UPKAR'S

OBJECTIVE ELECTRONIC ENGINEERING

[Railway & Other Engineering (Diploma) Competitive Exams.]

P. K. MISHRA

UPKAR'S

Objective Electronic Engineering

[For competitive selection examinations of Railway Service, Engineering (diploma) level, State Public Service Commissions, C.P.W.D., P.W.D., Coal India, Irrigation Departments and other equivalent services.]

By

Pramod Kumar Mishra

UPKAR PRAKASHAN, AGRA–2

Publishers

UPKAR PRAKASHAN
(An ISO 9001 : 2000 Company)
2/11A, Swadeshi Bima Nagar, AGRA–282 002
Phone : 4053333, 2530966, 2531101
Fax : (0562) 4053330, 4031570
E-mail : care@upkar.in, **Website :** www.upkar.in

Branch Offices :

4845, Ansari Road, Daryaganj,
New Delhi—110 002
Phone : 011–23251844/66

Pirmohani Chowk,
Kadamkuan,
Patna—800 003
Phone : 0612–2673340

1-8-1/B, R.R. Complex (Near Sundaraiah Park, Adjacent to Manasa Enclave Gate),
Bagh Lingampally,
Hyderabad—500 044 (A.P.)
Phone : 040–66753330

28, Chowdhury Lane, Shyam Bazar, Near Metro Station,
Gate No. 4
Kolkata—700004 (W.B.)
Phone : 033–25551510

B-33, Blunt Square, Kanpur
Taxi Stand Lane, Mawaiya,
Lucknow—226 004 (U.P.)
Phone : 0522–4109080

ISBN : 978-81-7482-031-0

Price : ₹ 99·00
(Rs. Ninety Nine Only)

Code No. 964

Printed at : UPKAR PRAKASHAN (Printing Unit) Bye-pass, AGRA

PREFACE

Success in examinations depends on proper planning of studies and appropriate selection of study materials. The pattern of examinations become tough. This is the reason that a right choice of study materials plays a very important role. This book cover thoroughly all the basics of the whole course as well as present to the examinee a wide spectrum of the multiple choice questions having a huge variety. The author has made a sincere attempt in this direction in the present book. Various unique features of the book are as under for example :

- A brief review of concepts at a glance covering all fundamentals and important conclusions are given at the start of every chapter.
- Chapters are classified under different units.
- Multiple choice questions in every chapter are arranged in a systematic and sequencial way covering the whole text and spectrum of the chapter.
- Answers are provided at the end of every chapters.
- **Model Test Papers** covering the whole syllabus are also provided at the end of the book again with their answers. These papers will prove to be fit for examination and provide a chance to students in assessing their level of preparation.

The present book is self-sufficient in all respects.

I am thankful to my wife Mrs. Rita Mishra who has put a hard labour in reading the proofs thoroughly and pointing out errors and omissions. My sincere thanks are also to publisher Mr. Mahendra Jain who gave me a chance to write this type of books. This edition is a nice form.

Although all attempts have been made to avoid errors and printing mistakes, but omissions are a human weakness and, therefore, constructive suggestions, modifications and errors brought to my notice will be highly appreciated and incorporated in the next edition.

—Pramod Kumar Mishra

CONTENTS

PART (A)
BASIC CONCEPTS

PART (B)
ELECTRONICS

PART (C)
ELECTRONICS MEASUREMENTS AND SYMBOLS

PART (D)

PART (E)

Electronic Engineering

Electronics

Electronics is that branch of science which deals with electron devices *i.e.*, such devices in which conduction by electrons and other charged particles takes place through vacuum, gases or semiconductors. Thus, the science of electronics primarily deals with the study of electron tubes (both vacuum and gas filled tubes), semiconductor diodes and transistors *etc.*, and their applications in electrical circuits.

PART-A

Chapter-1

NETWORKING THEORY

(Circuit Theory)

Circuit—A conducting path through which an electric current either flows or is intended to flow is called a circuit. The various elements of an electric circuit are called parameters (*e.g.*, resistance, inductance and capacitance) these parameters may be distributed or lumped.

Linear Circuit—The circuit whose parameters are constant (*i.e.*, they do not change with voltage or current) is called a linear circuit.

Non-linear Circuit—The circuit whose parameters change with voltage or current is called a non-linear circuit.

Unilateral Circuit—A unilateral circuit is one whose properties or characteristics change with the direction of its operation (*e.g.*, diode, rectifier).

Bilateral Circuit—It is that circuit whose properties or characteristics are same in either direction (*e.g.*, transmission line).

Electric Network—An electric network arises when a number of parameters or electric elements co-exist or combine in any manner or arrangement.

Active Network—An active network is one which contains one or more than one sources of e.m.f.

Passive Network—A passive network is one which does not contain any source of e.m.f.

Node—A node is a junction in a circuit where two or more circuit elements are connected together.

Branch—The part of a network which lies between two junctions is called branch.

Kirchhoff's Law—For complex circuit computations are following two laws first stated by Gutsav R. Kirchhoff (1824-87) are indispensable.

First Law (Point or Current Law)—It states as follows—

"The sum of the current entering a junction is equal to the sum of the currents leaving the junction."

$$i.e., \sum \text{current entering} = \sum \text{currents leaving}$$

Second Law (Mesh or Voltage Law)—It states as follows "The sum of e.m.f. (rise of potential) around any closed loop of circuit equals the sum of the potential drops in that loop."

Considering a rise of potential as positive (+ve) and a drop of potential as negative (–ve) algebraic sum of potential differences (voltages) around a closed loop of a circuit is zero.

$$\sum E - \sum I\,R \text{ drops} = 0 \quad \text{(around closed loop)}$$

$$\sum E = \sum IR$$

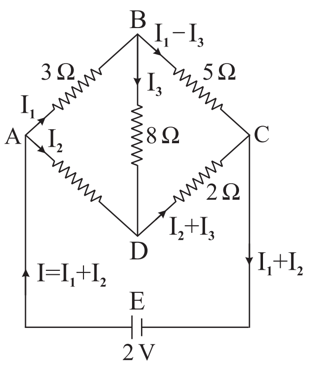
$$\text{or,} \sum \text{potential rises} = \sum \text{potential drops}$$

Application of Kirchhoff's Law

Kirchhoff's laws may be employed in the following methods of solving networks—

1. Branch-Current method
2. Maxwell's loop (or mesh) Current method
3. Nodal voltage method.

Example or Application (1)—Determine the current in each of the resistors of the network shown in given figure.



Applying Kirchhoff's law to the various circuits.

Circuit ABDA—

$$-3I_1 - 8I_3 + 4I_2 = 0$$

or, $$3I_1 - 4I_2 + 8I_3 = 0 \quad \ldots\text{(i)}$$

Circuit BCDB—

$$-5(I_1 - I_3) + 2(I_2 + I_3) + 8I_3 = 0$$

$$5I_1 - 2I_2 - 151_3 = 0 \quad \ldots\text{(ii)}$$

Circuit ADCEA—

$$-4I_2 - 2(I_2 + I_3) + 2 = 0$$

$$3I_2 + I_3 = 0 \quad \ldots\text{(iii)}$$

On solving equations (i), (ii) and (iii), we get

$$I_1 = 0{\cdot}283 \text{ A}$$

$$I_2 = 0{\cdot}316 \text{ A}$$

$$I_3 = 0{\cdot}052 \text{ A.}$$

Superposition Theorem

This theorem stated as follows—

"In any network containing more than one sources of e.m.f. the current in any branch is the algebraic sum of a number of individual fictitious currents, each of which is due to the separate action of each source of e.m.f. taken in order, when the remaining sources of e.m.f. are replaced by conductors, the resistances of which are equal to the internal resistances of the respective sources."

The procedure of applying superposition theorem is as follows—

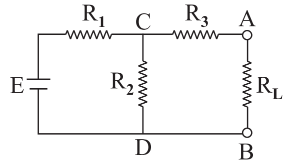
1. Replace all but one of the sources by their internal resistances. If the internal resistance of any source is small as compared to the other resistances present in the network, the source is replaced by a short circuit.

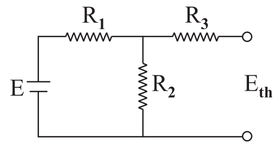
2. Find the currents in different branches by using Ohm's law.

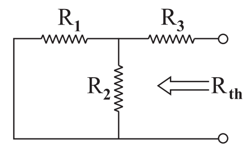
3. Repeat the process using each of the e.m.fs. as the sole e.m.f. each time.

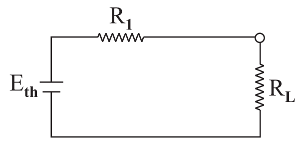
The total current in any branch of the circuit is the algebraic sum of currents due to each source.

Thevenin's Theorem—This theorem states that "For the purpose of determining the current in a resistor R_L, connected across two terminals of a network which contains sources of e.m.f. and resistor, the network can be replaced by a single source of e.m.f. and a series resistor, R_{th}. This e.m.f. E_{th} is equal to potential difference between the terminals of the network when the resistor R, is removed; the resistance of series resistor, R_{th}, is equal to the equivalent resistance of the network with the resistor R removed—



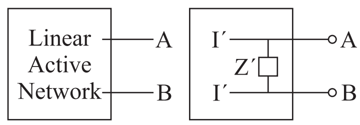






Hence, $$I = \frac{E}{R_L + R_{th}}$$

Nortons Theorem—It states that any linear current active network with output terminals AB as shown in figure (A). A can be replaced by a single source I′ is parallel with a single impedance Z′ as shown below in fig. (B).



(A) (B)

The Norton equivalent current source I′ is the current through a short circuit applied to the terminals of the active network. The shunt impedance Z′ is the driving point impedance of the network at the terminals AB when all interval source are set equal to zero.

Hence, given a linear active circuit, the impedance Z′ of the Norton and Thevenin equivalent circuits are identical.

Maximum Power Transfer Theorem

It is stated as follows—

"Maximum power output is obtained from a network when the load resistance is equal to the output resistance of the network as seen from the terminals of the load."

Compensation Theorem

The compensation theorem is particularly useful for the following purpose—

(i) To calculate the sensitivity of a bridge network.

(ii) The analyse those networks where the values of the branch elements are varied and for studying the effect.

This theorem is stated as follows—

If a change, say ΔR is made in the resistance of any branch of a network when the current was originally I, then the change of current at any other point in the network may be calculated by assuming that an e.m.f.—$I \Delta R$ has been introduced into the changed branch while all other sources have their e.m.f.s suppressed and are represented by their internal resistances only."

Reciprocity Theorem

This theorem is stated as follows—

"In any linear bilateral network, if a source of e.m.f. E in any branch produces a current I in any other branch, then the same e.m.f. acting in the second branch would produce the same current I in the first branch."

Milliman's Theorem—This theorem is stated as follows—

"Any number of current sources in parallel may be replaced by a single current source whose current is the algebraic sum of individual source currents and source resistance is the parallel combination of individual source resistances."

Alternating Voltage and Current

Modern alternators produce an e.m.f. which is for all practical purposes sinusoidal (*i.e.*, a sine curve) the equation between the e.m.f. and time being—

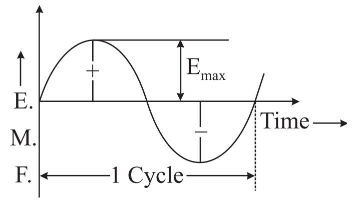
$$\boxed{e = E_{max} \sin \omega t}$$

where, e = instantaneous voltage,

E_{max} = maximum voltage

ωt = angle through which the armature has turned from neutral

Cycle—One complete set of positive and negative values of an alternating quantity is known as cycle. One complete cycle is said to spread over 360° or 2π radian.



Amplitude—The maximum value, positive or negative, of an alternating quantity is known as its amplitude.

Frequency—The number of cycles/second is called the frequency of the alternating quantity. Its unit is hertz (Hz).

Time Period (T)—The time taken by an alternating quantity to complete the cycle is called its time period. Time period is the reciprocal of frequency.

$$\boxed{T = \frac{1}{f} \text{ or } f = \frac{1}{T}}$$

Root Mean Square (R.M.S.) Value—The r.m.s. value of an alternating current is given by that steady (D.C.) current which when flowing through a given circuit for a given time produces the same heat as produced by the alternating current when flowing through the same circuit for the same time.

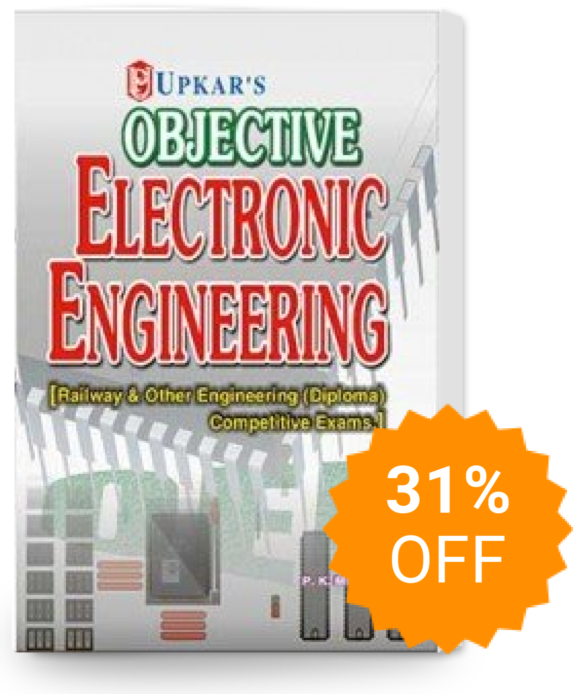
$$E_{r.m.s.} = E_{max} \times \frac{1}{\sqrt{2}}$$

Average or Mean Value—The average value of an alternating current is expressed by that steady current which transfers across any circuit the same charge as is transferred by that alternating current during the same time.

Reasons for Using Alternating Current (or Voltage) of Sinusoidal Form

The alternating current (or voltage) of Sinusoidal form is normally used because of the following reasons—

Objective Electronic Engineering Railway and Other Engineering Diploma Competttive Exams



Publisher : Upkar Prakashan

ISBN : 9788174820310

Author : Pramod Kumar Mishra