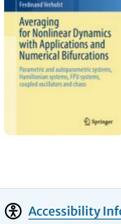


Home &gt; Book



# Averaging for Nonlinear Dynamics with Applications and Numerical Bifurcations

Parametric and autoparametric systems, Hamiltonian systems, FPU systems, coupled oscillators and chaos

Book | © 2026

 Access provided by Utrecht University

[Download book PDF](#) 

[Download book EPUB](#) 

 [Accessibility Information](#)

## Overview

**Authors:** [Ferdinand Verhulst](#)

- Integrates classical averaging theory with modern numerical bifurcation techniques
- Connects nonlinear dynamics, oscillations, and chaos through rich applied examples
- Offers a unified analytic–computational approach for complex physical and engineering systems

 Part of the book series: [Applied Mathematical Sciences](#) (AMS, volume 223)

## About this book

This book presents a comprehensive and practical survey of averaging methods for differential equations. Combining rigorous theory with applied perspectives, this book serves as both a study text and a reference for mathematicians and scientists in fields such as engineering, physics, and biology.

Divided into two complementary parts, the book begins with **Part I**, the Toolbox of Averaging Theorems, providing clear definitions, theorem formulations, and foundational results. While mathematicians may be content with existence proofs and qualitative analyses, applied scientists require tools that link theory to real–world problems—an essential motivation for **Part II**.

**Part II** explores applications in physics and engineering, blending theory with practice and incorporating numerical bifurcation analysis using tools such as AUTO, Mathematica, and MatCont. Interspersed theoretical interludes provide the background necessary for understanding and applying these methods.

Highlights include:

- Hamiltonian systems** (Ch. 9), examining resonance phenomena in physics and engineering.
- Fermi–Pasta–Ulam chains** (Ch. 10), extending fundamental theory.
- Parametric excitation** (Ch. 11) and **dissipation–induced instability** (Ch. 13), showcasing classical but lesser–known engineering results.
- Coupled oscillators and chaos** (Ch. 12), a detailed exploration of complex nonlinear dynamics.
- Diffusion and waves** (Ch. 14), providing essential guidance while pointing to broader material for further study.

Whether as a reference, teaching aid, or bridge between theory and application, *Averaging for Nonlinear Dynamics* equips readers with the tools to analyze, approximate, and apply nonlinear systems across a wide range of scientific disciplines.

**Similar content being viewed by others**

**Study of Stability and Chaotic Behavior of a Parametrically Forced Oscillator Under...**

Article | 29 September 2025

**Bifurcation, chaotic behavior, sensitivity analysis, and dynamical investigations of third...**

Article | Open access | 14 October 2025

**Exploring soliton dynamics in the nonlinear Helmholtz equation: bifurcation,...**

Article | 09 February 2025

**Explore related subjects**

Discover the latest articles, books and news in related subjects.

Computational Mathematics and Numerical Analysis

Dynamical Systems

Mathematics

Numerical Analysis

Search within this book

 Search

## Table of contents (14 chapters)

**Front Matter** [Download chapter PDF](#) 

Pages i–xiii

**Introduction** [Download chapter PDF](#) 

Ferdinand Verhulst  
Pages 1–21

## Averaging Theorems and Examples

**Front Matter** [Download chapter PDF](#) 

Pages 23–23

**First Order Periodic Averaging** [Download chapter PDF](#) 

Ferdinand Verhulst  
Pages 25–34

**Periodic Solutions** [Download chapter PDF](#) 

Ferdinand Verhulst  
Pages 35–46

**Second Order Periodic Averaging** [Download chapter PDF](#) 

Ferdinand Verhulst  
Pages 47–54

**First Order General Averaging** [Download chapter PDF](#) 

Ferdinand Verhulst  
Pages 55–62

**Approximations on Timescales Longer Than  $1/\epsilon$**  [Download chapter PDF](#) 

Ferdinand Verhulst  
Pages 63–69

**Averaging over Angles** [Download chapter PDF](#) 

Ferdinand Verhulst  
Pages 71–83

**Averaging for Partial Differential Equations** [Download chapter PDF](#) 

Ferdinand Verhulst  
Pages 85–93

## Averaging and Numerical Bifurcation Analysis

**Front Matter** [Download chapter PDF](#) 

Pages 95–95

**Hamiltonian Systems** [Download chapter PDF](#) 

Ferdinand Verhulst  
Pages 97–145

**Fermi–Pasta–Ulam Chains** [Download chapter PDF](#) 

Ferdinand Verhulst  
Pages 147–168

**Parametric and Autoparametric Oscillations** [Download chapter PDF](#) 

Ferdinand Verhulst  
Pages 169–185

**Interactions, Bifurcations and Chaos** [Download chapter PDF](#) 

Ferdinand Verhulst  
Pages 187–225

**Instability Induced by Dissipation** [Download chapter PDF](#) 

Ferdinand Verhulst  
Pages 227–239

**Diffusion and Waves** [Download chapter PDF](#) 

Ferdinand Verhulst  
Pages 241–264

**Back Matter** [Download chapter PDF](#) 

Pages 265–276

[Back to top](#) 

## Authors and Affiliations

Mathematisch Instituut, University of Utrecht, Utrecht, The Netherlands  
 Ferdinand Verhulst

## About the author

Ferdinand Verhulst graduated in theoretical astrophysics in 1966 at the University of Amsterdam, and he got his Ph.D. in mathematics at Utrecht University in 1973. His main interest and research are on approximation theory of solutions of differential equations and applications in physics and engineering. The author wrote a number of books on these topics and co-authored; also he edited a number of lecture notes in mathematics and conference proceedings. He is now still active in these fields as Emeritus Professor of nonlinear dynamics at Utrecht University.

## Accessibility Information

### PDF accessibility summary

This PDF has been created in accordance with the PDF/UA–1 standard to enhance accessibility, including screen reader support, described non–text content (images, graphs), bookmarks for easy navigation, keyboard–friendly links and forms and searchable, selectable text. We recognize the importance of accessibility, and we welcome queries about accessibility for any of our products. If you have a question or an access need, please get in touch with us at [accessibilitysupport@springernature.com](mailto:accessibilitysupport@springernature.com). Please note that a more accessible version of this eBook is available as ePub.

### EPUB accessibility summary

This ebook is designed with accessibility in mind, aiming to meet the ePub Accessibility 1.0 AA and WCAG 2.2 Level AA standards. It features a navigable table of contents, structured headings, and alternative text for images, ensuring smooth, intuitive navigation and comprehension. The text is reflowable and resizable, with sufficient contrast. We recognize the importance of accessibility, and we welcome queries about accessibility for any of our products. If you have a question or an access need, please get in touch with us at [accessibilitysupport@springernature.com](mailto:accessibilitysupport@springernature.com).

## Bibliographic Information

|   |  |   |
|---|--|---|
| <b>Book Title</b><br>Averaging for Nonlinear Dynamics with Applications and Numerical Bifurcations                    | <b>Book Subtitle</b><br>Parametric and autoparametric systems, Hamiltonian systems, FPU systems, coupled oscillators and chaos   | <b>Authors</b><br>Ferdinand Verhulst                                      |
| <b>Series Title</b><br><a href="#">Applied Mathematical Sciences</a>  | <b>DOI</b><br><a href="https://doi.org/10.1007/978-3-032-12745-7">https://doi.org/10.1007/978-3-032-12745-7</a>  | <b>Publisher</b><br>Springer Cham   |
| <b>eBook Packages</b><br><a href="#">Mathematics and Statistics</a> , <a href="#">Mathematics and Statistics (RO)</a> | <b>Copyright Information</b><br>The Editor(s) (if applicable) and The Author(s), under exclusive license to Springer Nature Switzerland AG 2026  | <b>Hardcover ISBN</b><br>978–3–032–12744–0<br>Published: 08 February 2026 |
| <b>Softcover ISBN</b><br>978–3–032–12747–1<br>Due: 22 February 2027   | <b>eBook ISBN</b><br>978–3–032–12745–7<br>Published: 07 February 2026  | <b>Series ISSN</b><br>0066–5452   |
| <b>Series E–ISSN</b><br>2196–968X   | <b>Edition Number</b><br>1   | <b>Number of Pages</b><br>XIII, 276                                       |
| <b>Number of Illustrations</b><br>24 b/w illustrations, 58 illustrations in colour                                    | <b>Topics</b><br><a href="#">Dynamical Systems and Ergodic Theory</a> , <a href="#">Vibration, Ergodic Theory, Control, Numerical Analysis, Computational Mathematics and Numerical Analysis</a> |   |

## Keywords

[nonlinear dynamics](#) [averaging](#) [differential equations](#) [Hamiltonian systems](#)  
[parametric excitation](#) [stability](#) [chaos](#) [diffusions and waves](#)

## Publish with us

[Policies and ethics](#) 

[Back to top](#) 

## Discover content

[Journals A–Z](#)

[Books A–Z](#)

## Publish with us

[Journal finder](#)

[Publish your research](#)

[Language editing](#)

[Open access publishing](#)

## Products and services

[Our products](#)

[Librarians](#)

[Societies](#)

[Partners and advertisers](#)

## Our brands

[Springer](#)

[Nature Portfolio](#)

[BMC](#)

[Palgrave Macmillan](#)

[Apress](#)

[Discover](#)

[Your privacy choices/Manage cookies](#) [Your US state privacy rights](#) [Accessibility statement](#) [Terms and conditions](#) [Privacy policy](#)

[Help and support](#) [Legal notice](#) [Cancel contracts here](#)

178.224.220.161

Universiteit Utrecht, BSL (4500901011) – Utrecht University / ASC (4500026619) – SURF B.V. (3000174899) – Utrecht University Library DV E–collection (450001134) – SURF B.V. (3001974408) – Utrecht University (2000323035) – UMC Utrecht Facilitair Bedrijf Huispostnr MOL.320, (2000446553)

© 2026 Springer Nature