

Contents

Preface	xi
1 Analysis of Six-Phase Grid Connected Synchronous Generator in Wind Power Generation	1
<i>Arif Iqbal and Girish Kumar Singh</i>	
1.1 Introduction	2
1.2 Analytical Modeling of Six-Phase Synchronous Machine	4
1.2.1 Voltage Equation	5
1.2.2 Equations of Flux Linkage Per Second	5
1.3 Linearization of Machine Equations for Stability Analysis	10
1.4 Dynamic Performance Results	12
1.5 Stability Analysis Results	15
1.5.1 Parametric Variation of Stator	16
1.5.2 Parametric Variation of Field Circuit	19
1.5.3 Parametric Variation of Damper Winding, K_d	22
1.5.4 Parametric Variation of Damper Winding, K_q	24
1.5.5 Magnetizing Reactance Variation Along q -axis	26
1.5.6 Variation in Load	28
1.6 Conclusions	29
References	30
Appendix	31
Symbols Meaning	32
2 Artificial Intelligence as a Tool for Conservation and Efficient Utilization of Renewable Resource	37
<i>Vinay N., Ajay Sudhir Bale, Subhashish Tiwari and Baby Chithra R.</i>	
2.1 Introduction	38
2.2 AI in Water Energy	39
2.2.1 Prediction of Groundwater Level	39
2.2.2 Rainfall Modeling	46

2.3	AI in Solar Energy	47
2.3.1	Solar Power Forecasting	47
2.4	AI in Wind Energy	53
2.4.1	Wind Monitoring	53
2.4.2	Wind Forecasting	54
2.5	AI in Geothermal Energy	55
2.6	Conclusion	60
	References	61
3	Artificial Intelligence-Based Energy-Efficient Clustering and Routing in IoT-Assisted Wireless Sensor Network	79
	<i>Nitesh Chouhan</i>	
3.1	Introduction	80
3.2	Related Study	81
3.3	Clustering in WSN	84
3.4	Research Methodology	85
3.4.1	Creating Wireless Sensor-Based IoT Environment	85
3.4.2	Clustering Approach	86
3.4.3	AI-Based Energy-Aware Routing Protocol	87
3.5	Conclusion	89
	References	89
4	Artificial Intelligence for Modeling and Optimization of the Biogas Production	93
	<i>Narendra Khatri and Kamal Kishore Khatri</i>	
4.1	Introduction	93
4.2	Artificial Neural Network	96
4.2.1	ANN Architecture	96
4.2.2	Training Algorithms	98
4.2.3	Performance Parameters for Analysis of the ANN Model	98
4.2.4	Application of ANN for Biogas Production Modeling	99
4.3	Evolutionary Algorithms	103
4.3.1	Genetic Algorithm	103
4.3.2	Ant Colony Optimization	104
4.3.3	Particle Swarm Optimization	106
4.3.4	Application of Hybrid Models (ANN and Evolutionary Algorithms) for Biogas Production Modeling	106
4.4	Conclusion	107
	References	111

5	Battery State-of-Charge Modeling for Solar PV Array Using Polynomial Regression	115
	<i>Siddhi Vinayak Pandey, Jeet Patel and Harsh S. Dhiman</i>	
5.1	Introduction	115
5.2	Dynamic Battery Modeling	119
5.2.1	Proposed Methodology	120
5.3	Results and Discussion	122
5.4	Conclusion	126
	References	127
6	Deep Learning Algorithms for Wind Forecasting: An Overview	129
	<i>M. Lydia and G. Edwin Prem Kumar</i>	
	Nomenclature	129
6.1	Introduction	131
6.2	Models for Wind Forecasting	133
6.2.1	Persistence Model	133
6.2.2	Point vs. Probabilistic Forecasting	133
6.2.3	Multi-Objective Forecasting	134
6.2.4	Wind Power Ramp Forecasting	134
6.2.5	Interval Forecasting	134
6.2.6	Multi-Step Forecasting	134
6.3	The Deep Learning Paradigm	135
6.3.1	Batch Learning	136
6.3.2	Sequential Learning	136
6.3.3	Incremental Learning	136
6.3.4	Scene Learning	136
6.3.5	Transfer Learning	136
6.3.6	Neural Structural Learning	136
6.3.7	Multi-Task Learning	137
6.4	Deep Learning Approaches for Wind Forecasting	137
6.4.1	Deep Neural Network	137
6.4.2	Long Short-Term Memory	138
6.4.3	Extreme Learning Machine	138
6.4.4	Gated Recurrent Units	139
6.4.5	Autoencoders	139
6.4.6	Ensemble Models	139
6.4.7	Other Miscellaneous Models	139
6.5	Research Challenges	139
6.6	Conclusion	141
	References	142

7 Deep Feature Selection for Wind Forecasting-I	147
<i>C. Ramakrishnan, S. Sridhar, Kusumika Krori Dutta, R. Karthick and C. Janamejaya</i>	
7.1 Introduction	148
7.2 Wind Forecasting System Overview	152
7.2.1 Classification of Wind Forecasting	153
7.2.2 Wind Forecasting Methods	153
7.2.2.1 Physical Method	154
7.2.2.2 Statistical Method	154
7.2.2.3 Hybrid Method	155
7.2.3 Prediction Frameworks	155
7.2.3.1 Pre-Processing of Data	155
7.2.3.2 Data Feature Analysis	156
7.2.3.3 Model Formulation	156
7.2.3.4 Optimization of Model Structure	156
7.2.3.5 Performance Evaluation of Model	157
7.2.3.6 Techniques Based on Methods of Forecasting	157
7.3 Current Forecasting and Prediction Methods	158
7.3.1 Time Series Method (TSM)	159
7.3.2 Persistence Method (PM)	159
7.3.3 Artificial Intelligence Method	160
7.3.4 Wavelet Neural Network	161
7.3.5 Adaptive Neuro-Fuzzy Inference System (ANFIS)	162
7.3.6 ANFIS Architecture	163
7.3.7 Support Vector Machine (SVM)	165
7.3.8 Ensemble Forecasting	166
7.4 Deep Learning-Based Wind Forecasting	166
7.4.1 Reducing Dimensionality	168
7.4.2 Deep Learning Techniques and Their Architectures	169
7.4.3 Unsupervised Pre-Trained Networks	169
7.4.4 Convolutional Neural Networks	170
7.4.5 Recurrent Neural Networks	170
7.4.6 Analysis of Support Vector Machine and Decision Tree Analysis (With Computation Time)	170
7.4.7 Tree-Based Techniques	172
7.5 Case Study	173
References	176

8 Deep Feature Selection for Wind Forecasting-II	181
<i>S. Oswalt Manoj, J.P. Ananth, Balan Dhanka and Maharaja Kamatchi</i>	
8.1 Introduction	182
8.1.1 Contributions of the Work	184
8.2 Literature Review	185
8.3 Long Short-Term Memory Networks	186
8.4 Gated Recurrent Unit	190
8.5 Bidirectional Long Short-Term Memory Networks	194
8.6 Results and Discussion	196
8.7 Conclusion and Future Work	197
References	198
9 Data Falsification Detection in AMI: A Secure Perspective Analysis	201
<i>Vineeth V.V. and S. Sophia</i>	
9.1 Introduction	201
9.2 Advanced Metering Infrastructure	202
9.3 AMI Attack Scenario	204
9.4 Data Falsification Attacks	205
9.5 Data Falsification Detection	206
9.6 Conclusion	207
References	208
10 Forecasting of Electricity Consumption for G20 Members Using Various Machine Learning Techniques	211
<i>Jaymin Suhagiya, Deep Raval, Siddhi Vinayak Pandey, Jeet Patel, Ayushi Gupta and Akshay Srivastava</i>	
10.1 Introduction	211
10.1.1 Why Electricity Consumption Forecasting Is Required?	212
10.1.2 History and Advancement in Forecasting of Electricity Consumption	212
10.1.3 Recurrent Neural Networks	213
10.1.3.1 Long Short-Term Memory	214
10.1.3.2 Gated Recurrent Unit	214
10.1.3.3 Convolutional LSTM	215
10.1.3.4 Bidirectional Recurrent Neural Networks	216
10.1.4 Other Regression Techniques	216

x CONTENTS

10.2	Dataset Preparation	217
10.3	Results and Discussions	218
10.4	Conclusion	225
	Acknowledgement	225
	References	225
11	Use of Artificial Intelligence (AI) in the Optimization of Production of Biodiesel Energy	229
	<i>Manvinder Singh Pahwa, Manish Dadhich, Jaskaran Singh Saini and Dinesh Kumar Saini</i>	
11.1	Introduction	230
11.2	Indian Perspective of Renewable Biofuels	230
11.3	Opportunities	232
11.4	Relevance of Biodiesel in India Context	233
11.5	Proposed Model	234
11.6	Conclusion	236
	References	237
Index		239