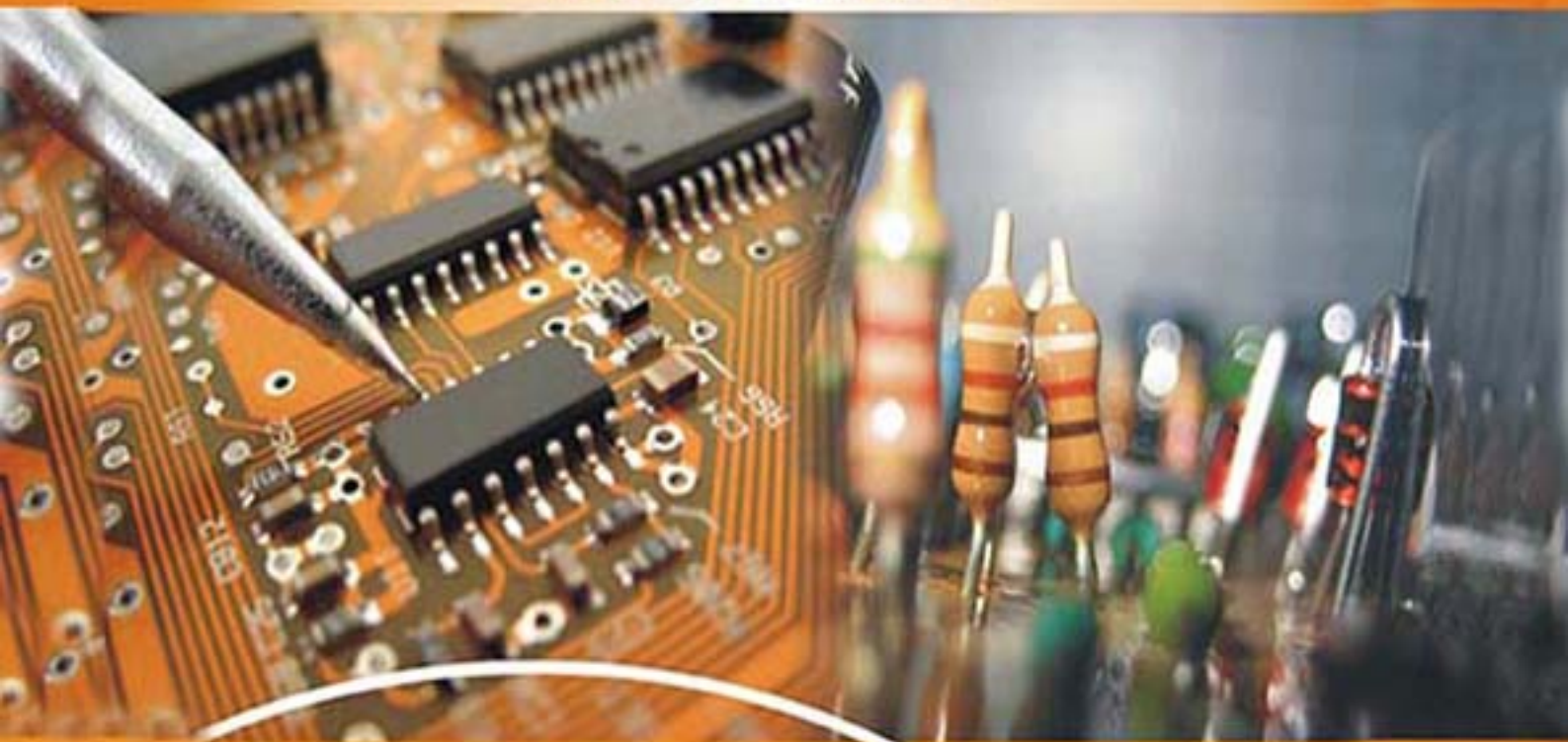




Power Electronics

P.S. Bimbhra



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Part1

POWER ELECTRONICS

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*In
Loving Memory
of My Late Parents*

Preface

Power electronics blends the three major areas of Electrical Engineering: Power, Electronics and Control. As load performance is superior under controlled power conditions, there has been a spurt in demand for the power modulators. It is power electronics that has made possible the availability of a wide variety of controlled power converters. Power electronics has really revolutionized the art of conversion and its control. The advent of power semiconductor device, 'thyristor', in 1957 has been the most exciting breakthrough, because its launch gave a boost to the art of power conversion and its control, and took this art to its fore-front. As a result of technological evolution, many more semiconductor devices such as triacs, asymmetrical thyristors, gate turn-off thyristors, power MOSFETs, insulated gate bipolar transistors, SITs, SITHs, MCTs, ETOs and integrated gate-commutated thyristors are now available. The use of these semiconductor devices has pervaded the industrial applications relating to the field of Electrical, Electronics, Instrumentation and Control Engineering. In other words, power-electronic components find their use in low as well as high-power applications.

The purpose of this book is to provide a good understanding of the power-electronic components and the behaviour of power-electronic converters by presenting systematically all important aspects of semiconductor devices and the common type of electric-power controllers. The book begins with the study of salient features of power diodes, power transistors, MOS-controlled thyristor, silicon controlled rectifier and other members of thyristor family. Then their applications in the different types of power-converter configurations are presented in a lucid detail. In other words, this book follows the bottom-down approach (device characteristics first and then their applications). Major part of the book is intended to serve as an introductory course in power-electronics to the undergraduate students of Electrical, Electronics, Instrumentation and Control disciplines. It is presumed that the reader is familiar with the basics of elementary electronics and circuit theory. The material presented here can be covered in one semester with the omission of some topics. The instructor, after browsing through the book for some time, can plan the course contents and its sequence without loss of continuity.

The book contains fourteen chapters. **Chapter 1** gives an overview of merits and demerits of power-electronic controllers and briefly discusses the topics covered in this book. This chapter also touches upon the significance of power electronics. **Chapter 2** describes the characteristics of power diodes, power transistors and MCTs. In **Chapter 3** are presented diode characteristics, rectifiers, performance parameters and filters. **Chapter 4** explains the characteristics of thyristors in detail and of Triacs, GTOs etc. Thyristor commutation techniques are given in **Chapter 5**. In **Chapter 6**, the principles of conversion from ac to dc involving single-phase as well as three-phase converters are presented. **Chapters 7 to 10** pertain to the treatment of dc choppers, inverters, ac voltage controllers and cycloconverters respectively. While **Chapter 11** gives study of several applications of power electronics, **Chapter 12** discusses electric drives. Power factor improvement and the methods of reactive power compensation are detailed in **Chapter 13**. In **Chapter 14** are presented some miscellaneous topics like ETOs, IGCTs etc. A large number of illustrative diagrams and a wide variety of worked examples add to the clarity of the subject matter. The material given in this book is class-room tested. In the appendices, Fourier Analysis, Laplace Transform, Objective Type Questions, some useful functions and references are given.

The material added in the present edition includes :

(i) SOA of MOSFET and IGBT, (ii) ideal characteristics of power electronic devices, (iii) step-up/step-down chopper, (iv) quality of inverters, (v) induction heating and its applications, battery charger etc. and (vi) Chapter 14 on miscellaneous topics.

Some topics have been re-written to make the presentation more lucid. Many more illustrative examples to reinforce the understanding of the subject matter are also included. Objective-type questions are thoroughly updated. It is hoped that the book in its present form will serve the purpose for the courses on power electronics of all Indian as well as foreign universities.

The author is grateful to all those students who had interacted with the author, in the class-room or outside, during the teaching of this subject. This interaction has greatly influenced the author's style of teaching and writing to a large extent and every effort has gone into making the subject matter presentation as easily comprehensible as possible. Discussion with several instructors has also been of immense help and inspiration. The author is beholden to all of them. The author, however, regrets he cannot name them all, for it is a voluminous task.

Finally, the author expresses his gratitude to his wife for her perennial encouragement, understanding and patience during the preparation of this book. The author is also full of appreciation for other members of his family for consistently boosting the author's morale, much needed during the revision of a book.

Suggestions leading to the improvement of the book will be gratefully acknowledged.

Dr. P.S. Bimbhra

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