

# Contents

<b>Abstract</b>	<b>v</b>
<b>List of Figures</b>	<b>ix</b>
<b>1 Introduction</b>	<b>1</b>
1.1 Literature Review . . . . .	2
1.2 The Non-Differentiability Constraints in Control . . . . .	6
1.3 The Fractional Calculus . . . . .	7
1.4 The Regularization Approach . . . . .	12
1.5 The Equivalent Control Method . . . . .	13
1.6 Motivation . . . . .	15
1.7 Organization of the Thesis . . . . .	16
1.8 Summary . . . . .	17
<b>2 Non-Differentiable Function Tracking</b>	<b>19</b>
2.1 Introduction . . . . .	19
2.2 Motivation . . . . .	20
2.3 The Tracking Problem . . . . .	20
2.4 The Switch-Controlled <i>RL</i> Circuit: A Case Study . . . . .	21
2.5 Tracking of Constant and Smooth Reference Functions . . . . .	22
2.6 The Fractional Calculus Approach to Tracking Problem . . . . .	24
2.7 General Class of Nonlinear Systems Affine in Control . . . . .	29
2.8 Illustrative Example . . . . .	31
2.9 Summary . . . . .	32

<b>3 Differentiator Design under Non-Differentiability</b>	<b>35</b>
3.1 Introduction . . . . .	35
3.2 Motivation . . . . .	37
3.3 Notations . . . . .	37
3.4 Problem Formulation . . . . .	38
3.5 Fractional-Order Differentiator . . . . .	38
3.6 Discretization of Fractional-Order Differential Equations . . . . .	39
3.7 Implicit Euler Discretization . . . . .	40
3.8 Illustrative Example . . . . .	47
3.9 Summary . . . . .	49
<b>4 Fractional-Order Sliding Mode Control under Uncertainty</b>	<b>51</b>
4.1 Introduction . . . . .	51
4.2 Motivation . . . . .	53
4.3 Fractional-Order Sliding Mode Control . . . . .	53
4.4 Extension of Lyapunov's Theory to Fractional-Order Systems . . . . .	55
4.5 Main Results . . . . .	57
4.6 Illustrative Example . . . . .	61
4.7 Summary . . . . .	63
<b>5 Conclusions and Future Scope</b>	<b>65</b>
5.1 Conclusions . . . . .	65
5.2 Contribution . . . . .	66
5.3 Future Scope . . . . .	66