



# Basic Theory of Fractional Differential Equations

*Yong Zhou*

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This invaluable book is devoted to a rapidly developing area on the research of the qualitative theory of fractional differential equations. It is self-contained and unified in presentation, and provides readers the necessary background material required to go further into the subject and explore the rich research literature.

The tools used include many classical and modern nonlinear analysis methods such as fixed point theory, measure of noncompactness method, topological degree method, the Picard operators technique, critical point theory and semigroups theory. Based on research work carried out by the author and other experts during the past four years, the contents are very new and comprehensive. It is useful to researchers and graduate students for research, seminars, and advanced graduate courses, in pure and applied mathematics, physics, mechanics, engineering, biology, and related disciplines.

### Contents:

#### • *Preliminaries:*

- Introduction
- Some Notations, Concepts and Lemmas
- Fractional Calculus
- Some Results from Nonlinear Analysis
- Semigroups

#### • *Fractional Functional Differential Equations:*

- Introduction
- Neutral Equations with Bounded Delay
- $p$ -Type Neutral Equations
- Neutral Equations with Infinite Delay
- Iterative Functional Differential Equations
- Notes and Remarks

#### • *Fractional Ordinary Differential Equations in Banach Spaces:*

- Introduction
- Cauchy Problems via Measure of Noncompactness Method
- Cauchy Problems via Topological Degree Method
- Cauchy Problems via Picard Operators Technique
- Notes and Remarks

#### • *Fractional Abstract Evolution Equations:*

- Introduction
- Evolution Equations with Riemann-Liouville Derivative
- Evolution Equations with Caputo Derivative
- Nonlocal Cauchy Problems for Evolution Equations
- Abstract Cauchy Problems with Almost Sectorial Operators
- Notes and Remarks

#### • *Fractional Boundary Value Problems via Critical Point Theory:*

- Introduction
- Existence of Solution for BVP with Left and Right Fractional Integrals
- Multiple Solutions for BVP with Parameters

- Infinite Solutions for BVP with Left and Right Fractional Integrals
- Existence of Solutions for BVP with Left and Right Fractional Derivatives
- Notes and Remarks
- ***Fractional Partial Differential Equations:***
  - Introduction
  - Fractional Euler-Lagrange Equations
  - Time-Fractional Diffusion Equations
  - Fractional Hamiltonian Systems
  - Fractional Schrödinger Equations
  - Notes and Remarks

**Readership:** Graduate students and researchers in the fields of fractional differential equations, fractional calculus and related areas of research.

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