

Contents

Title	Content	Pg.No.
	Declaration by Research Scholar–Originality of Research Work	I
	Certificate of Supervisor	II
	Thesis Approval Form	III
	Declaration by Research Scholar – Submission of Thesis	IV
	Acknowledgement	V
	Dedication	VII
	Contents	VIII
	List of Figures	X
	List of Tables	XI
	List of Abbreviation	XII
	Nomenclature	XIII
	Abstract	XV
Chapter: 1	Background	1
	1.1 Introduction	1
	1.2 Flexible AC Transmission Systems	2
	1.2.1 FACTS controllers' function in the management of the power system	3
	1.3 Modelling Philosophy	4
	1.3.1 SVC modelling	4
	1.3.2 TCSC modelling	6
	1.3.3 UPFC modelling	7
	1.4 Integration of FACT controllers into power system	8
	1.4.1 Sensitivity Based Methods	8
	1.4.2 Optimization Based Methods	8
	1.5 Distribution Systems Utilizing FACTS Controllers	9
	1.6 Optimal Power Flow	12
	1.6.1 Features of OPF	13
	1.6.2 OPF applications	14
	1.7 Organization of the Thesis	14
Chapter: 2	FACTS DEVICES AND COMPUTATIONAL TECHNIQUE	16
	2.1 FACTS Devices	16

2.2 Literature Review	18
2.3 Meta heuristic optimization Technique	19
2.3.1 Swarm Intelligence Algorithms	21
2.3.2 Particle Swarm Optimization Algorithm	22
2.3.3 Ant Colony Optimization Algorithm	23
2.3.4 Evolutionary Algorithms	24
2.3.5 Genetic Algorithms	25
2.4 Objective and scope	27
Chapter: 3 Applicability of Optimization Algorithm	29
3.1 Implementation of proposed method	29
3.2 KGMO-CSA HYBRID	30
3.2.1 Kinetic Gas Molecular Optimization Algorithm	31
3.2.2 Cuckoo search algorithm	33
3.3 Problem formulation	34
Chapter: 4 Result And Discussion	37
4.1 Performance Analysis	37
4.1.1 30 Bus System	41
4.1.2 14 Bus System	51
4.1.3 57 Bus System	55
4.2 Comparative analysis	58
Bibliography	63
Appendix A Plagiarism Report	
Appendix B Publication	
Appendix C IEEE BUS DATA	

List of Figures

Figure No.	Name of the Figure	Pg. No.
Figure 1.1	Model of SVC	5
Figure 1.2	Model of TCSC	6
Figure 1.3	Schematic representation of the UPFC	7
Figure 2.1	Taxonomy of FACTS deviices	16
Figure 2.2	Classification of Optimization Techniques	21
Figure 2.3	Swarm Intelligence Algorithm	22
Figure 2.4	PSO Algorithm	23
Figure 2.5	ACO Algorithm	24
Figure 2.6	Evolutionary Algorithms	25
Figure 2.7	GA Algorithm	26
Figure 2.8	Proposed Algorithm	28
Figure 3.1	Block diagram for the system	31
Figure 4.1	Fitness function for scenario 1	43
Figure 4.2	Fitness function for scenario 2	45
Figure 4.3	Fitness function for scenario 3	46
Figure 4.4	Fitness function for scenario 4	48
Figure 4.5	Fitness function for scenario 5	50

List of Tables

Table No.	Name of Table	Pg. No.
Table 1.1	FACTS controller's function	4
Table 3.1	Parameter description of KGMO-CSA	34
Table 4.1	Specifications of the IEEE 14 & 30 bus system	41
Table 4.2	Population Count for Optimization Methods	41
Table 4.3	Performance analysis for Scenario 1	42
Table 4.4	Performance analysis for Scenario 2	44
Table 4.5	Performance analysis for Scenario 3	46
Table 4.6	Performance analysis for Scenario 4	48
Table 4.7	Performance analysis for Scenario 5	50
Table 4.8	Statistical Inference Values	51
Table 4.9	Bus voltage for each line	52
Table 4.10	Performance analysis of SVC & TCSC for IEEE 14 bus system	53
Table 4.11	Performance analysis of SVC, TCSC & UPFC for IEEE 14 bus system	55
Table 4.12	Performance analysis of SVC, TCSC, UPFC and STATCOM for IEEE 57 bus system	57
Table 4.13	Statistical Inference Values	57
Table 4.14	Comparative analysis of the hybrid KGMO-CSA method for 30 bus	58
Table 4.15	Comparative analysis for IEEE 14 bus system	60
Table 4.16	Performance between proposed and existing methods for Real power loss savings [22]	61

List of Abbreviation

Artificial Bee Colony	ABC
Bacteria Foraging Algorithm	BFA
Chemical Reaction Optimization	CRO
Cuckoo Search Algorithm	CSA
Flexible AC Transmission Systems	FACTS
Genetic Algorithm	GA
Gravitational Search Algorithm	GSA
Grey Wolf Optimization	GWO
Honey Bee Algorithm	HBA
Kinetic Gas Molecular Optimization	KGMO
Line Loading	LL
Particle Swarm Optimization	PSO
Quasi-Oppositional Based Learning	QOBL
Quasi-Oppositional Chemical Reaction Optimization	QOCRO
Reactive Power Dispatch	RPD
Static VAR compensator	SVC
Strength Pareto Multi-Objective EvolutionaryAlgorithm	SPMOEA
Teaching Learning Based Optimization	TLBO
Thyristor Controlled Series Compensator	TCSC
Total Voltage Deviation	TVD
Unified Power Flow Controllers	UPFC

Nomenclature

P_{gi}	Active power generation
Q_{gi}	Reactive power generation
$Cost_a$	Cost of active power
$Cost_r$	Cost of reactive power
a_i, b_i and c_i	Cost Coefficients
N_L	Amount of load bus
V_i	load bus voltage
V_{ref}	reference voltage
P_{ij}	power flow at each line
P_{ijmax}	maximum power flow limit
L	total amount of transmission lines
G_{ij}	conductance of line i-j
δ_i and δ_j	voltage angle of i th and j th bus
ΔQ	Size of SVC
s	functional limit of the FACTS device
X_{Line}	transmission line reactance
r_{TCSC}	Degree of composition by TCSC
P	Amount of particles
k	location of the agent
z^p_j	specifies the k th agent position at d th dimension
T^d_j	k^{th} agent temperature at dimension d
b	Boltzmann constant
$pbest_j$	best previous location of j th gas molecule
$gbest_j$	best previous location of j th gas molecules
E_1 and E_2	acceleration coefficients
w	inertia weight
$rand_j$	uniform random variable
z^j_{r+1}	Position of the molecule

a^d	acceleration of agent k in dimension d
j	
fit_q	fitness value of the solution.
q	proportionality index of the quality of an egg
$nest_q$	New nest
S_{pq}	Step size
$p \& q$	randomly chosen indexes
λ	Levy Coefficient
α	random number generated between $[-1,1]$
Γ	gamma function
x^{gen+1}	Nest Location
p_q	
p_a	discovery rate