Study Notes in Electrical Science

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Preface

This book is a collection of notes and essential diagrams for the study of the subjects of electrical science and electrical principles in T.E.C. courses, City and Guilds of London Institute courses, O.N.C. and O.N.D. courses, and science-based O-level and A-level subjects. The treatment is abbreviated and is produced in the most economical form possible.

Present-day syllabuses place an immense burden on students, who have also to deal with advances in technology. This book provides the reader with a summary of the work in electrical science and principles, allowing him to streamline the activities that lead to his final goal.

I should like to express my gratitude to my wife for the assistance she has given during the preparation of this book. Thanks are also due to the Macmillan production and editorial staff for their guidance and help during the production of the book.

Useful Examination Tips

1. Find out, at the earliest moment, the time and place of the examination. Start revision well before the examination date (it is often helpful to work out a revision 'timetable', on which you can indicate the days when you intend to deal with each subject area).

2. If you wish to use a portable electronic hand-held calculator, check that the examination regulations permit its use. Remember — an electronic calculator can sometimes provide wrong results more quickly than any other known method! Take a slide rule into the examination with you in case the calculator develops a fault.

3. Be in the examination room at least ten minutes before the start of the examination; this allows time to fill in particulars on the answer paper.

4. Take pencils, drawing instruments, pens, etc., into the examination room with you. A tube of your favourite mints or barley sugar can provide refreshment and aid concentration.

5. Spend several minutes reading through the examination paper before starting your solutions. Make sure that you understand the type of solution required. Mark on the question paper the problems you are going to attempt, and also the order in which you will attempt them.

6. Estimate the time allowed for each question or, alternatively, estimate the time required to obtain each 'mark'. Do not spend an excessive time on sections you prefer to answer at the expense of topics you find more difficult.

7. Clearly number each question in the answer book as you begin it.

8. If you are unable to complete a question, leave sufficient space at the end of it in case you wish to add to it later.

9. Make your drawings large enough to show all necessary detail.

10. If you complete your solutions before the allotted time has elapsed, carefully check your solutions before leaving the room.

Quantities, Multiples and Physical Constants

Basic SI units

Quantity	Symbol	Unit	Unit symbol
length	l, L	metre	m
mass	m	kilogram	kg
time	t	second	s
current	I	ampere	A
absolute temperature	T	kelvin	K
luminous intensity	I	candela	cd
plane angle	α, β, θ	radian	rad
solid angle	Ω, ω	steradian	sr

Multiples and submultiples of 10

Symbol	Prefix	Multiple	Symbol	Prefix	Multiple
T	tera	10^{12}	μ	micro	10^{-6}
G	giga	10^9	n	nano	10^{-9}
M	mega	10^6	p	pico	10^{-12}
k	kilo	10^3	f	femto	10^{-15}
m	milli	10^{-3}	a	atto	10^{-18}

Useful physical constants

Constant	Symbol	Value
electron charge	e	$-1.602 \times 10^{-19} \text{ C}$
electron rest-mass	m_e	$9.109 \times 10^{-31} \text{ kg}$
proton rest-mass	m_p	$1.673 \times 10^{-27} \text{ kg}$
neutron rest-mass	m_n	$1.675 \times 10^{-27} \text{ kg}$
speed of e.m. waves in a vacuum	c	$2.998 \times 10^8 \text{ m/s}$
permeability of free space	μ_0	$4\pi \times 10^{-7} \text{ H/m}$
permittivity of free space	ϵ_0	$8.854 \times 10^{-12} \text{ F/m}$

Some Constants and Useful Information

base of natural logarithms = $e = 2.71828$

The general relationship between numbers (or antilogarithms), bases and logarithms is

$$\text{number (antilogarithm)} = \text{base}^{(\text{logarithm})}$$

$$\log_{10} e = 0.4343 \quad \log_e 10 = 2.3026$$

$$\log_{10} N = 0.4343 \log_e N \quad \log_e N = 2.3026 \log_{10} N$$

Note: $\log_{10}$ is sometimes written as $\lg$ and $\log_e$ is sometimes written as $\ln$ (= natural logarithm).

$$\log_a m = \log_b m \times \log_a b = \log_b m / \log_b a$$

$$\pi = 3.14159$$

$$360 \text{ degrees} = 2\pi \text{ radians}$$

$$1 \text{ rad} = 360/2\pi^\circ = 57.2958^\circ = 57^\circ 17' 45''$$

$$1^\circ = 0.01745 \text{ rad}$$

$$0 \text{ K} = -273.15^\circ \text{C}$$

$$273.15 \text{ K} = 0^\circ \text{C}$$