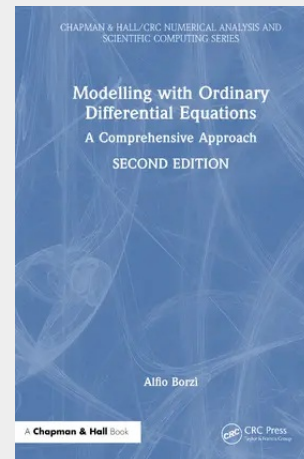


Modelling with Ordinary Differential Equations

A Comprehensive Approach

"Alfio Borzi's Modelling with Ordinary Differential Equations is a remarkably comprehensive text that succeeds in something rare: it covers the classical foundations of ODE theory with precision and rigour, while consistently opening windows to advanced and genuinely original applications that are hard to find in comparable textbooks" — Professor Volker Schulz, Universität Trier "Expertly written, organized and presented, Modelling with Ordinary Differential Equations: A Comprehensive Approach is an ideal textbook for college and university Numerical Analysis & Scientific Computing curriculums. [...] unreservedly recommended as a critically important addition to academic library collections" —Midwest Book Review Modelling with Ordinary Differential Equations: A Comprehensive Approach aims to provide a broad and self-contained introduction to the mathematical tools necessary to investigate and apply ODE models. The book starts by establishing the existence of solutions in various settings and analysing their stability properties. The next step is to illustrate modelling issues arising in the calculus of variation and optimal control theory that are of interest in many applications. This discussion is continued with an introduction to inverse problems governed by ODE models and to differential games. The book is completed with an illustration of stochastic differential equations and the development of neural networks to solve ODE systems. Many numerical methods are presented to solve the classes of problems discussed in this book. New to the Second Edition: This second edition has been thoroughly revised, reorganised, and expanded with new material across most chapters. The theoretical foundations are strengthened by additional results on existence and uniqueness, Lipschitz conditions, blow-up phenomena, and Green functions, as well as new sections on compartment models and Hamiltonian systems. A major addition is a new chapter on mechanics, ranging from classical to relativistic and quantum frameworks. The numerical analysis part now includes the Verlet method, while stability theory has been extended to cover chaos and synchronization. Optimal control is treated in greater depth, with new material on the HJB equation, controllability, and free-horizon problems. Further additions include evolutionary differential games and enhanced inverse problem examples. The chapter on neural networks has been also expanded, introducing residual networks, and reservoir computing for dynamical systems.

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