Fundamentals of Electrical Engineering and Electronics

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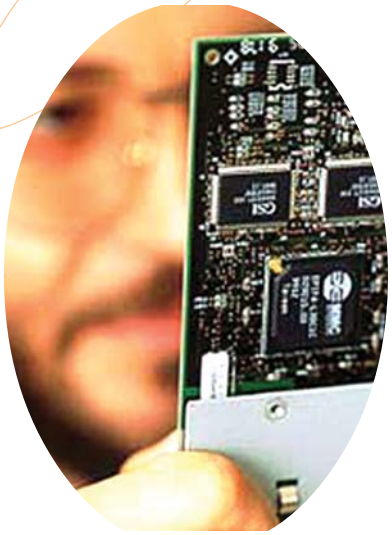

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Dedicated
to
My Wife

PREFACE TO THE FIRST MULTICOLOUR ILLUSTRATIVE EDITION

The author feels great pleasure in presenting to his esteemed readers, the first **multicolour illustrative edition.** Multicolour pictures have been added to enhance the content value and to give the students an idea of what he will be dealing in reality, and to bridge the gap between theory and practice.

As ever before, I take this opportunity to thank my publisher Sh. Ravindra Kumar Gupta, CMD, and Sh. Navin Joshi, GM (Sales & Marketing) of S. Chand & Company Ltd. for the personal interest they took in printing this book.

I also thank the editorial staff of S. Chand & Company Ltd., especially Mr. Shishir Bhatnagar, Senior Coordinator (Editorial), Mr. Rupesh Kumar Gupta, Mr. Riyaz Baqar Asst. Editors (Science & Technology) and Mr. Chander Shekhar, for their help in converting the book into **multicolour edition** and Mr. Pradeep Kumar Joshi for Designing and Layouting this book.

Any suggestions for the improvement of this book will be thankfully acknowledged and incorporated in the next edition.

B.L.Theraja

PREFACE TO THE TWENTY-EIGHTH EDITION

Time, he explained, is the prime factor
Governing human advancement:
The heart of measurement is time;
Measurement is the blood of Science

– Cal Clothier in Knowledge is Power

It is a pleasure to present the twenty-eighth revised edition of this popular textbook which has been enthusiastically received by numerous teachers and students both in India and abroad. In the Electrical Engineering portion of the book, lot of fresh material has been added in the form of articles on Source Conversion, Swinburn's Test, Battery Charging from AC Source, Speed of Rotor Field in Three-phase Motors, Neutral Current in Unbalanced Star Connection and Balanced Y/Δ and Δ /Y connections.

In the Electronics portion of the book, following four new chapters have been added : Optoelectronic Devices, Digital Electronic Devices, Analog and Digital Communication and Electron Ballistics. Lot of new material concerning tungsten filament lamps, discharge lamps, sodium vapour lamps, starters and stroboscopic effect has been added in the chapter on Illumination.

There has been extensive pruning of the Solved Examples in the text. Majority of the old examples have been replaced by questions set in the latest examination papers of different engineering colleges and technical institutions.

It is sincerely hoped that with these extensive additions and revisions, the present edition will prove even more useful to my esteemed readers than the earlier ones.

As ever before, I take this opportunity to thank my publishers particularly Sh. Ravinder Kumar Gupta for the personal interest he took in the printing of this book. I would also love to record my sincere appreciation for Ms. Shweta Bhardwaj for cheerfully rendering secretarial services in the preparation of this edition and to Mr. Cal Clothier, Lecturer, Leads Polytechnic, U.K. for borrowing a few beautiful lines from his famous poem "Knowledge is Power."

B.L. Theraja

New Delhi
March, 1997

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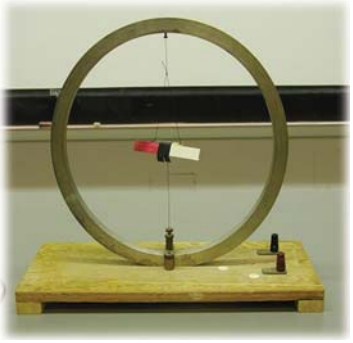

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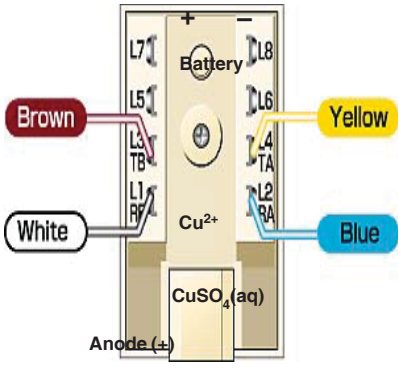

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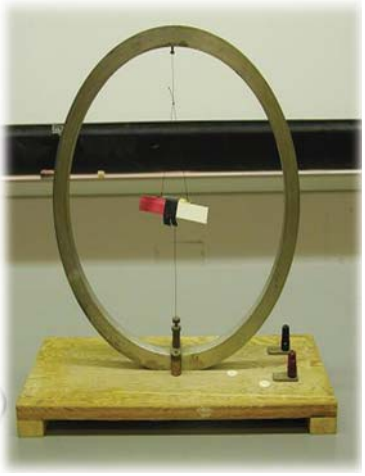

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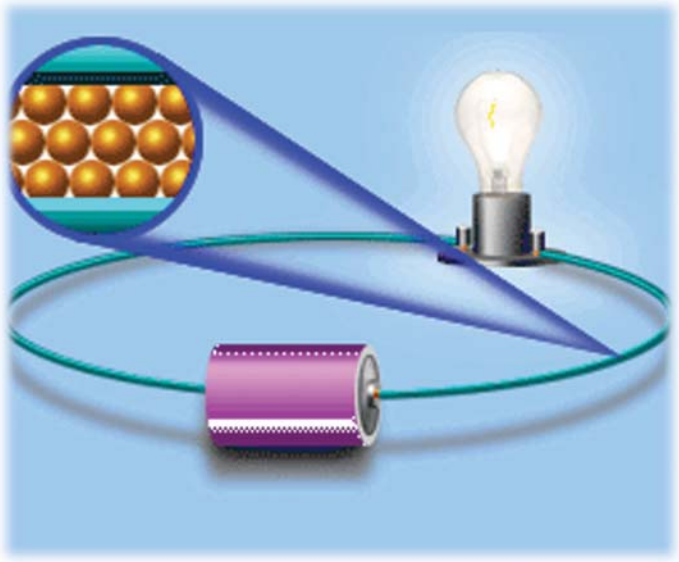

CHAPTER 1

Electric Current and Ohm's Law

1.1. MODERN ELECTRON THEORY

Modern research has established that all matter whether solid, liquid or gaseous, consists of minute particles called **'molecules'** which are themselves made up of still minute particles known as **atoms**. Those substances whose molecules consist of similar atoms are known as **elements** and those whose molecules consist of dissimilar atoms are called **compounds**. The number of elements so far discovered is 106, whereas the number of compounds is unlimited.

An atom is taken to consist of the following:

1. It has a hard central core, known as **nucleus**. It contains two types of particles*; one is known as **proton** and carries positive charge, the other is **neutron** (discovered by Chadwick in 1932) which is electrically neutral i.e. it carries no charge, though it is as heavy as a proton. The protons and neutrons are very closely held together with tremendous nuclear forces.
2. Revolving round the relatively massive nucleus, in more or less elliptical orbits (or shells), are infinitesimally small particles known as **electrons**. These electrons carry the smallest negative charge and have a negligible mass. The mass of electron is approximately 1/1840 that of a proton.

Such a view of an atom, known as Bohr-Rutherford model, is shown in Fig. 1.1. It has been found that an atom is like a miniature solar system, a heavy positively charged nucleus taking the

* In addition to protons and neutrons, there have been discovered other particles like mesons and neutrino etc. and electrons inside the nucleus. All these particles within the nucleus are known as *nucleons*.

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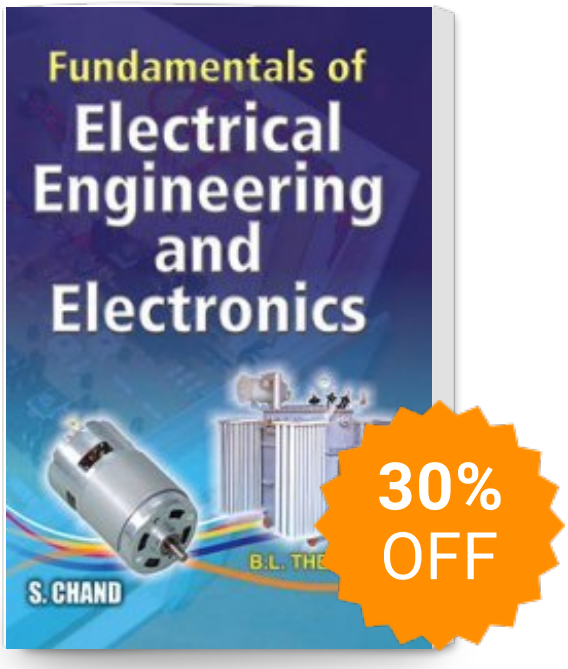

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