A Study On Fixed Point Theory With Applications

The purpose of this contributed volume is to provide a primary resource for anyone interested in fixed point theory with a metric flavor. The book presents information for those wishing to find results that might apply to their own work and for those wishing to obtain a deeper understanding of the theory. The book should be of interest to a wide range of researchers in mathematical analysis as well as to those whose primary interest is the study of fixed point theory and the underlying spaces. The level of exposition is directed to a wide audience, including students and established researchers. Key topics covered include Banach contraction theorem, hyperconvex metric spaces, modular function spaces, fixed point theory in ordered sets, topological fixed point theory for set-valued maps, coincidence theorems, Lefschetz and Nielsen theories, systems of nonlinear inequalities, iterative methods for fixed point problems, and the Ekeland’s variational principle.

This book provides a primary resource in basic fixed-point theorems due to Banach, Brouwer, Schauder and Tarski and their applications. Key topics covered include Sharkovsky’s theorem on periodic points, Thron’s results on the convergence of certain real iterates, Shield’s common fixed theorem for a commuting family of analytic functions and Bergweiler’s existence theorem on fixed points of the composition of certain meromorphic functions with transcendental entire functions. Generalizations of Tarski’s theorem by Merrifield and Stein and Abian’s proof of the equivalence of Bourbaki–Zermelo fixed-point theorem and the Axiom of Choice are described in the setting of posets. A detailed treatment of Ward’s theory of partially ordered topological spaces culminates in Sherrer fixed-point theorem. It elaborates Manka’s proof of the fixed-point property of arcwise connected hereditarily unicoherent continua, based on the connection he observed between set theory and fixed-point theory via a certain partial order. Contraction principle is provided with two proofs: one due to Palais and the other due to Barranga. Applications of the contraction principle include the proofs of algebraic Weierstrass preparation theorem, a Cauchy–Kowalevsky theorem for partial differential equations and the central limit theorem. It also provides a proof of the converse of the contraction principle due to Jachymski, a proof of fixed point theorem for continuous generalized contractions, a proof of Browder–Gohde–Kirk fixed point theorem, a proof of Stalling's generalization of Brouwer's theorem, examine Caristi's fixed point theorem, and highlights Kakutani's theorems on common fixed points and their applications.

It is an indisputable argument that the formulation of metrics (by Fréchet in the early 1900s) opened a new subject in mathematics called non-linear analysis after the appearance of Banach’s fixed point theorem. Because the underlying space of this theorem is a metric space, the theory that developed following its publication is known as metric fixed point theory. It is well known that metric fixed point theory provides essential tools for solving problems arising in various branches of mathematics and other sciences such as split feasibility problems, variational inequality problems, non-linear optimization problems, equilibrium problems, selection and matching problems, and problems of proving the existence of solutions of integral and differential equations are closely related to fixed point theory. For this reason, many people over the past seventy years have tried to generalize the definition of metric space and corresponding fixed point theory. This trend still continues. A few questions lying at the heart of the theory remain open and there are many unanswered questions regarding the limits to which the theory may be extended. Metric Structures and Fixed Point Theory provides an extensive understanding and the latest updates on the subject. The book not only shows diversified aspects of popular generalizations of metric spaces such as symmetric, b-metric, w-distance, G-metric, modular metric, probabilistic metric, fuzzy metric, graphical metric and corresponding fixed point theory but also motivates work on existing open problems on the subject. Each of the nine chapters—contributed by various authors—contains an

Introduction section which summarizes the material needed to read the chapter independently of the others and contains the necessary background, several examples, and comprehensive literature to comprehend the concepts presented therein. This is helpful for those who want to pursue their research career in metric fixed point theory and its related areas. Features Explores the latest research and developments in fixed point theory on the most popular generalizations of metric spaces Description of various generalizations of metric spaces Very new topics on fixed point theory in graphical and modular metric spaces Enriched with examples and open problems This book serves as a reference for scientific investigators who need to analyze a simple and direct presentation of the fundamentals of the theory of metric fixed points. It may also be used as a text book for postgraduate and research students who are trying to derive future research scope in this area.

The present work of the book is devoted to the study of fixed point theorems in complete metric spaces, partially ordered metric spaces, complex valued metric spaces and fixed point iterative procedures. The book ends with an application of fixed point theory as fractal tiling and colour stealing from digital natural images. The book is divided into seven chapters. The first chapter is introductory in nature and presents some definitions, notions and fundamental preliminaries on fixed point theory, fixed point iterative procedures and fractal.

This text provides an introduction to some of the best-known fixed-point theorems, with an emphasis on their interactions with topics in analysis. The level of exposition increases gradually throughout the book, building from a basic requirement of undergraduate proficiency to graduate-level sophistication. Appendices provide an introduction to (or refresher on) some of the prerequisite material and exercises are integrated into the text, contributing to the volume’s ability to be used as a self-contained text. Readers will find the presentation especially useful for independent study or as a supplement to a graduate course in fixed-point theory. The material is split into four parts: the first introduces the Banach Contraction-Mapping Principle and the Brouwer Fixed-Point Theorem, along with a selection of interesting applications; the second focuses on Brouwer’s theorem and its application to John Nash’s work; the third applies Brouwer’s theorem to spaces of infinite dimension; and the fourth rests on the work of Markov, Kakutani, and Ryll–Nardzewski surrounding fixed points for families of affine maps.

Fixed-point theory initially emerged in the article demonstrating existence of solutions of differential equations, which appeared in the second quarter of the 18th century (Joseph Liouville, 1837). Later on, this technique was improved as a method of successive approximations (Charles Emile Picard, 1890) which was extracted and abstracted as a fixed-point theorem in the framework of complete normed space (Stefan Banach, 1922). It ensures presence as well as uniqueness of a fixed point, gives an approximate technique to really locate the fixed point and the a priori and a posteriori estimates for the rate of convergence. It is an essential device in the theory of metric spaces. Subsequently, it is stated that fixed-point theory is initiated by Stefan Banach. Fixed-point theorems give adequate conditions under which there exists a fixed point for a given function and enable us to ensure the existence of a solution of the original problem. In an extensive variety of scientific issues, beginning from different branches of mathematics, the existence of a solution is comparable to the existence of a fixed point for a suitable mapping.The book "Fixed Point Theory & its Applications to Real World Problems" is an endeavour to present results in fixed point theory which are extensions, improvements and generalizations of classical and recent results in this area and touches on distinct research directions within the metric fixed-point theory. It provides new openings for further exploration and makes for an easily accessible source of knowledge. This book is apposite for young researchers who want to pursue their research in fixed-point theory and is the latest in the field, giving new techniques for the existence of a superior fixed point, a fixed point, a near fixed point, a fixed circle, a near fixed interval circle, a fixed disc, a near fixed interval disc, a coincidence point, a common fixed point, a coupled common fixed point, amiable fixed sets, strong coupled fixed points and so on, utilizing minimal conditions. It offers novel applications besides traditional applications which are applicable to real world problems. The book is self-contained and unified which will serve as a reference book to researchers who are in search of novel ideas. It will be a valued addition to the library.

Fixed point theory touches on many areas of mathematics, such as general topology, algebraic topology, nonlinear functional analysis, and ordinary and partial differential equations and serves as a useful tool in applied mathematics. This book represents the proceedings of an informal three-day seminar held during the International Congress of Mathematicians in Berkeley in 1986. Bringing together topologists and analysts concerned with the study of fixed points of continuous functions, the seminar provided a forum for presentation of recent developments in several different areas. The topics covered include both topological fixed point theory from both the algebraic and geometric viewpoints, the fixed point theory of nonlinear operators on normed linear spaces and its applications, and the study of solutions of ordinary and partial differential equations by fixed point theory methods.Because the papers range from broad expositions to specialized research papers, the book provides readers with a good overview of the subject as well as a more detailed look at some specialized recent advances.

In recent years, the fixed point theory of Lipschitzian-type mappings has rapidly grown into an important field of study in both pure and applied mathematics. It has become one of the most essential tools in nonlinear functional analysis. This self-contained book provides the first systematic presentation of Lipschitzian-type mappings in metric and Banach spaces. The first chapter covers some basic properties of metric and Banach spaces. Geometric considerations of underlying spaces play a prominent role in developing and understanding the theory. The next two chapters provide background in terms of convexity, smoothness and geometric coefficients of Banach spaces including duality mappings and metric projection mappings. This is followed by results on existence of fixed points, approximation of fixed points by iterative methods and strong convergence theorems. The final chapter explores several applicable problems arising in related fields. This book can be used as a textbook and as a reference for graduate students, researchers and applied mathematicians working in nonlinear functional analysis, operator theory, approximations by iteration theory, convexity and related geometric topics, and best approximation theory.

Fixed point theory is an attractive and interesting subject with a large number of applications in various fields of mathematics and other branches of science. Fixed point theory is divided into three major types: i) Topological Fixed Point Theory ii) Metric Fixed Point Theory iii) Order-Theoretic Fixed Point Theory. Fixed point theory has become not only a field with a huge development but also a very helpful means for solving various problems in different fields of mathematics. Fixed point theorems are used for proving the existence and uniqueness to differential, integral and partial differential equations and variational inequalities etc. Above all, they are also useful in the field of computer science, image processing, artificial intelligence, decision making, population dynamics, operational research, industrial engineering, pattern recognition, medicine, group health underwriting, management and many other fields. Only a few common selected applications are provided here.

Analysis and Computation of Fixed Points contains the proceedings of a Symposium on Analysis and Computation of Fixed Points, held at the University of Wisconsin-Madison on May 7-8, 1979. The papers focus on the analysis and computation of fixed points and cover topics ranging from paths generated by fixed point algorithms to strongly stable stationary solutions in nonlinear programs. A simple reliable numerical algorithm for following homotopy paths is also presented. Comprised of nine chapters, this book begins by describing the techniques of numerical linear algebra that possess attractive stability properties and exploit sparsity, and their application to the linear systems that arise in algorithms that solve equations by constructing piecewise-linear homotopies. The reader is then introduced to two triangulations for homotopy fixed point algorithms with an arbitrary grid refinement, followed by a discussion on some generic properties of paths generated by fixed point algorithms. Subsequent chapters deal with topological perturbations in the numerical study of nonlinear eigenvalue and bifurcation problems; general equilibrium analysis of taxation policy; and solving urban general equilibrium models by fixed point methods. The book concludes with an evaluation of economic equilibrium under deformation of the economy. This monograph should be of interest to students and specialists in the field of mathematics.

Fixed point theory arose from the Banach contraction principle and has been studied for a long time. Its application mostly relies on the existence of solutions to mathematical problems that are formulated from economics and engineering. After the existence of the solutions is guaranteed, the numerical methodology will be established to obtain the approximated solution. Fixed points of function depend heavily on the considered spaces that are defined using the intuitive axioms. In particular, variant metrics spaces are proposed, like a partial metric space, b-metric space, fuzzy metric space and probabilistic metric space, etc. Different spaces will result in different types of fixed point theorems. In other words, there are a lot of different types of fixed point theorems in the literature. Therefore, this Special Issue welcomes survey articles. Articles that unify the different types of fixed point theorems are also very welcome. The topics of this Special Issue include the following: Fixed point theorems in metric space Fixed point theorems in fuzzy metric space Fixed point theorems in probabilistic metric space Fixed point theorems of set-valued functions in various spaces The existence of solutions in game theory The existence of solutions for equilibrium problems The existence of solutions of differential equations The existence of solutions of integral equations Numerical methods for obtaining the approximated fixed points

This monograph gives an introductory treatment of the most important iterative methods for constructing fixed points of nonlinear contractive type mappings. For each iterative method considered, it summarizes the most significant contributions in the area by presenting some of the most relevant convergence theorems. It also presents applications to the solution of nonlinear operator equations as well as the appropriate error analysis of the main iterative methods.

The theory of Fixed Points is one of the most powerful tools of modern mathematics. This book contains a clear, detailed and well-organized presentation of the major results, together with an entertaining set of historical notes and an extensive bibliography describing further developments and applications. From the reviews: "I recommend this excellent volume on fixed point theory to anyone interested in this core subject of nonlinear analysis." --MATHEMATICAL REVIEWS

This book develops the central aspect of fixed point theory – the topological fixed point index – to maximal generality, emphasizing correspondences and other aspects of the theory that are of special interest to economics. Numerous topological consequences are presented, along with important implications for dynamical systems. The book assumes the reader has no mathematical knowledge beyond that which is familiar to all theoretical economists. In addition to making the material available to a broad audience, avoiding algebraic topology results in more geometric and intuitive proofs. Graduate students and researchers in economics, and related fields in mathematics and computer science, will benefit from this book, both as a useful reference and as a well-written rigorous exposition of foundational mathematics. Numerous problems sketch key results from a wide variety of topics in theoretical economics, making the book an outstanding text for advanced graduate courses in economics and related disciplines.

Fixed Point Theory is an attractive and interesting subject with a large number of applications in various fields of mathematics and other branches of science. This book offers encouragement and empowers readers to embrace the basic history, the basic types of fixed point theories, important theorems and some common selected applications of fixed point theory. Above all, only lucid language is used so that this book will also be beginners friendly. A brief description of the contents is given below: Chapter 1: Introduction: 2 pages Concept of fixed point, a brief history, basic types of the theory. Chapter 2: Topological Fixed Point Theory: 68 pages Introduction and Background: Topological Fixed Point Property, Background on Simplexes and Triangulations, Background in Analysis And Topology, Upper Semi-continuous Multifunctions. The Brower's Fixed point Theorem: Proof by Non Analytic Methods, Proof by Analytic Methods. Sperner's Lemma and Brower's Fixed Point Theorem, Barycentric Coordinates. Generalization: Extension in Infinite Dimensions, Fixed Point Properties for Closed Boundary Convex Sets, Theorems with boundary Conditions Condition on Compactness. Multifunctions and Kakutani's Theorem, Theory with Boundary Conditions. Applications. Chapter 3: Metric Fixed Point Theory: 45 pages Introduction: Banach's Contraction Principle, Extensions of the Contraction Principle, Generalization. Converse of Banach's Contraction Principle. Metric Fixed Point Theory in Banach Spaces. Metric Fixed Point Theory in Metric Spaces. Applications. Chapter 4: Order-Theoretic Fixed Point Theory: 17 pages Introduction, Completeness Condition for Posets, Conditionally Complete Posets, Countably Chain-Complete Posets, Chain-Complete Posets. Iterative Fixed Point Theorems, The Tarski-Kantorovitch Fixed Point Theorem, Applications to

Functional Equations, The Contraction Mapping Theorem. The Tarski's Fixed Point Theorems, The Knaster-Tarski's Theorem, Application. The Abian-Brown Theorem, Application. An extensive bibliography.

This monograph provides a unified and comprehensive treatment of an order-theoretic fixed point theory in partially ordered sets and its various useful interactions with topological structures. The material progresses systematically, by presenting the preliminaries before moving to more advanced topics. In the treatment of the applications a wide range of mathematical theories and methods from nonlinear analysis and integration theory are applied; an outline of which has been given an appendix chapter to make the book self-contained. Graduate students and researchers in nonlinear analysis, pure and applied mathematics, game theory and mathematical economics will find this book useful.

This volume contains the proceedings of the special session on Fixed Point Theory and Applications held during the Summer Meeting of the American Mathematical Society at the University of Toronto, August 21-26, 1982. The theory of contractors and contractor directions is developed and used to obtain the existence theory under rather weak conditions. Theorems on the existence of fixed points of nonexpansive mappings and the convergence of the sequence of iterates of nonexpansive and quasi-nonexpansive mappings are given. Degree of mapping and its generalizations are given in detail. A class of eventually condensing mappings is studied and multivalued condensing mappings with multiple fixed points are also given.Topological fixed points, including the study of the Nielsen number of a selfmap on a compact surface, extensions of a well-known result of Krasnoselskii's Compression of a Cone Theorem, are given. Also, fixed points, antipodal points, and coincidences of multifunctions are discussed. Several results with applications in the field of partial differential equations are given. Application of fixed point theory in the area of Approximation Theory is also illustrated.

Fixed Point Theory and Graph Theory provides an intersection between the theories of fixed point theorems that give the conditions under which maps (single or multivalued) have solutions and graph theory which uses mathematical structures to illustrate the relationship between ordered pairs of objects in terms of their vertices and directed edges. This edited reference work is perhaps the first to provide a link between the two theories, describing not only their foundational aspects, but also the most recent advances and the fascinating intersection of the domains. The authors provide solution methods for fixed points in different settings, with two chapters devoted to the solutions method for critically important non-linear problems in engineering, namely, variational inequalities, fixed point, split feasibility, and hierarchical variational inequality problems. The last two chapters are devoted to integrating fixed point theory in spaces with the graph and the use of retractions in the fixed point theory for ordered sets. Introduces both metric fixed point and graph theory in terms of their disparate foundations and common application environments Provides a unique integration of otherwise disparate domains that aids both students seeking to understand either area and researchers interested in establishing an integrated research approach Emphasizes solution methods for fixed points in non-linear problems such as variational inequalities, split feasibility, and hierarchical variational inequality problems that is particularly appropriate for engineering and core science applications

Metric Fixed Point Theory has proved a flourishing area of research for many mathematicians. This book aims to offer the mathematical community an accessible, self-contained account which can be used as an introduction to the subject and its development. It will be understandable to a wide audience, including non-specialists, and provide a source of examples, references and new approaches for those currently working in the subject.

This book addresses fixed point theory, a fascinating and far-reaching field with applications in several areas of mathematics. The content is divided into two main parts. The first, which is more theoretical, develops the main abstract theorems on the existence and uniqueness of fixed points of maps. In turn, the second part focuses on applications, covering a large variety of significant results ranging from ordinary differential equations in Banach spaces, to partial differential equations, operator theory, functional analysis, measure theory, and game theory. A final section containing 50 problems, many of which include helpful hints, rounds out the coverage. Intended for Master's and PhD students in Mathematics or, more generally, mathematically oriented subjects, the book is designed to be largely self-contained, although some mathematical background is needed: readers should be familiar with measure theory, Banach and Hilbert spaces, locally convex topological vector spaces and, in general, with linear functional analysis.

Written by a team of leading experts in the field, this volume presents a self-contained account of the theory, techniques and results in metric type spaces (in particular in G-metric spaces); that is, the text approaches this important area of fixed point analysis beginning from the basic ideas of metric space topology. The text is structured so that it leads the reader from preliminaries and historical notes on metric spaces (in particular G-metric spaces) and on mappings, to Banach type contraction theorems in metric type spaces, fixed point theory in partially ordered G-metric spaces, fixed point theory for expansive mappings in metric type spaces, generalizations, present results and techniques in a very general abstract setting and framework. Fixed point theory is one of the major research areas in nonlinear analysis. This is partly due to the fact that in many real world problems fixed point theory is the basic mathematical tool used to establish the existence of solutions to problems which arise naturally in applications. As a result, fixed point theory is an important area of study in pure and applied mathematics and it is a flourishing area of research.

This book is a self-contained and comprehensive reference for advanced fixed-point theory and can serve as a useful guide for related research. The book can be used as a teaching resource for advanced courses on fixed-point theory, which is a modern and important field in mathematics.

Fixed Point Theory, Variational Analysis, and Optimization not only covers three vital branches of nonlinear analysis-fixed point theory, variational inequalities, and vector optimization-but also explains the connections between them, enabling the study of a general form of variational inequality problems related to the optimality conditions invol

The concept of fuzzy sets and fuzzy logic was introduced by Professor Lofti A Zadeh in 1965. The success of research in fuzzy sets and fuzzy logic has been demonstrated in a variety of fields, such as artificial intelligence, computer science, control engineering, computer applications, robotics and many moreIn the book we adopt the notion of fuzzy metric space due to George and Veeramani [14] which is a modification of the notion of fuzzy metric space as studied by Kramosil and Michalek [29]. The notion of fuzzy metric space by George and Veeramani has many advantages in analysis as many notions and results from classical metric spaces can be extended and generalized to the setting of fuzzy metric spaces, for instance: the notion of completeness, completion of spaces as well as extension of maps

This book collects chapters on contemporary topics on metric fixed point theory and its applications in science, engineering, fractals, and behavioral sciences. Chapters contributed by renowned researchers from across the world, this book includes several useful tools and techniques for the development of skills and expertise in the area. The book presents the study of common fixed points in a generalized metric space and fixed point results with applications in various modular metric spaces. New insight into parametric metric spaces as well as study of variational inequalities and variational control problems have been included.

This book discusses a variety of topics in mathematics and engineering as well as their applications, clearly explaining the mathematical concepts in the simplest possible way and illustrating them with a number of solved examples. The topics include real and complex analysis, special functions and analytic number theory, q-series, Ramanujan’s mathematics, fractional calculus, Clifford and harmonic analysis, graph theory, complex analysis, complex dynamical systems, complex function spaces and operator theory, geometric analysis of complex manifolds, geometric function theory, Riemannian surfaces, Teichmüller spaces and Kleinian groups, engineering applications of complex analytic methods, nonlinear analysis, inequality theory, potential theory, partial differential equations, numerical analysis , fixed-point theory, variational inequality, equilibrium problems, optimization problems, stability of functional equations, and mathematical physics. It includes papers presented at the 24th International Conference on Finite or Infinite Dimensional Complex Analysis and Applications (24ICFIDCAA), held at the Anand International College of Engineering, Jaipur, 22–26 August 2016. The book is a valuable resource for researchers in real and complex analysis.

This book provides a clear exposition of the flourishing field of fixed point theory. Starting from the basics of Banach's contraction theorem, most of the main results and techniques are developed: fixed point results are established for several classes of maps and the three main approaches to establishing continuation principles are presented. The theory is applied to many areas of interest in analysis. Topological considerations play a crucial role, including a final chapter on the relationship with degree theory. Researchers and graduate students in applicable analysis will find this to be a useful survey of the fundamental principles of the subject. The very extensive bibliography and close to 100 exercises mean that it can be used both as a text and as a comprehensive reference work, currently the only one of its type.

Presents up-to-date Banach space results. * Features an extensive bibliography for outside reading. * Provides detailed exercises that elucidate more introductorymaterial.

Metric fixed point theory encompasses the branch of fixed point theory which metric conditions on the underlying space and/or on the mappings play a fundamental role. In some sense the theory is a far-reaching outgrowth of Banach's contraction mapping principle. A natural extension of the study of contractions is the limiting case when the Lipschitz constant is allowed to equal one. Such mappings are called nonexpansive. Nonexpansive mappings arise in a variety of natural ways, for example in the study of holomorphic mappings and hyperconvex metric spaces. Because most of the spaces studied in analysis share many algebraic and topological properties as well as metric properties, there is no clear line separating metric fixed point theory from the topological or set-theoretic branch of the theory. Also, because of its metric underpinnings, metric fixed point theory has provided the motivation for the study of many geometric properties of Banach spaces. The contents of this Handbook reflect all of these facts. The purpose of the Handbook is to provide a primary resource for anyone interested in fixed point theory with a metric flavor. The goal is to provide information for those wishing to find results that might apply to their own work and for those wishing to obtain a deeper understanding of the theory. The book should be of interest to a wide range of researchers in mathematical analysis as well as to those whose primary interest is the study of fixed point theory and the underlying spaces. The level of exposition is directed to a wide audience, including students and established researchers.

The book entitled "A STUDY ON METRIC FIXED POINT THEORY" has been written with a prime objective to take care of fast paced development in the knowledge of the Fixed Point Theory applied on Metric Spaces. This book explains those concepts of this theory which are helpful for the reader to understand the topics easily. Each topic of this book has been written in an easy and lucid manner with emphasis that concept and terminology should be introduced well before they used. At present time, Metric Fixed Point Theory has a vast area of applications in other subjects, so this text contain the basic concept like Metric Space, 2-Metric Spaces, Compatible mapping, Complete metric spaces, Symmetric spaces, Integral type contractive condition and many more. Our aim through this book is to increase the interest of researcher towards this theory and to develop the Fixed Point Theory for further research.

This book explores fixed point theorems and its uses in economics, co-operative and noncooperative games.

Multiple Fixed-Point Theorems and Applications in the Theory of ODEs, FDEs and PDEs covers all the basics of the subject of fixed-point theory and its applications with a strong focus on examples, proofs and practical problems, thus making it ideal as course material but also as a reference for self-study. Many problems in science lead to nonlinear equations T x + F x = x posed in some closed convex subset of a Banach space. In particular, ordinary, fractional, partial differential equations and integral equations can be formulated like these abstract equations. It is desirable to develop fixed-point theorems for such equations. In this book, the authors investigate the existence of multiple fixed points for some operators that are of the form T + F, where T is an expansive operator and F is a k-set contraction. This book offers the reader an overview of recent developments of multiple fixed-point theorems and their applications. About the Authors Svetlin G. Georgiev is a mathematician who has worked in various areas of mathematics. He currently focuses on harmonic analysis, functional analysis, partial differential equations, ordinary differential equations, Clifford and quaternion analysis, integral equations and dynamic calculus on time scales. Khaled Zennir is assistant professor at Qassim University, KSA. He received his PhD in mathematics in 2013 from Sidi Bel Abbès University, Algeria. He obtained his Habilitation in mathematics from Constantine University, Algeria in 2015. His research interests lie in nonlinear hyperbolic partial differential equations: global existence, blow up and long-time behavior.

This book collects papers on major topics in fixed point theory and its applications. Each chapter is accompanied by basic notions, mathematical preliminaries and proofs of the main results. The book discusses common fixed point theory, convergence theorems, split variational inclusion problems and fixed point problems for asymptotically nonexpansive semigroups; fixed point property and almost fixed point property in digital spaces, nonexpansive semigroups over CAT(?) spaces, measures of noncompactness, integral equations, the study of fixed points that are zeros of a given function, best proximity point theory, monotone mappings in modular function spaces, fuzzy contractive mappings, ordered hyperbolic metric spaces, generalized contractions in b-metric spaces, multi-tupled fixed points, functional equations in dynamic programming and Picard operators. This book addresses the mathematical community working with methods and tools of nonlinear analysis. It also serves as a reference, source for examples and new approaches associated with fixed point theory and its applications for a wide audience including graduate students and researchers.

This book provides a detailed study of recent results in metric fixed point theory and presents several applications in nonlinear analysis, including matrix equations, integral equations and polynomial approximations. Each chapter is accompanied by basic definitions, mathematical

preliminaries and proof of the main results. Divided into ten chapters, it discusses topics such as the Banach contraction principle and its converse; Ran-Reurings fixed point theorem with applications; the existence of fixed points for the class of ?-? contractive mappings with applications to quadratic integral equations; recent results on fixed point theory for cyclic mappings with applications to the study of functional equations; the generalization of the Banach fixed point theorem on Branciari metric spaces; the existence of fixed points for a certain class of mappings satisfying an implicit contraction; fixed point results for a class of mappings satisfying a certain contraction involving extended simulation functions; the solvability of a coupled fixed point problem under a finite number of equality constraints; the concept of generalized metric spaces, for which the authors extend some well-known fixed point results; and a new fixed point theorem that helps in establishing a Kelisky–Rivlin type result for q-Bernstein polynomials and modified q-Bernstein polynomials. The book is a valuable resource for a wide audience, including graduate students and researchers.
This book is an attempt to give a systematic presentation of results and meth ods which concern the fixed point theory of multivalued mappings and some of its applications. In selecting the material we have restricted ourselves to study ing topological methods in the fixed point theory of multivalued mappings and applications, mainly to differential inclusions. Thus in Chapter III the approximation (on the graph) method in fixed point theory of multi valued mappings is presented. Chapter IV is devoted to the homo logical methods and contains more general results, e. g. , the Lefschetz Fixed Point Theorem, the fixed point index and the topological degree theory. In Chapter V applications to some special problems in fixed point theory are formulated. Then in the last chapter a direct application's to differential inclusions are presented. Note that Chapter I and Chapter II have an auxiliary character, and only results con nected with the Banach Contraction Principle (see Chapter II) are strictly related to topological methods in the fixed point theory. In the last section of our book (see Section 75) we give a bibliographical guide and also signal some further results which are not contained in our monograph. The author thanks several colleagues and my wife Maria who read and com mented on the manuscript. These include J. Andres, A. Buraczewski, G. Gabor, A. Gorka, M. Gorniewicz, S. Park and A. Wieczorek. The author wish to express his gratitude to P. Konstanty for preparing the electronic version of this monograph.
This is a monograph on fixed point theory, covering the purely metric aspects of the theory–particularly results that do not depend on any algebraic structure of the underlying space. Traditionally, a large body of metric fixed point theory has been couched in a functional analytic framework. This aspect of the theory has been written about extensively. There are four classical fixed point theorems against which metric extensions are usually checked. These are, respectively, the Banach contraction mapping principal, Nadler’s well known set-valued extension of that theorem, the extension of Banach’s theorem to nonexpansive mappings, and Caristi’s theorem. These comparisons form a significant component of this book. This book is divided into three parts. Part I contains some aspects of the purely metric theory, especially Caristi’s theorem and a few of its many extensions. There is also a discussion of nonexpansive mappings, viewed in the context of logical foundations. Part I also contains certain results in hyperconvex metric spaces and ultrametric spaces. Part II treats fixed point theory in classes of spaces which, in addition to having a metric structure, also have geometric structure. These specifically include the geodesic spaces, length spaces and CAT(0) spaces. Part III focuses on distance spaces that are not necessarily metric. These include certain distance spaces which lie strictly between the class of semimetric spaces and the class of metric spaces, in that they satisfy relaxed versions of the triangle inequality, as well as other spaces whose distance properties do not fully satisfy the metric axioms.
Fixed point theory is a growing and exciting branch of mathematics with a variety of wide applications in biological and mathematical sciences, proposing newer applications in discrete

dynamics and super fractals. The present endeavour is to report the latest trend in metric fixed point theory, emphasising newer applications in numerical analysis, discrete dynamics and fractal graphics, besides traditional applications. The book is useful to a large class of readers interested in analysis, applicable mathematics and fractal graphics. The articles have been selected carefully so that the book is useful for sophomores up to senior researchers looking for new material and new ideas in the existence of fixed points, new applications and survey articles. A few chapters included herein are formal in nature and suggest new directions of research in this area, which are especially useful to beginners in the field. The book is divided into two parts: Part I contains surveys and existence and convergence results. In Part II (Applications), various applications of fixed point theory to initial value problems, local attractivity of certain functional integral equation solutions, fractals and super-fractals, and solving equations in numerical praxis have been discussed. The present book, which is dedicated to Professor Shyam Lal Singh, consists of articles contributed by outstanding workers all over the world. Of course, some of the articles were selected from the Symposium on Fixed Point Theory and Applications (dedicated to him) held during the 19th Annual Conference Of India (10-12 November 2016), organised by Pauri Garhwal of the Department of Mathematics, H N B Garhwal (Central) University.

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