goal of obtaining valuable information about fibrillation crises.

The chapter "Good covers for vortex nerve complexes. Free group presentation of intersecting nested cycles in planar CW spaces" discusses good covers for cell complexes in the form of path nerve complexes in a planar Whitehead CW space, as well as their Rotman free group presentations. The main results are that every path triangle cluster has a free group presentation, every path triangle cluster has a free group presentation, every path vortex has a free group presentation, every path vortex nerve has a free group presentation, a vortex nerve and the union of the sets in the nerve have the same homotopy type, and every path triangulaton of a cell complex has a good cover. In terms of video frame shape approximation, vortex nerves are applied.

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