S*pringer* **M***onographs in* **M***athematics*

Kung-Ching Chang

Methods in Nonlinear Analysis

Springer

Kung-Ching Chang
School of Mathematical Sciences
Peking University
100871 Beijing
People's Republic of China
E-mail: kcchang@math.pku.edu.cn

Library of Congress Control Number: 2005931137

Mathematics Subject Classification (2000): 47H00, 47J05, 47J07, 47J25, 47J30, 58-01, 58C15, 58E05, 49-01, 49J15, 49J35, 49J45, 49J53, 35-01

ISSN 1439-7382
ISBN-10 3-540-24133-7 Springer Berlin Heidelberg New York
ISBN-13 978-3-540-24133-1 Springer Berlin Heidelberg New York

Springer is a part of Springer Science+Business Media
springeronline.com

Printed in The Netherlands

Typesetting: by the authors and TechBooks using a Springer LaTeX macro package

Cover design: *design & production* GmbH, Heidelberg

Printed on acid-free paper SPIN: 11369295 41/TechBooks 5 4 3 2 1 0

Preface

Nonlinear analysis is a new area that was born and has matured from abundant research developed in studying nonlinear problems. In the past thirty years, nonlinear analysis has undergone rapid growth; it has become part of the mainstream research fields in contemporary mathematical analysis.

Many nonlinear analysis problems have their roots in geometry, astronomy, fluid and elastic mechanics, physics, chemistry, biology, control theory, image processing and economics. The theories and methods in nonlinear analysis stem from many areas of mathematics: Ordinary differential equations, partial differential equations, the calculus of variations, dynamical systems, differential geometry, Lie groups, algebraic topology, linear and nonlinear functional analysis, measure theory, harmonic analysis, convex analysis, game theory, optimization theory, etc. Amidst solving these problems, many branches are intertwined, thereby advancing each other.

The author has been offering a course on nonlinear analysis to graduate students at Peking University and other universities every two or three years over the past two decades. Facing an enormous amount of material, vast numbers of references, diversities of disciplines, and tremendously different backgrounds of students in the audience, the author is always concerned with how much an individual can truly learn, internalize and benefit from a mere semester course in this subject.

The author's approach is to emphasize and to demonstrate the most fundamental principles and methods through important and interesting examples from various problems in different branches of mathematics. However, there are technical difficulties: Not only do most interesting problems require background knowledge in other branches of mathematics, but also, in order to solve these problems, many details in argument and in computation should be included. In this case, we have to get around the real problem, and deal with a simpler one, such that the application of the method is understandable. The author does not always pursue each theory in its broadest generality; instead, he stresses the motivation, the success in applications and its limitations.

The book is the result of many years of revision of the author's lecture notes. Some of the more involved sections were originally used in seminars as introductory parts of some new subjects. However, due to their importance, the materials have been reorganized and supplemented, so that they may be more valuable to the readers.

In addition, there are notes, remarks, and comments at the end of this book, where important references, recent progress and further reading are presented.

The author is indebted to Prof. Wang Zhiqiang at Utah State University, Prof. Zhang Kewei at Sussex University and Prof. Zhou Shulin at Peking University for their careful reading and valuable comments on Chaps. 3, 4 and 5.

Peking University
September, 2003

Kung Ching Chang

Contents