

Contents

Notations	xiii
Preface	xv
1 Preliminaries	1
1.1 Some Notations, Concepts, and Theorems	1
1.2 Basic Fractional Calculus	4
1.3 Gamma Function	5
1.4 Beta Function	5
1.5 Mittag-Leffler Function	6
1.6 Riemann-Liouville Operators	7
1.7 Caputo Fractional Derivatives	9
1.8 Riesz-Caputo Fractional Operator	10
1.9 Semigroup Theory	11
1.10 Fractional Powers of Closed Linear Operators	18
2 Introduction	23
2.1 Fractional Differential Equations	24
2.2 Delay Differential Equations	25
2.3 Evolution Equations	26
2.4 Nonlocal Conditions	28
2.5 Model Problems	29
2.5.1 Nonautonomous Fractional Integro-Differential System with Nonlocal Condition	30
2.5.2 Nonautonomous Fractional Control System with Nonlocal Con- dition	31
2.5.3 Fractional Delay Differential Equations with Riesz-Caputo Deriva- tive	32
2.5.4 Fractional Delay Integro-Differential Equations with Riesz- Caputo Derivative	33
2.6 Literature Review	33

2.6.1	Literature Review for Nonautonomous Fractional Integro-Differential System with Nonlocal Condition	38
2.6.2	Literature Review for Nonautonomous Fractional Control System with Nonlocal Condition	39
2.6.3	Literature Review for Fractional Delay Differential Equations with Riesz-Caputo Derivative	42
2.6.4	Literature Review for Fractional Delay Integro-Differential Equations with Riesz-Caputo Derivative	43
2.7	Objectives	44
2.8	Outline of the Thesis	45
3	Existence and Controllability Results of Fractional Integro-Differential Equations	49
3.1	Introduction	49
3.2	Preliminary Results	53
3.3	Existence and Uniqueness Results	54
3.4	Controllability Result	62
3.5	Applications	67
3.6	Conclusion	70
4	Existence and Approximate Controllability Results for Fractional Integro-Differential Equations	73
4.1	Introduction	73
4.2	Preliminary Results	76
4.3	Existence and Uniqueness Results	77
4.4	Approximate Controllability Results	84
4.5	Applications	91
4.6	Conclusion	93
5	Study of Existence Results for Fractional Functional Differential Equations Involving Riesz-Caputo Derivative	95
5.1	Introduction	95
5.2	Preliminary Results	98
5.3	Existence Results	101
5.4	Applications	114
5.5	Conclusion	117
6	Analysis of a Class of Fractional Delay Integro-Differential Equations with Riesz-Caputo Derivative	119
6.1	Introduction	119
6.2	Preliminary Results	122
6.3	Existence and Uniqueness Results	123
6.4	Existence of Extremal Solutions	132

6.5 Applications	137
6.6 Conclusion	139
7 Conclusions and Future Plan	141
7.1 Conclusion	141
7.2 Future Plan	143
Bibliography	145