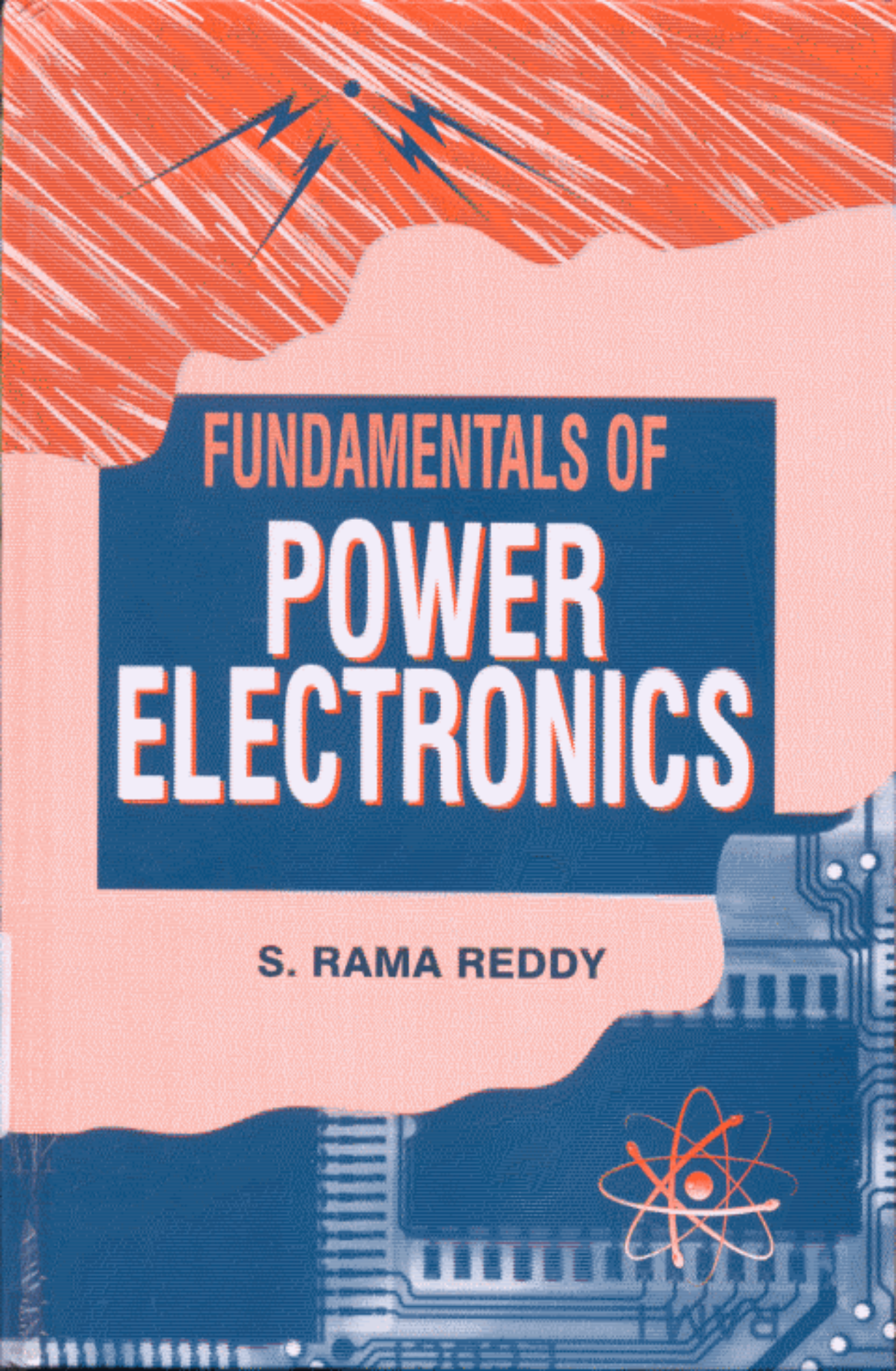




FUNDAMENTALS OF **POWER ELECTRONICS**

S. RAMA REDDY



Contents

<i>Preface</i>	v
1. Semiconductor Devices	1
1.1 Introduction	1
1.2 P-N Diode	4
1.3 Bipolar Junction Transistor (BJT)	6
1.4 Silicon Controlled Rectifier (SCR)	7
1.5 DIAC	17
1.6 TRIAC	17
1.7 MOSFET	19
1.8 Gate Turn Off Thyristor (GTO Thyristor)	20
1.9 Insulated Gate Bipolar Transistor (IGBT)	20
1.10 Programmable Unijunction Transistor (PUT)	21
1.11 Silicon Controlled Switch (SCS)	21
1.12 Silicon Unilateral Switch (SUS)	22
1.13 Reverse Conducting Thyristor (RCT)	22
1.14 Light Activated SCR (LASCR)	23
<i>Short Questions and Answers</i>	23
2. Triggering Circuits	25
2.1 R-Triggering	25
2.2 R-C Triggering	26
2.3 UJT Triggering	26
<i>Short Questions and Answers</i>	29
3. Commutation Circuits	30
3.1 Introduction	30
3.2 Commutation	30
3.3 Series LC Circuit	30
3.4 Ringing Circuit	32
3.5 Turn Off Methods	32
<i>Short Questions and Answers</i>	37
4. Phase Controlled Rectifiers	38
4.1 Introduction	38
4.2 Classifications of Rectifiers	38
4.3 Performance of Rectifiers	39
4.4 Single Phase Rectifiers	42
4.5 Half Controlled Rectifier with R-Load	42

4.6	Half Controlled Rectifier with R-L Load	43
4.7	1- ϕ Fully Controlled Rectifier with R-Load	43
4.8	1- ϕ Fully Controlled Rectifier (Bridge Type)	44
4.9	1- ϕ Fully Controlled Rectifier with R-L Load	45
4.10	Fully Controlled Rectifier with Source Inductance	47
4.11a	1- ϕ Fully Controlled Rectifier with Free Wheeling Diode	48
4.11b	Semiconverter	48
4.12	Fully Controlled Rectifier Using One SCR	50
4.13	3- ϕ Half Controlled Converter (3-Pulse Converter)	51
4.14	3- ϕ Fully Controlled Bridge Converter (6-Pulse Converter)	51
4.15	Synchronized UJT Triggering Circuit	58
4.16	Firing Circuit for 3- ϕ Converter	60
	<i>Short Questions and Answers</i>	64
5.	D.C. Choppers	67
5.1	Introduction	67
5.2	Basic Principle	67
5.3	Control Strategies	68
5.4	Classification of Choppers	69
5.5	Voltage Commutated Chopper	72
5.6	Current Commutated Chopper (CCC)	75
5.7	Load Commutated Chopper	77
5.8	Jones Chopper	78
5.9	Step-Up Chopper	80
	<i>Short Questions and Answers</i>	83
6.	Inverters	85
6.1	Introduction	85
6.2	Series Inverter	85
6.3	Parallel Inverter	87
6.4	Bridge Inverters	88
6.5	Mc-Murray Inverter (Voltage Source Inverter)	90
6.6	Mc-Murray-Bedford Inverter	92
6.7	3- ϕ Inverters	94
6.8	3- ϕ Current Source Inverter	94
6.9	Voltage Control	98
6.10	Harmonic Control (Waveform Control)	100
	<i>Short Questions and Answers</i>	103
7.	Cycloconverters	104
7.1	Introduction	104
7.2	Single Phase Step Down Cycloconverter	104
7.3	Step-Up Cycloconverter	105
7.4	3- ϕ to 1- ϕ Cycloconverter	105
7.5	3- ϕ to 3- ϕ Cycloconverter	106
7.6	1- ϕ to 3- ϕ Cycloconverters	108
	<i>Short Questions and Answers</i>	108

8. A.C. Choppers	109
8.1 Introduction	109
8.2 AC Chopper Using Triac	110
8.3 AC Chopper with R-Load	111
8.4 AC Chopper with R-L Load	112
Short Questions and Answers	114
9. Applications	115
9.1 Introduction	115
9.2 Speed Control of Induction Motor	115
9.3 Braking of Induction Motor	120
9.4 Closed Loop Operation	122
9.5 Speed Control of DC Motors	123
9.6 Braking of DC Motors	126
9.7 Closed Loop Controlled DC Drive	126
9.8a Regulated Power Supply (RPS)	128
9.8b Switch Mode Power Supply (SMPS)	128
9.9 Welding	129
9.10 Heating	129
9.11 Thyristor Controlled Static On-Load Tap-Changing Gear	131
9.12 Static Var Compensators	133
9.13 Generex Excitation System of Alternators	136
9.14 Uninterruptible Power Supply	136
9.15 HVDC Transmission	139
9.16 Microprocessor Based Thyristor Controlled Electrical Drives	140
Short Questions and Answers	146
10. Resonant Inverters	147
10.1 Static Power Conversion	147
10.2 Advantages of Zero Voltage Switching	147
10.3 Disadvantages of Zero Voltage Switching	148
10.4 Resonant DC Link Converter	148
10.5 Base Drive Circuit of Bipolar Junction Transistor	149
10.6 Single Phase IPMRI	150
10.7 Analysis of IPMRI with R-Load	154
10.8 Single Phase IPMRI with R-L Load	154
11. Quasi Resonant Converters	157
11.1 General	157
11.2 Zero Current Switching	157
11.3 Resonant Switch Topologies	158
11.4 Principle of Operation of QRC	159
12. Microprocessor Based Triggering Schemes	163
12.1 Firing Scheme for 3 Phase Converters Proposed by Huy, Roye and Perret	163
12.2 Firing Scheme Proposed by S.B. Dewan	165

Appendix I: Basic Experiments in Power Electronics	168
1. SCR Characteristics	168
2. UJT Firing Circuit	170
3. Triac Characteristics	171
4. RC Triggering Scheme of SCR	172
5. Voltage Commutation	173
6. Current Commutation	176
Appendix II: Short Questions and Answers	178
Questions and Answers Bank-I	178
Questions and Answers Bank-II	185
Applications	187
REFERENCES	188
INDEX	189