

CONTENTS

Content details	Page No.
Title Page	i
Dedication	ii
Certificate	iii
Declaration	iv
Acknowledgment	v
Abstract	vi-vii
List of Figures	viii-xi
List of Tables	xii-xiii
List of Abbreviations	xiv-xv
List of Symbols	xvi-xvii
1 Introduction	1-5
1.1 Background	1
1.2 Motivation and Objective	2
1.3 Overview of the work done and methods	3
1.4 Contribution of thesis	3
1.5 Organization of thesis	4
2 Literature Review	6-22
2.1 Introduction	6
2.2 Overview of different fractional order controller	6
2.3 Summary	22
3 Design and Performance Evaluation of FOPID controller for Automatic Voltage Regulator System using Ant Lion Optimizer	23-58
3.1 Introduction	23
3.2 System Description	26
3.2.1 Model of AVR System	26
3.2.2 Integer order PID controller	27
3.2.3 Fractional order PID controller	28
3.3 Optimal design of proposed controller	30

3.3.1	Ant Lion Optimizer Algorithm	30
3.3.1.1	Random walks of ants	30
3.3.1.2	Construction trap	31
3.3.1.3	Setups of ants in traps	31
3.3.1.4	Slipping ants towards the ant lions	32
3.3.1.5	Hunting the prey and reconstruct the trap	32
3.3.1.6	Elitism	32
3.3.2	Parameter estimation of PID and FOPID controller	33
3.3.3	Proposed ALO based PID design	35
3.3.4	Proposed ALO based FOPID design	38
3.4	Result analysis and discussion	39
3.4.1	AVR system parameters	39
3.4.2	Effect of Objective Function	40
3.4.3	Transient response of PID controller	42
3.4.4	Bode Plot	43
3.4.5	Sensitivity Analysis	48
3.4.6	Robustness Analysis	49
3.4.7	Disturbance Rejection	55
3.5	Summary	58
4	Comparative Performance Evaluation of Fractional Order PID Controller for Heat Flow System using Evolutionary Algorithms	59-88
4.1	Introduction	59
4.2	Preliminaries	62
4.2.1	Modeling the Heat Flow System	62
4.2.2	The Integer order PID Controller	64
4.2.3	The Fractional Order PID Controller	65
4.3	The Proposed Algorithm based Controller	66
4.3.1	Performance Criteria and Problem Formulation	66
4.3.2	Proposed Algorithms	67
4.3.2.1	Proposed controller design using Particle Swarm Optimization (PSO)	67

	4.3.2.2	Proposed controller design using Grey Wolf Optimization (GWO)	69
	4.3.2.3	Proposed controller design using Ant Lion Optimization (ALO)	70
	4.3.2.4	Proposed controller design using Moth Flame Optimization (MFO)	73
	4.3.2.5	Proposed controller design using Hybrid PSO-GSA for Heat Flow System	74
4.4		Result and Analysis	75
	4.4.1	Parameters of Proposed Algorithms	75
	4.4.2	Transient Response Analysis	76
	4.4.3	Bode Analysis	85
	4.4.4	Robustness Analysis	87
4.5		Summary	88
5		Performance Evaluation of PID and FOPID Controller for an Automobile Cruise Control System	89-111
5.1		Introduction	89
5.2		System Dynamics of Automobile Cruise Control System (ACCS)	90
	5.2.1	Linearized model of cruise control system	91
5.3		Proposed Control Design	94
	5.3.1	Tuning of PID using ALO Algorithm	94
	5.3.2	Tuning of PID using Bode reference model	95
	5.3.3	Tuning by Pole Placement Method	96
5.4		Implementation and Analysis	98
	5.4.1	Problem Formulation for PID Controller Design	98
	5.4.2	Proposed ALO-based PID parameter design	99
	5.4.3	FOPID controller design parameters for cruise control system	99
5.5		Comparative Analysis of Result	100
	5.5.1	Transient Analysis	100

	5.5.2	Root Locus Analysis	102
	5.5.3	Bode Analysis	104
	5.5.4	Robustness Analysis	106
	5.5.5	Disturbance rejection performance analysis	110
	5.6	Summary	111
6		Tuning of Optimal fractional order PID controller using Ant Lion Optimizer	112-131
	6.1	Introduction	112
	6.2	Preliminaries of Fractional Order Calculus	114
	6.3	The Proposed Algorithm	116
		6.3.1 Performance Criteria	116
		6.3.2 Proposed ALO based FOPID controller design	118
	6.4	Results and Discussion	120
	6.5	Summary	131
7		Conclusion and Future Scopes	132-134
	7.1	Conclusion	132
	7.2	Future Scopes	134
		References	135-160
		Curriculum Vitae	161
		Thesis dissemination	162
		Appendix	
