

Contents

1	Preliminaries	1
1.1	Definitions and Results from Multivalued Analysis	1
1.2	Definitions and Results from Fractional Calculus	3
1.3	Fixed Point Theorems	6
2	IVP and BVP for Hadamard-Type Differential Equations and Inclusions	13
2.1	Introduction	13
2.2	Functional and Neutral Fractional Differential Equations	13
2.2.1	Functional Differential Equations	15
2.2.2	Neutral Functional Differential Equations	18
2.2.3	An Example	21
2.3	Functional and Neutral Fractional Differential Inclusions	22
2.3.1	Functional Differential Inclusions	22
2.3.2	Neutral Functional Differential Inclusions	27
2.3.3	Examples	29
2.4	BVP for Fractional Order Hadamard-type Functional Differential Equations and inclusions	30
2.4.1	Fractional Order Hadamard-Type Functional Differential Equations	31
2.4.2	Fractional Order Hadamard-Type Functional Differential Inclusions	37
2.5	Notes and Remarks	43
3	Nonlocal Hadamard Fractional Boundary Value Problems	45
3.1	Introduction	45
3.2	A Three-Point Hadamard-Type Fractional Boundary Value Problem	46
3.2.1	The Case of Fractional Integral Boundary Conditions	52

3.3	Nonlocal Hadamard BVP of Fractional Integro-Differential Equations	54
3.3.1	Existence and Uniqueness Result via Banach's Fixed Point Theorem	56
3.3.2	Existence Result via Krasnoselskii's Fixed Point Theorem	59
3.3.3	Existence Result via Leray-Schauder's Nonlinear Alternative	60
3.3.4	Existence Result via Leray-Schauder's Degree	62
3.3.5	A Companion Problem	64
3.4	Nonlocal Hadamard BVP of Fractional Integro-Differential Inclusions	65
3.4.1	The Carathéodory Case	65
3.4.2	The Lower Semicontinuous Case	70
3.4.3	The Lipschitz Case	71
3.5	Nonlocal Hadamard Fractional Boundary Value Problems	74
3.6	Existence Results: The Single-Valued Case	75
3.7	Existence Result: The Multivalued Case	79
3.8	Notes and Remarks	85
4	Fractional Integro-Differential Equations and Inclusions	87
4.1	Introduction	87
4.2	Mixed Hadamard and Riemann-Liouville Fractional Integro-Differential Equations	87
4.3	Mixed Hadamard and Riemann-Liouville Fractional Integro-Differential Inclusions	95
4.3.1	The Upper Semicontinuous Case	96
4.3.2	The Lipschitz Case	100
4.3.3	Examples	103
4.4	Existence Result via Endpoint Theory	105
4.5	Notes and Remarks	108
5	Factional Differential Equations with Hadamard Fractional Integral Conditions	109
5.1	Introduction	109
5.2	Nonlocal Hadamard Fractional Differential Equations	109
5.2.1	Existence and Uniqueness Result via Banach's Fixed Point Theorem	111
5.2.2	Existence and Uniqueness Result via Banach's Fixed Point Theorem and Hölder's Inequality ..	113
5.2.3	Existence and Uniqueness Result via Nonlinear Contractions	115
5.2.4	Existence Result via Krasnoselskii's Fixed Point Theorem	116
5.2.5	Existence Result via Leray-Schauder's Nonlinear Alternative	118
5.2.6	Existence Result via Leray-Schauder's Degree Theory ..	120

5.3	Nonlocal Hadamard Fractional Differential Inclusions	122
5.3.1	The Lipschitz Case	123
5.3.2	The Carathéodory Case.....	126
5.3.3	The Lower Semicontinuous Case.....	130
5.4	Nonlocal Hadamard Fractional Boundary Value Problems	131
5.4.1	Existence Results: The Single-Valued Case.....	132
5.4.2	Existence Results: The Multivalued Case	137
5.5	Multiple Hadamard Fractional Integral Conditions.....	144
5.6	Riemann-Liouville Fractional Differential Inclusions.....	155
5.6.1	The Carathéodory Case.....	155
5.6.2	The Lower Semicontinuous Case.....	159
5.6.3	The Lipschitz Case	159
5.7	Hadamard Nonlocal Fractional Integral Boundary Value Problems	162
5.8	Notes and Remarks.....	172
6	Coupled Systems of Hadamard and Riemann-Liouville Fractional Differential Equations with Hadamard Type Integral Boundary Conditions	173
6.1	Introduction.....	173
6.2	A Fully Hadamard Type Integral Boundary Value.	173
6.3	A Coupled System of Riemann-Liouville Fractional Differential Equations with Coupled and Uncoupled Hadamard Fractional Integral Boundary Conditions	181
6.3.1	Coupled Integral Boundary Conditions Case	181
6.3.2	Uncoupled Integral Boundary Conditions Case.....	193
6.4	Multiple Hadamard Fractional Integral Conditions for Coupled Systems	196
6.5	Notes and Remarks.....	208
7	Nonlinear Langevin Equation and Inclusions Involving Hadamard-Caputo Type Fractional Derivatives	209
7.1	Introduction.....	209
7.2	Nonlinear Langevin Equation Case	209
7.2.1	Existence and Uniqueness Result via Banach's Fixed Point Theorem	213
7.2.2	Existence Result via Krasnoselskii's Fixed Point Theorem	217
7.2.3	Existence Result via Leray-Schauder's Nonlinear Alternative.....	220
7.2.4	Existence Result via Leray-Schauder's Degree Theory ..	224
7.3	Langevin Inclusions Case.....	226
7.3.1	The Lipschitz Case	226
7.3.2	The Carathéodory Case.....	230
7.3.3	The Lower Semicontinuous Case	237
7.3.4	Examples.....	238

7.4	Systems of Langevin equation	239
7.5	Langevin Equations with Fractional Uncoupled Integral Conditions	256
7.5.1	Existence Results for Uncoupled Case	257
7.6	Notes and Remarks	261
8	Boundary Value Problems for Impulsive Multi-Order Hadamard Fractional Differential Equations	263
8.1	Introduction	263
8.2	Boundary Value Problems for First Order Impulsive Multi-Order Hadamard Fractional Differential Equations	264
8.3	On Caputo-Hadamard Type Fractional Impulsive Boundary Value Problems with Nonlinear Fractional Integral Conditions	274
8.3.1	Existence Result via Krasnoselskii-Zabreiko's Fixed Point Theorem	278
8.3.2	Existence Result via Sadovskii's Fixed Point Theorem ..	284
8.3.3	Existence Result via O'Regan's Fixed Point Theorem ...	290
8.4	Notes and Remarks	295
9	IVP and BVP for Hybrid Hadamard Fractional Differential Equations and Inclusions	297
9.1	Introduction	297
9.2	IVPs for Hybrid Hadamard Fractional Differential Equations	297
9.3	Fractional Hybrid Differential Inclusions of Hadamard Type	302
9.4	BVP for Hybrid Fractional Differential Equations and Inclusions of Hadamard Type	307
9.5	Boundary Value Problems for Fractional Hybrid Differential Inclusions	313
9.6	Nonlocal BVPs for Hybrid Hadamard Fractional Differential Equations and Inclusions	319
9.6.1	Existence Results: The Single Valued Case	319
9.6.2	Existence Result: The Multivalued Case	324
9.7	Notes and Remarks	330
10	Positive Solutions for Hadamard Fractional Differential Equations on Infinite Domain	331
10.1	Introduction	331
10.2	Positive Solutions for Hadamard Fractional Differential Equations on Infinite Domain	331
10.3	Auxiliary Results	332
10.4	Existence of at Least Three Positive Solutions	340
10.5	Existence of at Least One Positive Solution	344
10.6	Notes and Remarks	346

11 Fractional Integral Inequalities via Hadamard's Fractional Integral	347
11.1 Introduction	347
11.2 Hadamard Fractional Integral Inequalities	347
11.3 On Mixed Type Riemann-Liouville and Hadamard Fractional Integral Inequalities	360
11.4 Chebyshev Type Inequalities for Riemann-Liouville and Hadamard Fractional Integrals	365
11.4.1 Applications	373
11.5 Chebyshev Integral Inequalities via Hadamard's Fractional Integral	379
11.5.1 Special Cases	384
11.6 Integral Inequalities with "maxima"	385
11.6.1 Useful Lemmas	386
11.6.2 Main Results	387
11.6.3 Applications to Hadamard Fractional Differential Equations with "maxima"	396
11.7 Notes and Remarks	401
References	403
Index	413

Hadamard-Type Fractional Differential Equations,
Inclusions and Inequalities

Ahmad, B.; Alsaedi, A.; Ntouyas, S.K.; Tariboon, J.

2017, XIII, 414 p. 1 illus., Hardcover

ISBN: 978-3-319-52140-4