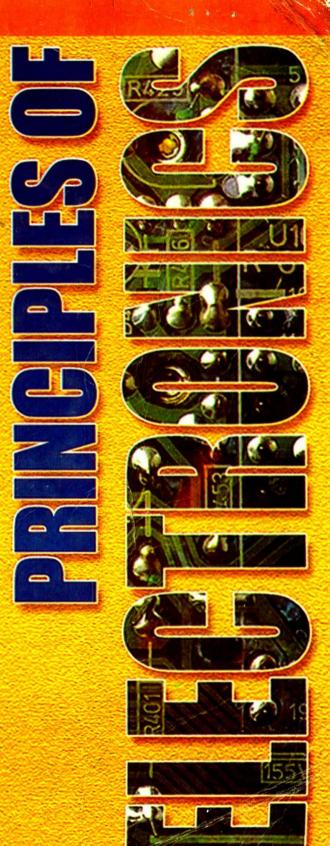
# Revised Edition in Two Colours

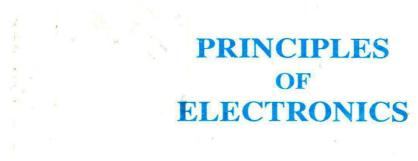
# V.K. MEHTA











.

.

a s

ат.<sup>3</sup>

# PRINCIPLES OF ELECTRONICS

(For Diploma, AMIE, Degree & other Engineering Examinations)

## V.K. MEHTA SHALU MEHTA

Dear Students,

Beware of fake/pirated editions. Many of our best selling titles have been unlawfully printed by unscrupulous persons. Your sincere effort in this direction may stop piracy and save intellectuals rights.

For the genuine book check the 3-D hologram which gives a rainbow effect.



2003 S. CHAND & COMPANY LTD. RAM NAGAR, NEW DELHI-110 055



Blackle House, 103/5, Walchand Hirachand Marg, Opp. G.P.O., Mumbal-400 001. Ph : 2690881, 2610885 3, Gandhi Sagar East, Nagpur-440 002. Ph : 723901

104, Citicentre Ashok, Govind Mitra Road, Patna-800 004. Ph: 671366

© 1980, V.K. Mehta, Shalu Mehta

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission of the Publisher.

#### S. CHAND'S Seal of Trust



In our endeavour to protect you against counterfeit/fake books we have put a Hologram Sticker on the cover of some of our fast moving titles. The hologram displays a unique 3D multi-level, multi-colour effect of our logo from different angles when tilted or properly illuminated under a single source of light.

Background artwork seems to be "under" or "behind" the logo, giving the illusion of depth. A fake hologram does not give any illusion of depth.

#### By the same author :

(i) Principles of Power System (ii) Principles of Electrical Machines (iii) Basic Electrical Engineering (iv) Electronics Made Simple

First Edition 1980 Subsequent Editions and Reprints 1981, 83, (Twice), 84, 85 (Twice), 86 (Twice), 87 (Twice), 88 (Thrice), 89 (Twice), 90 (Twice), 91 (Twice), 92, 93 (Thrice), 94, 95 (Twice), 97, 98 (Twice), 99, 2000, 2001 (Twice), 2002 **Eighth Edition 2003** 

ISBN: 81-219-1723-9

PRINTED IN INDIA

By Rajendra Ravindra Printers (Pvt.) Ltd., 7361, Ram Nagar, New Delhi-110 055 and published by S. Chand & Company Ltd., 7361, Ram Nagar, New Delhi-110 055.

na 1944 na sana ang ang ang ang ang ang ang ang ang	
4t	S. CHAND h LUCKY DRAW COUPON
d PRIZE Total	<ul> <li>5 - (One Each Zone) New Standard Encyclopaedia (20 Volu</li> <li>10 - (Two Each Zone) World of Science (24 Volumes)</li> <li>25 - (Five Each Zone) Britannica CD</li> </ul>
CONSOLATIO	ON PRIZES Total 500 – One hundred for each Zone
Booksellers	also to be awarded for 1st and 2nd prizes
(Zon	es: North, East, West, South & Central India)
	date of receiving entries 31 <sup>st</sup> October 2002 his page, duly filled in Capital Letters.
PRINCIPLES	OF ELECTRONICS — V.K. MEHTA & SHALU MEHTA
Purchaser's Name	e: Mr./Ms
Address	
1	StatePin
Phone	AgeE-MailClass
	Name and address of the
•2	
bookseller from v	whom you have purchased this book
( <del></del>	
Date of purchase	
Our address:	S. CHAND & COMPANY LTD. (An ISO 9002 Company) 7361, Ram Nagar, Qutab Road Hotel Tourist Complex New Delhi – 110055
	Tel. No. 3672080, 81, 82 Fax: 91-11-3677446 E-mail: schand@vsnl.com

)

×

- X Cut here

X

# **BEAT PIRACY AND SAVE THE WORLD**

Dear Reader,

Most of our best selling titles have been unlawfully printed by unscrupulous persons resulting in spurious and unethical books in the market. We appeal to our students to buy only authentic and genuine books, pasted with 3D Holograms on the title cover. (The genuine 3D Hologram contains the logo of the company and when it is tilted it gives 'rainbow' effect).

Your cooperation in buying genuine/ authentic books with 3D Holograms will help us to:

- 1. Eradicate piracy which has taken a cancerous shape.
- 2. To help the authors in getting their lawful share of the royalties on their sale of books.
- 3. To help the publisher to educate the underprivileged and downtrodden children through benevolent schemes.

# Publisher

# PREFACE TO THE EIGHTH EDITION

The general response to the seventh edition of the book was very encouraging. The authors feel that their work has been amply rewarded and wish to express their deep sense of gratitude to the large number of readers who have used it and in particular to those of them who have sent helpful suggestions from time to time for the improvement of the book.

In the present edition, authors have made sincere efforts to make the book up-to-date. A notable feature is the inclusion of **Multiple-Choice Questions** toward the end of each chapter. A large number of practical problems are given to make the book more useful to the students. It is our hope that you will enjoy reading this text and profit from its content. After studying this book, it is hoped that you will have a good understanding of the ideas of electronics and its application to many real world situations.

Authors have taken considerable care to ensure that this text is as error-free and effective as possible. We welcome comments, suggestions and corrections from both students and teachers.

Welcome to the exciting world of electronics.

### V.K. MEHTA SHALU MEHTA

## **PREFACE TO THE FIRST EDITION**

Electronics has become the most important and talked about since today. More and more people are taking a serious interest in this subject, either as a career or as an absorbing hobby. Here is a book which leads you to the world of electronics. This text is intended primarily for the students preparing for diploma, A.M.I.E. section B, degree and other engineering examinations. It also meets the needs of those readers who want to gain a sound understanding of the principles of electronics.

Three outstanding features are claimed for this book. First is the styling-the author has used the same lecture style that proved successful in his previous texts. Second, the book is easy to read and stimulating in its direct personal approach. Third, the emphasis is on concepts and not on mathematical derivations. It is hoped that these features will help the readers to understand the theoretical and practical aspects of electronics.

Author lays no claim to the original research in preparing the book. Liberal use of the materials available in the works of eminent authors have been made. What he may claim, in all modesty, is that he has tried to fashion the vast amount of material available from primary and secondary sources into coherent body of description and analysis.

The author wishes to thank his colleagues and friends who have contributed many valuable suggestions regarding the scope and content-sequence of the book. Author is also indebted to M/s S. Chand & Company for bringing out the book in a short time and pricing it moderately, inspite of heavy cost of paper and printing.

Errors might have crept in despite utmost care to avoid them and author shall be grateful if these are pointed out along with other suggestions for the improvement of the book.

#### V.K. MEHTA

# CONTENTS

#### 1. INTRODUCTION

Electronics-Atomic structure-Structure of elements-The electron-Energy of an electron-Valence electrons-Free electrons-Voltage source-Constant voltage source-Constant current source-Conversion of voltage source into current source-Maximum power transfer-Thevenin's theorem-Nortan's theorem-Chassis and ground.

#### 2. ELECTRON EMISSION

Electron emission-Types of electron emission-Thermionic emission-Thermionic emitter-Commonly used thermionic emitters-Cathode construction-Field emission-Secondary emission-Photo electric emission.

#### 3. VACUUM TUBES

Vacuum tube–Vacuum diode–Characteristics of vacuum diode–Plate resistance of diode–Vacuum triode–Triode characteristics–Static characteristics of triode–Vacuum tube constants–Relationship between and –Valve constants from characteristics–Dynamic characteristics–Applications of triode–Limitations of triode–Tetrode valve–Tetrode characteristics–Tetrode constants–Limitation of tetrode– Pentode valve–Pentode characteristics–Comparison of valve constants–Limitations in the operating conditions of tubes–Why current in vacuum? Causes of tube failure.

#### 4. VACUUM TUBE RECTIFIERS

Rectifier–Vacuum diode as a rectifier–Single phase vacuum tube rectifiers–Halfwave rectifier–Rectification efficiency of half-wave rectifier–Disadvantages of halfwave rectifier–Vacuum tube full-wave rectifiers–Centre-tap full-wave rectifier–Fullwave bridge rectifier–Rectification efficiency of full-wave rectifier–Advantages of full-wave rectifier–Filter circuits–D.C. power supply.

#### 5. VACUUM TUBE AMPLIFIERS

Vacuum tube amplifiers–Faithful amplification–Triode as an amplifier–Graphical analysis of triode amplifier–Phase reversal–A.C. equivalent circuit of triode–Selfbiasing of triode–Practical circuit of triode amplifier–Types of amplifiers–Classification of amplifiers–Amplifier coupling methods–Resistance–Capacitance (R.C.) coupled amplifiers–Choke–Capacitance coupled amplifiers–Transformer coupled amplifiers–Stages of a practical power amplifier–Push-pull amplifier.

#### 6. GAS-FILLED TUBES

Gas-filled tubes-Conduction in a gas-Cold-cathode gas diode-Characteristics of coldcathode diode-Applications of glow tubes-Hot-cathode gas diode-Thyratron-Application of Thyratron.

#### 7. ATOMIC STRUCTURE

Bohr's atomic model-Energy levels-Energy bands-Important energy bands in solids- Classification of solids and energy bands.

## 8. SEMIC ONDUCTOR PHYSICS

Semiconductor-Bonds in semiconductors-Crystals-Commonly used semiconductors -Energy band description of semiconductors-Effect of temperature on semiconductors-Hole current-Intrinsic semiconductor-Extrinsic semiconductorn-*n*-type semiconductor-*p*-type semiconductor-Charge on *n*-type and *p*-type semiconductors-Majority and minority carriers-*pn*-junction-Properties of *pn*-junction-Applying 25-34

35-62

63-76

77-98

99-107

108-113

voltage across-pn junction-Current flow in a forward biased pn-junction-Volt-ampere characteristics of pn-junction-Important terms-Limitations in the operating condition of pn-junction.

#### 9. SEMICONDUCTOR DIODE

Semiconductor diode–Crystal diode as a rectifier–Resistance of crystal diode–Equivalent circuit of crystal diode–Crystal diode equivalent circuits–Important terms–Crystal diode rectifiers–Half-wave rectifier–Efficiency of half-wave rectifier–Full-wave rectifier–Centre-tap full-wave rectifier–Full-wave bridge rectifier–Efficiency of fullwave rectifier–Nature of rectifier output–Ripple factor–Comparison of rectifiers– Filter circuits–Types of filter circuits–Voltage stabilisation–Zener diode–Equivalent circuit of zener diode–Zener diode as voltage stabiliser–Solving zener diode circuits–Crystal diodes versus vacuum-diodes.

#### **10. TRANSISTORS**

Transistor–Naming the transistor terminals–Some facts about the transistor–Transistor action–Transistor symbols–Transistor as an amplifier–Transistor connections– Common base connection–Characteristics of common base connection–Common emitter connection–Characteristics of common emitter connection–Common collector connection–Characteristics of common emitter connection–Common collector connection–Characteristics of common emitter connection–Common collector connection–Transistor as an amplifier in CE arrangement–Transistors load line analysis–Operating point–Practical way of drawing –CE circuit–Output from transistor amplifier–Performance of transistor amplifier–Cut off and saturation points– Power rating of transistor–Semiconductor device numbering system–Transistor lead identification. –Transistor testing–Applications of common base amplifiers.

#### **11. TRANSISTOR BIASING**

Faithful amplification-Transistor biasing-Inherent variations of transistor parameters-Stabilisation-Essentials of a transistor biasing circuit-Methods of transistor biasing-Base resistor method-Baising with feedback resistor-Voltage divider bias method-Design of transistor biasing circuits-Mid point baising-Which value of to be used-Silicon versus germanium-Instantaneous current and voltage wave forms.

## **12. SINGLE STAGE TRANSISTOR AMPLIFIERS**

Single stage transistor amplifier–How transistor amplifies–Graphical demonstration of transistor amplifier–Practical circuit of transistor amplifier–Phase reversal– D.C. and A.C. equivalent circuits–Load line analysis–A.C. emitter resistance–Formula for A.C. emitter resistance–Voltage gain in terms of A.C. emitter resistance– Voltage gain–Classification of amplifiers–Amplifier equivalent circuit–Equivalent circuit with signal source–Input impedance of an amplifier

#### 13. MULTI-STAGE TRANSISTOR AMPLIFIERS

Multistage transistor amplifier–Important terms–R.C. coupled transistor amplifier– Transformer coupled amplifier–Direct-coupled amplifier–Comparison of different types of coupling–Difference between transistor and tube amplifier.

#### **14. TRANSISTOR AUDIO POWER AMPLIFIERS**

Transistor audio power amplifier–Difference between voltage and power amplifiers–Performance quantities of power amplifiers–Classification of power amplifiers–Expression for collector efficiency -Maximum collector efficiency of series-fed class A amplifier–Maximum collector efficiency of transformed coupled class A power amplifier–Important points about class A power amplifier–Thermal runway– 136-176

177-211

212-245

246-275

276-297

Heat sinks-Mathematical analysis-Stages of a practical power amplifier-Driver stage-Output stage-Push pull amplifier-Complementary-Symmetry amplifier.

#### **15. AMPLIFIERS WITH NEGATIVE FEEDBACK**

Feedback–Principles of negative voltage feedback in amplifiers–Gain of negative feedback amplifier–Advantages of negative voltage feedback–Principles of negative current feedback–Current gain with negative feedback–Effects of negative feedback–Emitter follower–D.C. analysis of emitter follower–Voltage gain of emitter follower–Input impedence of emitter follower–Output impedence of emitter follower–Darlington amplifier.

#### 16. SINUSOIDAL OSCILLATORS

Sinusoidal oscillator–Types of sinusoidal oscillations–Oscillatory circuit–Undamped oscillations from tank circuit–Positive feedback amplifier–Oscillator–Essentials of transistor–Oscillator–Explanation of Barkhausen criterion–Different types of transistor oscillators–Tuned collector oscillator–Colpitt's oscillators–Hartley oscillator– Principles of phase shift oscillators–Phase shift oscillator–Wien bridge oscillator – Limitations of LC and RC oscillators–Piezoelectric crystals–Working of quartz crystal–Equivalent circuit of crystal–Frequency response of crystal–Transistor crystal oscillator.

#### **17. TRANSISTOR TUNED AMPLIFIERS**

Tuned amplifiers–Distinction between tuned amplifiers and other amplifiers–Analysis of paralled tuned circuit–Characteristics of parallel resonant circuit–Advantages of tuned amplifiers–Why not tuned circuits for low frequency amplification? Frequency response of tuned amplifier–Relation between Q and Bandwidth–Single tuned amplifier–Analysis of tuned amplifier–A.C. equivalent circuit of tuned amplifier–Double tuned amplifier–Bandwidth of double-tuned-circuit–Tuned class C amplifier–Class C operation–D.C. and A.C. loads–Maximum A.C. output power.

#### **18. MODULATION AND DEMODULATION**

Radio broadcasting, transmission and reception-Modulation-Types of modulation-Amplitude modulation-Modulation factor-Transistor AM modulator-Power in AM wave-Limitations of amplitude modulation-Frequency modulation- Demodulation-Essentials in demodulation-A.M. diode detector-A.M. radio receivers-Types of A.M. radio receivers-Stages of superhetrodyne radio receiver-Advantages of superhetrodyne circuit.

#### 19. REGULATED D.C. POWER SUPPLY

Ordinary D.C. power supply–Important terms–Regulated power supply–Types of voltage regulators–Zener diode voltage regulator–Transistor series voltage regulator–Series feedback voltage regulator–Short-circuit protection–Transistor shunt voltage regulator–Glow-tube voltage regulator–Series triode voltage regulator–Series double triode voltage regulator.

#### 20. SOLID-STATE SWITCHING CIRCUITS

Switching circuit–Switch–Mechanical switch–Electromechanical switch or relay– Electronic switches–Advantages of electronic switches–Important terms–Switching transistors–Switching action of a transistor–Multivibrators–Types of multivibrators–Transistor astable multivibrator–Transistor monostable multivibrator– Transistor bistable multivibrator–Differentiating circuit–Integrating circuit–Important applications of diodes–Clipping circuits–Applications of clippers–Clamping circuits–Basic idea of a clamper–Positive clamper–Negative clamper.

320-345

#### 346-368

369—387

388-410

411-427

#### **21. FIELD EFFECT TRANSISTORS**

Types of field effect transistors-Junction field effect transistor (JFET)-Working principles of JFET-Schematic symbol of JFET-Importance of JFET-Difference between JFET bipolar transistor-JFET as an amplifier-Output characteristics of JFET-Important terms-Advantages of JFET-Parameters JFET-Relation among JFET parameters-JFET biasing-JFET connections-Voltage gain of JFET amplifier-JFET applications-Metal oxide semiconductor FET (MOSFET)-Working principle of MOSFET.

#### 22. SILICON CONTROLLED RECTIFIER

Silicon controlled rectifier (SCR)–Working of SCR–Equivalent circuit of SCR-Important terms–V-I characteristies of SCR–SCR in normal operation–SCR as a switch–SCR switching–SCR half-wave rectifier–SCR-full-wave rectifier–Applications of SCR-Light-activated SCR.

#### **23. POWER ELECTRONICS**

Power electronics-The triac-Triac construction-Triac operation-Triac characteristics-Applications of triac-The Diac-Applications of diac-Unijunction transistor (UJT)-Equivalant circuit of a UJT-Characteristics of UJT-Advantages of UJT-Applications of UJT.

#### 24. ELECTRONIC INSTRUMENTS

Electronic instruments-Multimeter-Applications of multimeter-Sensitivity of multimeter-Merits and demerits of multimeter-Meter protection-Vacuum tube voltmeter-Applications of VTVM-Merits and demerits of VTVM-Cathode ray oscilloscope-Deflection sensitivity of CRT-Display of signal waveform on CRO-Signal pattern on screen-Various control of CRO-Applications of CRO.

#### 25. INTEGRATED CIRCUITS

Integrated circuit-Advantages and disadvantags of integrated circuits-IC classifications-Fabrication of components on monolithic IC-Simple monolithic ICs-IC packings-IC symbols.-Scale of integration-Some circuits using ICs.

#### **26. HYBRID PARAMETERS**

Hybrid parameters-Determination of h parameters-h parameter equivalent circuit-Performance of a linear circuit in h parameters-The h parameters of a transistor-Nomenclature for transistor h parameters-Transistor circuit performance in h parameters-Experimental determination of h parameters-Limitations of h parameters.

#### **27. DIGITAL ELECTRONICS**

Analog and digital signals–Digital circuit–Binary number system–Place value–Decimal to binary conversion–Binary to decimal conversion–Logic gates–Three basic logic gates–OR gate–AND gate–NOT gate or inverter–Combination of basic logic gate–NAND gate as a univrsal gate-EXCLUSIVE OR gate–Encoders and decoders–Advantages and disadvantages of digital electronics–Boolean algebra–Boolean theorems–DeMorgan's theorems–Operator precedence.

INDEX

479-494

495-510

511-532

533-544

545-559

560-584