

Contents

<i>Preface</i>	<i>xiii</i>	
<i>List of Symbols</i>	<i>xvii</i>	
One	SUPPLY SYSTEM AND DISTRIBUTION PRACTICES	1
	Introduction	1
1.1	Supply Systems	2
1.2	The Distribution Systems	5
1.3	Organisation and Contents of the Book	5
	<i>Summary</i>	5
	<i>Keywords</i>	6
	<i>Review Questions</i>	6
	<i>Multiple Choice Questions</i>	6
	<i>Fill in the Blanks</i>	7
	<i>Answers</i>	7
Two	LOAD CHARACTERISTICS AND LOAD MODELLING	8
	Introduction	8
2.1	Definitions	8
2.2	Loads and Load Characteristics	9
2.3	Load Curves and Load-Duration Curves	11
2.4	Relation Between Load and Loss Factor: A Simplified Approach	19
2.5	Load Growth and Diversified Demands	22
2.6	Load Modeling	24
2.7	Load Growth and Forecasting	27
	<i>Summary</i>	28
	<i>Keywords</i>	28
	<i>Review Questions</i>	28
	<i>Problem</i>	29
	<i>Multiple Choice Questions</i>	30
	<i>Fill in the Blanks</i>	31
	<i>Answers</i>	31

Three	OVERHEAD LINES AND CABLES	32
	Introduction	32
3.1	Line Parameters	33
3.2	Overhead Lines, Insulators and Supports	34
3.3	Cables	40
3.4	Insulation Resistance	44
3.5	Voltage Drop and Power Loss in Conductors	44
	<i>Summary</i>	46
	<i>Keywords</i>	46
	<i>Review Questions</i>	46
	<i>Problem</i>	47
	<i>Multiple Choice Questions</i>	47
	<i>Fill in the Blanks</i>	47
	<i>Answers</i>	48
Four	DISTRIBUTION FEEDERS	49
	Introduction	49
4.1	Primary and Secondary Distribution	50
4.2	Distribution Substation Location and Planning	50
4.3	Feeder Loading and Voltage-Drop Considerations	51
4.4	Voltage-Drop in Feeder Lines with Different Loadings	54
4.5	Voltage Drop Constant 'K' For Feeders with Different Types of Loadings	59
4.6	Feeder Rating with Square-type Distribution System	59
	<i>Summary</i>	65
	<i>Keywords</i>	65
	<i>Review Questions</i>	65
	<i>Problem</i>	66
	<i>Multiple Choice Questions</i>	66
	<i>Fill in the Blanks</i>	67
	<i>Answers</i>	68
Five	PRIMARY AND SECONDARY DISTRIBUTION NETWORKS	69
	Introduction	69
5.1	Primary Distribution System	69
5.2	Primary Feeder Voltage Levels and Loading	72
5.3	Secondary Distribution Systems	73
5.4	Distribution Feeders	76
5.5	Design Considerations	78
	<i>Summary</i>	81
	<i>Keywords</i>	81

	<i>Review Questions</i>	81	
	<i>Problem</i>	81	
	<i>Multiple Choice Questions</i>	82	
	<i>Short Questions</i>	83	
	<i>Answers</i>	84	
Six	VOLTAGE DROP AND POWER LOSS CALCULATIONS		85
	Introduction	85	
6.1	DC, 2-Wire Distribution System	85	
6.2	DC, 3-Wire System	89	
6.3	AC Single-Phase Distribution System	91	
6.4	Voltage Drop (% VD) Computation Based on Load Density	101	
6.5	Voltage Drop (VD) With Underground Cable Distribution	103	
6.6	Power-loss Estimation In Distribution System	106	
	<i>Summary</i>	109	
	<i>Keywords</i>	109	
	<i>Review Questions</i>	109	
	<i>Problem</i>	109	
	<i>Multiple Choice Questions</i>	112	
	<i>Fill in the Blanks</i>	113	
	<i>Answers</i>	113	
Seven	REACTIVE POWER COMPENSATION AND APPLICATIONS OF CAPACITORS		114
	Introduction	114	
7.1	Advantages and Benefits of Power Factor Improvement	114	
7.2	Power-factor Analysis and Basics	115	
7.3	Power-Factor Improvement Using Capacitors: Mathematical Calculation	116	
7.4	Location of Capacitors	118	
7.5	Voltage Improvement Achieved Using Capacitor Banks	119	
7.6	Application of Capacitors for Power-Factor Improvement	123	
7.7	Sub-harmonic Oscillations and Ferro-Resonance due to Capacitor Banks	128	
7.8	Synchronous Motors for Reactive Power Compensation and Power Factor Improvement	128	
7.9	Optimum Power Factor for Distribution Systems	130	
	<i>Summary</i>	132	
	<i>Keywords</i>	133	
	<i>Review Questions</i>	133	
	<i>Problem</i>	133	
	<i>Multiple Choice Questions</i>	135	
	<i>Fill in the Blanks</i>	135	
	<i>Answers</i>	136	

Eight	SUBSTATIONS EQUIPMENT, LOCATION AND GROUNDING	137
	Introduction 137	
8.1	Substation Types 137	
8.2	Substation Components, Equipment and Layouts 138	
8.3	Substation Location and Size 143	
8.4	Grounding 143	
8.5	Earth Connections and Earthing System 147	
8.6	Gas Insulated Substation (GIS) 148	
	<i>Summary</i> 156	
	<i>Keywords</i> 156	
	<i>Review Questions</i> 156	
	<i>Multiple Choice Questions</i> 156	
	<i>Fill in the Blanks</i> 157	
	<i>Answers</i> 158	
Nine	FAULTS AND OVER VOLTAGES IN DISTRIBUTION SYSTEMS	159
	Introduction 159	
9.1	Types of Faults 159	
9.2	Symmetrical Component Analysis 160	
9.3	Fault Analysis for Distribution System 162	
9.4	Overvoltage in Distribution Systems 174	
	<i>Summary</i> 175	
	<i>Keywords</i> 175	
	<i>Review Questions</i> 175	
	<i>Problem</i> 176	
	<i>Multiple Choice Questions</i> 177	
	<i>Fill in the Blanks</i> 178	
	<i>Answers</i> 178	
Ten	PROTECTION	179
	Introduction 179	
10.1	Basic Requirements 179	
10.2	Overcurrent Protection : Fuses 179	
10.3	Circuit Breakers 182	
10.4	Protective Relays and Relaying 183	
10.5	Coordination Between Different Protective Devices 190	
10.6	Protection Against Overvoltages 193	
	<i>Summary</i> 199	
	<i>Keywords</i> 199	

	<i>Review Questions</i>	199	
	<i>Multiple Choice Questions</i>	200	
	<i>Fill in the Blanks</i>	201	
	<i>Answers</i>	202	
Eleven	METERING, INSTRUMENTATION AND TARIFFS		203
	Introduction	203	
11.1	Measurement of Power	203	
11.2	Measurement of Energy	206	
11.3	Maximum Demand and Trivector Meters	209	
11.4	Substation Instrumentation	211	
11.5	Tariffs and Billing	211	
	<i>Summary</i>	213	
	<i>Keywords</i>	213	
	<i>Review Questions</i>	213	
	<i>Multiple Choice Questions</i>	214	
	<i>Fill in the Blanks</i>	215	
	<i>Answers</i>	216	
Twelve	VOLTAGE CONTROL: SYSTEM PLANNING AND AUTOMATION		217
	Introduction	217	
12.1	Basic Definitions	218	
12.2	Voltage Control	218	
12.3	Distribution Planning	223	
12.4	Distribution Automation	224	
12.5	Distribution Optimization	233	
	<i>Summary</i>	236	
	<i>Keywords</i>	236	
	<i>Review Questions</i>	236	
	<i>Multiple Choice Questions</i>	237	
	<i>Fill in the Blanks</i>	238	
	<i>Answers</i>	238	
	Appendix I	239	
	Appendix II	244	
	Bibliography and References	247	
	Index	249	