

工程技术英语注释读物

ELECTRICAL ENGINEERING FUNDAMENTALS

电工基础

清华大学外语教研组
英语读物注释小组 编



工程技术英语注释读物

ELECTRICAL ENGINEERING FUNDAMENTALS

电 工 基 础

清华大学外语教研组 编
英语读物注释小组

商 务 印 书 馆

1983 年 · 北京

工程技术英语注释读物

电 工 基 础

清华大学外语教研组 编
英语读物注释小组

商 务 印 书 馆 出 版

(北京王府井大街 36 号)

新华书店北京发行所发行

涿县印刷厂印刷

统一书号:9017·1248

1983 年 4 月第 1 版

开本 787×1092 1/32

1983 年 4 月北京第 1 次印刷

字数 246 千

印数 10,500 册

印张 11⁵/₈

定价: 1.20 元

编 者 的 话

工程技术英语注释读物按机械、动力、电力、电子、建筑、化工、原子能等不同专业分册出版。文章大部选自原著,力求由浅入深,对其中个别地方作了适当修改。专业内容浅近易懂。附有较详细的注释、参考译文和词汇表,便于读者自学,以培养独立阅读能力。

这本《电工基础》是这套读物电类的第二册之二。第2章至第9章内容选自 E. C. 李斯特著《电路和电机》,1975 年第 5 版(E. C. Lister, *Electric Circuits and Machines*, 5ed. 1975)。本校工程力学系热工 4 班学生参加翻译,该系教师参加审校。

由于编者水平的限制,以及缺乏编写经验,书中肯定存在不少缺点错误,热烈欢迎广大读者提出宝贵的批评意见,以便进一步修改。意见请寄清华大学外语教研室。

编 者

1982 年 1 月

CONTENTS

编者的话

1. ELECTRICAL UNITS	1
2. FUNDAMENTAL UNITS	5
2—1 The Structure of Matter	6
2—2 Electric Current	9
2—3 Unit of Current: The Ampere	10
2—4 Resistance: The Ohm	12
2—5 Potential Difference and Electromotive Force: The Volt	13
2—6 Measurement of Current, Voltage, and Re- sistance.....	15
3. DIRECT-CURRENT CIRCUITS	17
3—1 Series Circuits: Current Relations	18
3—2 Series Circuits: Voltage Relations	19
3—3 Parallel Circuits: Voltage Relations	21
3—4 Parallel Circuits: Current Relations	22
3—5 Ohm's Law	23
3—6 Applying Ohm's Law	25
3—7 Resistance in a Series Circuit	27
3—8 Resistance of a Parallel Circuit	27
3—9 Series-Parallel Circuits	31
3—10 Temperature Coefficient of Resistance	33
3—11 Line Drop	35
3—12 Kirchhoff's Laws	37

3—13 Work	38
3—14 Energy	39
3—15 Mechanical Power	40
3—16 Electric Power	42
3—17 Electric Work and Energy	44
3—18 Measurement of Electric Power and Energy ...	46
3—19 Line Loss	48
3—20 Three-Wire Distribution Circuits	49
4. MAGNETISM	54
4—1 Magnets and Magnetic Materials	54
4—2 Magnetic Fields and Lines of Force	55
4—3 Magnetic Attraction and Repulsion	58
4—4 Nature of Magnetism	59
4—5 Field around a Current-Carrying Conductor ...	60
4—6 Field around a Coil	62
4—7 Magnetomotive Force or MMF	64
4—8 Electromagnets	64
4—9 Saturation	68
5. ELECTROMAGNETIC INDUCTION	68
5—1 Induced EMF	69
5—2 Factors Affecting the Amount of Induced EMF.....	70
5—3 Faraday's Law of Induction	71
5—4 Numerical Value of Induced EMF	71
5—5 Direction of Induced EMF	72
5—6 Lenz's Law of Induction	73
5—7 Self-induced EMF: Inductance	74
5—8 Self-induction in a Coil	75
5—9 Mutual Induction	77
6. ALTERNATING CURRENT	79

6—1	Generation of an Alternating EMF.....	81
6—2	Alternating Current	83
6—3	Cycle; Frequency	84
6—4	Electrical Degrees: A Measure of Time	84
6—5	Effective Values of Alternating Current and EMF	86
6—6	Average Value of Alternating EMFs and Currents	87
6—7	Phase Relations	88
6—8	Phasor (Vector) Diagrams	90
6—9	Addition of Phasors	93
6—10	Subtraction of Phasors	98
6—11	Properties of an Electric Circuit	99
6—12	Resistance in an AC Circuit	100
6—13	Inductance	101
6—14	Inductive Reactance	102
6—15	Capacitors	105
6—16	Capacitors in Series	108
6—17	Capacitors in Parallel	108
6—18	Action of a Capacitor in an AC Circuit ..	109
6—19	Capacitive Reactance	110
6—20	Reactance	112
6—21	Impedance	112
6—22	Graphical Representation of Resistance, Reactance, and Impedance	114
6—23	Complex Quantity Notation for Phasor Representation	116
7.	SINGLE-PHASE CIRCUITS	124
7—1	Power and Power Factor	124
7—2	Current and Voltage Relations in Series ..	128

12	Circuits	127
38	7—3 Resistance and Inductance in Series	128
42	7—4 Resistance and Capacitance in Series	130
34	7—5 Resistance, Inductance, and Capacitance in Series	132
38	7—6 Impedance in Series	134
	7—7 Series Resonance	135
78	7—8 Parallel Circuits	137
33	7—9 Parallel Resonance	141
90	7—10 Power-Factor Correction	142
80	THREE-PHASE CIRCUITS	145
38	8—1 Reasons for Use of Three-phase Circuits ...	145
99	8—2 Generation of Three-phase Voltages	146
100	8—3 Voltage Relations in a Wye-connected Gen-erator	147
101	8—4 Current Relations in a Wye-connected Generator	150
102	8—5 Voltage Relations in a Delta-connected Generator	150
109	8—6 Current Relations in a Delta-connected Generator	151
110	8—7 Three-phase Power	152
112	8—8 Wye- and Delta-connected Loads	154
114	9. ELECTRICAL INSTRUMENTS AND ELECTRI-CAL MEASUREMENTS	158
116	9—1 Galvanometers	159
124	9—2 The Permanent-Magnet Moving-Coil Instrument	161
124	9—3 DC Voltmeters	164
	9—4 DC Ammeters	164

9—5	Moving-Iron Vane Instruments	166
9—6	Electrodynamometer Voltmeters and Ammeters	168
9—7	Power Measurements	170
9—8	The Varmeter	174
9—9	Energy Measurements in AC Circuits	175
9—10	Power-Factor Meter	179
9—11	Phase-Angle Meters	180
9—12	Measurement of Resistance: Voltmeter-Am- meter Method	182
9—13	Wheatstone Bridge	184
9—14	Insulation Resistance	187
9—15	Measurement of Resistance: Voltmeter Method	188
9—16	The Megger Insulation Tester	190
9—17	The Ohmmeter	194

参考译文

1. 电学单位	196
2. 基本单位	200
2-1 物质结构	201
2-2 电流	203
2-3 电流单位: 安培	203
2-4 电阻: 欧姆	204
2-5 电势差和电动势: 伏特	205
2-6 电流、电压和电阻的测量	207
3. 直流电路	208
3-1 串联电路: 电流的关系	208

3-2	串联电路: 电压的关系	209
3-3	并联电路: 电压的关系	210
3-4	并联电路: 电流的关系	211
3-5	欧姆定律	211
3-6	欧姆定律的运用	213
3-7	串联电路里的电阻	215
3-8	并联电路里的电阻	215
3-9	串并联电路	218
3-10	电阻的温度系数	220
3-11	线路电压降	221
3-12	基尔霍夫定律	223
3-13	功	224
3-14	能	224
3-15	机械功率	225
3-16	电功率	226
3-17	电功和电能	228
3-18	电功率和电能的量测	230
3-19	线路损耗	231
3-20	三线配电线路	232
4.	磁	235
4-1	磁铁和磁性材料	235
4-2	磁场和磁力线	236
4-3	磁吸引和磁排斥	237
4-4	磁的特性	238
4-5	载流导线周围的磁场	239
4-6	线圈周围的磁场	240
4-7	磁动势	240

4-8	电磁铁	241
4-9	饱和	242
5.	电磁感应	243
5-1	感应电动势	243
5-2	影响感应电动势数值的诸因素	244
5-3	法拉第感应定律	244
5-4	感应电动势的数值	245
5-5	感应电动势的方向	245
5-6	楞兹感应定律	246
5-7	自感电动势: 电感	246
5-8	线圈的自感	247
5-9	互感	248
6.	交流电	250
6-1	交流电动势的产生	251
6-2	交流电	252
6-3	周期; 频率	253
6-4	电角度: 时间的一种度量单位	253
6-5	交变电流和电动势的有效值	254
6-6	交流电动势和电流的平均值	255
6-7	相位关系	255
6-8	相矢量(矢量)图	256
6-9	相矢量的相加	258
6-10	相矢量的相减	262
6-11	电路的参量	263
6-12	交流电路里的电阻	263
6-13	电感	264
6-14	感抗	264

6-15	电容器	267
6-16	串联电容器	269
6-17	并联电容器	269
6-18	电容器在交流电路里的作用	269
6-19	容抗	270
6-20	电抗	271
6-21	阻抗	272
6-22	电阻、电抗和阻抗的图示法	273
6-23	相矢量的复数表示法	274
7.	单相电路	280
7-1	功率和功率因数	280
7-2	串联电路里电流和电压的关系	282
7-3	电阻和电感的串联	283
7-4	电阻和电容的串联	285
7-5	电阻、电感和电容的串联	286
7-6	串联阻抗	287
7-7	串联谐振	288
7-8	并联电路	289
7-9	并联谐振	293
7-10	功率因数补偿	293
8.	三相电路	295
8-1	采用三相电路的原因	295
8-2	三相电压的产生	296
8-3	星形连接发电机的电压关系	296
8-4	星接发电机里的电流关系	298
8-5	三角形连接发电机里的电压关系	298
8-6	三角形接法发电机里的电流关系	299

8-7	三相功率	299
8-8	星接和三角接法负载	302
9.	电测仪表和电测量	305
9-1	检流计	305
9-2	永磁动圈式仪表	306
9-3	直流伏特计	307
9-4	直流安培计	308
9-5	动铁叶片式仪表	309
9-6	电动力式伏特计和安培计	310
9-7	功率量测	311
9-8	无功伏安计	312
9-9	交流电路里能量的量测	313
9-10	功率因数计	315
9-11	相角计	316
9-12	电阻的量测: 伏特计-安培计法	317
9-13	惠斯顿电桥	318
9-14	绝缘电阻	319
9-15	电阻的量测: 伏特计法	320
9-16	兆欧计	321
9-17	欧姆计	323
	总词汇表	324

calorie: The unit quantity of heat in the CGS system, replaced by the joule in the SI system. The 15°C calorie (cal) is the quantity of heat required to raise the temperature of 1 g of water by 1 degree C at 15°C.

① MKSA: Meters, Kilogram, Second, and Ampere (system) 的缩写。
 ② hr: hour 的缩写, 小时。 ③ Abbrev: Abbreviated 的缩写, 缩写。
 ④ SI: (法语) Systeme International d'Unites 的缩写, 国际单位制。

1. ELECTRICAL UNITS

active volt-amperes. Product of the active voltage and the amperes in a circuit, or of the active current (amperes) and the voltage of the circuit; equal to the power in 1 watts. Also termed **active power.**

ampere. MKSA^① unit of current flow, such that 1 ampere in two parallel conductors 1 m apart repels itself with a force of 2×10^{-7} newton/m length, the conductors being infinitely thin, long, and in a vacuum.

ampere hour. MKSA unit of charge, equal to 1 ampere passing a point in a circuit for 1 hr.^②

ampere-turn. MKSA unit of magnetomotive force, which drives flux through magnetic circuits, arising from 1 ampere flowing round one turn of a conductor. Abbrev.^③ **a. t.**

Board of Trade Unit. The commercial unit of electrical energy, equal to 1 kilowatt-hour. Abbrev. **B. T. U.** (Abbrev. **B. O. T.** is obsolete).

calorie. The unit quantity of heat in the CGS system, replaced by the *joule* in the SI^④ system. The 15°C calorie (cal_{15}) is the quantity of heat required to raise the temperature of 1 g of water by 1 degree C at

① MKSA: Meter, Kilogram, Second, and Ampere (System) 的缩写。

② hr: hour 的缩写, 小时。 ③ Abbrev.: Abbreviated 的缩写, 缩写。

④ SI: [法语] Systeme International d'Unites 的缩写, 标准国际单位制。

15°C; this equals 4.1855 J. By agreement the International Table calorie (cal_{IT}) equals 4.1868 J exactly; the thermochemical calorie equals 4.184 J exactly. There are other designations, e. g.,^① gramme calorie, mean calorie, and large or kilocalorie (=1000 cal; used particularly in nutritional work). This proliferation in nomenclature has occasioned the call for the abandonment of the calorie in favour of the joule.

coulomb. MKSA unit of electric charge, realized by 1 amp passing a point in a circuit or across a surface in 1 sec. Symbol **Q**, abbrev. **C**.

dyne. The unit of force in the CGS system of units. A force of one dyne, acting on a mass of 1 g, imparts to it an acceleration of 1 cm/sec². Approximately 981 dynes are equal to 1 g weight. 10^5 dynes = 1 newton.

erg. Unit of work or energy. In the CGS metric system, the *erg* is the work done by a force of 1 dyne moving through 1 cm in the direction of force; the SI unit, the *joule*, is equal to 10^7 ergs and is the work done by a force of 1 newton moving through 1 m in the direction of force. The foot-pound force (ft lbf) of the British system = 1.356 joules.

farad. The practical and absolute MKSA unit of electrostatic capacitance, defined as that which, when charged by a p.d.^② of one volt, carries a charge of one coulomb. Equal to 10^{-9} electromagnetic units and 9×10^{11} electrostatic units. Symbol **F**. This unit is in practice too large, and the subdivisions, *microfarad* (μF), *nano-*

① e.g. = for example 例如。 ② p.d.: potential difference 的缩写, 电位差。

farad (nF), and *picofarad* (pF), are in more general use.

gauss. CGS electromagnetic unit of magnetic flux density; equal to 1 maxwell/cm², each unit magnetic pole terminating 4π lines.

gilbert. In the CGS electromagnetic system of units, m.m. f.^① of an enclosing coil equal to $10/4\pi$ ampere-turn.

henry. MKSA unit of self and mutual inductance, such that electromotive force of one volt is induced in a circuit by current variation of one ampere per second.

Symbol **H**.

horse power.^② The mechanical engineering unit of power, equivalent to working at the rate of 33,000 ft lb/min, or 42.41 B. t. u./min, or 746 watts. Abbrev. **h. p.**

joule. SI unit of work, energy, and heat, equal to work done when a force of 1 newton advances its point of application 1 m. One joule = 10^7 ergs = 0.2390 calorie.

maxwell. The CGS unit of magnetic flux, the MKSA (or SI) unit being the *weber*. One maxwell = 10^{-8} weber.

mho. Name for the reciprocal of the ohm in the CGS system.

newton. Symbol **N**. The unit of force in the MKS system, being the force required to impart, to a mass of 1 kg, an acceleration^③ of 1 m/sec.

① m.m.f.: magnetomotive force 的缩写, 磁(动)势。 ② horse power: 这里是指英制马力 (h.p.)。还有一种公制马力 (P.S. 即德语 Pferdestärke 的缩写), $1\text{PS}=75\text{ kgw}\cdot\text{m/s}=0.7355\text{ kW}$ 。 $1\text{PS}=0.9859\text{ h. p.}$ ③ acceleration: 加速度, 是 impart 的直接宾语, 中间隔了间接宾语 mass.

oersted. Unit of field strength in CGS electromagnetic units system, such that 2π oersted is field produced at the centre of a circular conductor, 1 cm in radius, carrying 1 abampere (10 amperes). In the MKSA (or SI)

system $1 \text{ oersted} = \frac{1000}{4\pi} \text{ ampere/meter}$.

ohm. Unit of electrical resistance, such that 1 ampere through it produces a potential difference of 1 volt. Symbol Ω .

reactive volt-amperes. Product of the reactive voltage and the amperes in a circuit, or the reactive current (amperes) and voltage of the circuit; measure of the wattless power in the circuit. Abbrev. **var** (*volt-amperes-reactive*).

var. Abbrev. for **volt-amperes reactive**. Unit of reactive power. See **reactive volt-amperes**.

volt. MKSA unit of potential difference, electrical potential or e.m. f., such that the pd across a conductor is 1 volt when 1 ampere in it dissipates 1 watt of power. This is 1 joule/sec, or 10^7 erg/sec, a mechanical unit.

volt-amperes. Product of actual voltage (in volts) and actual current (amperes), both r. m. s.,^① in a circuit. See **active volt-amperes**, **reactive volt-amperes**.

volt-ampere-hour. MKSA unit of apparent power, equivalent to the watt-hour.

watt. MKSA unit of electric power, equal to 1 joule/sec or 10^7 erg/sec. Thus, 1 horse-power (h. p.) equals 746 watts. Symbol **W**.

① r.m.s.: root mean square 的缩写,均方根值。