

Table of Contents

Introduction	7
Part I	
Electrotechnics	9
1. DC Current Linear Circuits	11
1.1. Definitions & Terminology	11
1.2. Electrostatic Field	24
2. Electromagnetic circuits	28
3. Time Domain Circuit Analysis	48
4. Alternating Sinusoidal Current	68
5. Three-phase electric power	82
Part II	
Electronics	85
1. Semiconductor devices	87
1.1. Diode	87
1.2. Thyristor (SCR)	91
1.3. Bipolar junction transistor (BJT)	94
2. Rectifiers	98
2.1. Half wave rectifier	98
2.2. Full wave rectifier with centre-tapped transformer	99
2.3. Full wave bridge rectifier	100
2.4. Controlled rectifiers	101
2.5. Three-phase uncontrolled bridge rectifier	101
3. Amplifier	103
3.1. Gain of amplifier	104
3.2. Frequency response and phase shift	105
3.3. Basic BJT amplifier	106
3.4. Basic BJT amplifier configurations	108
3.5. Feedback of amplifier	110
3.6. Operational amplifiers (op-amp)	111
4. Signal generator	114
Part III	
Electric Machines	117
<i>Non-rotating Electric Machines</i>	119
1. The basics of sinusoidal AC current harmonics generation	119
2. Oscillating and rotating electromagnetic field	122

3.	AC induction machine – transformer	126
3.1.	Idle state of transformer	128
3.2.	The load condition of transformer	129
3.3.	The simplified equivalent scheme and vector diagram for transformer's short circuit .	132
3.4.	Power and efficiency of transformer	133
3.5.	The three-phase transformer	134
	<i>Rotating Electric Machines</i>	135
1.	AC Induction Motor	135
1.1.	Construction of 3-phase AC induction motor	135
1.2.	Principles of operation	138
1.3.	The transformation ratio of AC induction motor	140
1.4.	Rotor and stator currents	141
1.5.	The rotating torque of AC induction motor – electromagnetic torque	142
1.5.1.	Electromagnetic torque	142
1.5.2.	Rotating torque	143
1.6.	Dependence of electromagnetic torque on stator supplying voltage	145
1.7.	Maximum value of electromagnetic torque	146
1.8.	Electromagnetic torque and its maximal value quotient	147
1.9.	Standard torque-speed-slip curves	147
1.10.	Single-phase AC induction motor	149
1.11.	Slip ring motor	150
1.12.	Basics of AC induction motor's torque-speed control	150
1.13.	Discussion of torque-slip and torque-speed curves for 2-quarter AC induction motor operation	153
2.	Direct Current (DC) Motor	156
2.1.	DC motor basics	156
2.2.	DC motor basic voltage/torque equations	160
2.3.	The generating mode of DC motor	164
2.4.	Main mechanical characteristics of DC motors	166
2.4.1.	Self-excited DC motor	166
2.4.2.	Series DC motor	168
2.5.	Torque/speed control of DC motor	170
2.6.	Separately excited DC motor dynamic analysis	174
3.	Conventional Synchronous Machine	177
3.1.	Synchronous motor	178
3.2.	Starting synchronous motor powered by a grid – machine synchronization	180
3.3.	The power factor	181
3.4.	PM synchronous Motor	182
3.4.1.	Operating Principles and Construction Evolution	182
3.4.2.	Converter circuits	185
3.5.	PM brushless DC motor (BLDC)	189
3.6.	Automotive alternators	191
	References	194