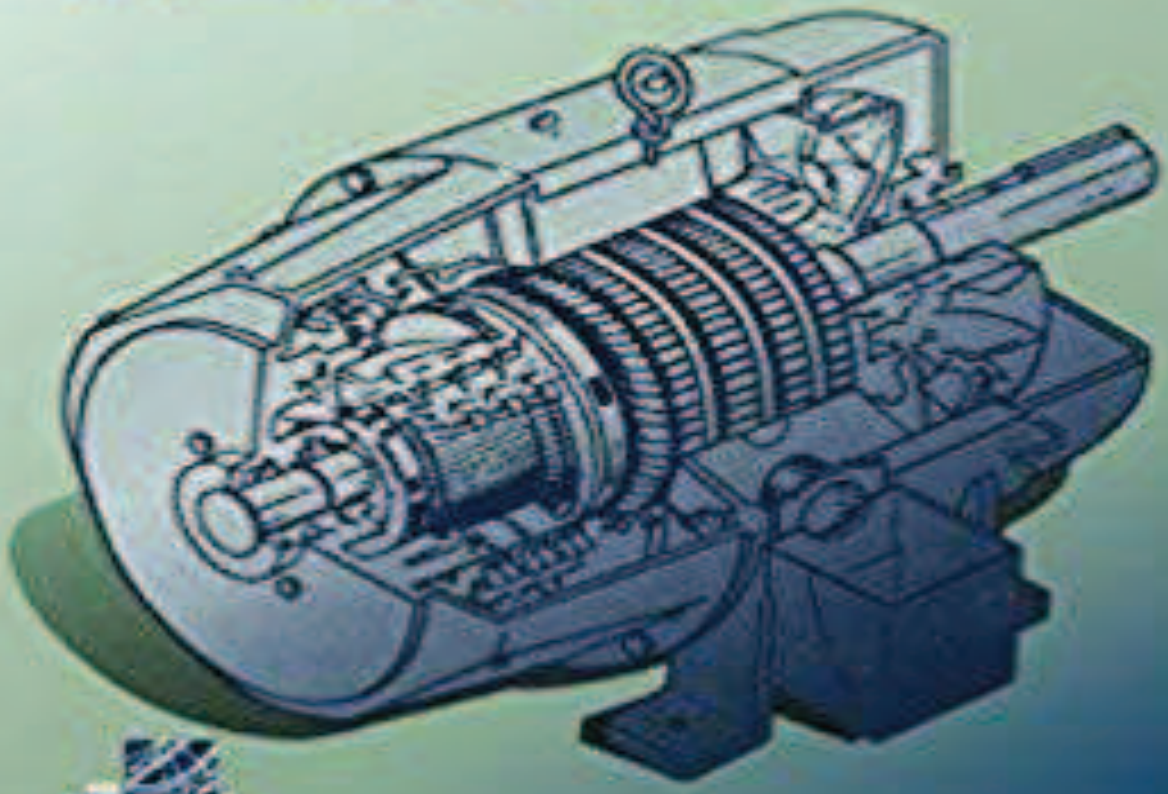
Principles of Electric Machines with Power Electronic Applications

Second Edition

Mohamed E. El-Hawary



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PREFACE

This book offers an introduction to principles of electric machines and the closely related area of power electronics and adjustable speed drives. It is designed for students in electrical and other engineering disciplines, as well as being a useful reference and self-study guide for the professional dealing with this important area. The coverage of the book is intended to enable its use in a number of ways including service courses taught to nonelectrical majors. The organization and details of the material allow a maximum flexibility for the instructor to select topics for inclusion in courses in the modern engineering curriculum.

This book does not require a level of mathematical sophistication beyond that given in undergraduate courses in basic physics and introductory electric circuits. The emphasis in coverage is given to an improved understanding of the operational characteristics of the electric apparatus discussed, on the basis of linear mathematical models. Almost every key concept is illustrated through the use of in-text examples that are worked out in detail to enforce the reader's understanding. Many practical problems in electric machines operation involve the use of known performance variables under a given operational condition to predict the same variables under different operating conditions. These problems can be easily dealt with using the basic performance characteristics to obtain some corollary results that are useful for this purpose. On many occasions, this text takes the time to derive some of these useful relations to allow the student to deal with these common and important problems.

The first chapter provides a historical perspective on the development of electromechanical energy conversion devices and starts by tracing the origins of electricity leading up to the fundamental discoveries of the not too distant past. While this topic is not an integral part of the conventional coverage in texts and courses in this

area, this chapter should provide interesting insights into the influence of these developments on present day civilization. It is through an appreciation of the past developments and achievements that we can understand our present and forge ahead with future advances.

Chapter 2 offers some background necessary to comprehend the basics of electric machine operations. The advent of the SCR and subsequent developments in solid state and power electronics technology introduced new elements in the practice of motor speed control. This important area is now of sufficient maturity that it should form an integral part of any comprehensive treatment of electric motors. This text recognizes this need by offering in Chapter 3, a detailed treatment of power electronic devices and systems to allow integration of the discussion with each electric motor with its adjustable speed drive application in the subsequent chapters. Chapters 4 to 8 deal with the conventional topics covered in present courses in electric machines and transformers. Emphasis is given to practical aspects, such as dealing with matching motors to loads, speed control, starting, and in general to the main performance characteristics of the devices discussed.

I have attempted to make this book as self-containing as much as possible. As a result, the reader will find that many background topics such as magnetic circuits, the per unit system and three-phase circuits are included in the text's main body, as opposed to the recent trend towards including many appendices dealing with these topics. In studying and teaching electrical machines, it has been my experience that a problem-solving approach is most effective when exploring this rich area. As a result, the reader will find many problems at the end of each chapter that reinforce the concepts learned in the chapter.

A textbook such as this could not have been written without the continuing input of the many students who have gone through many versions of its material as it was developed. My sincere thanks to the members of the many classes I was privileged to teach this fascinating area. I wish to acknowledge the able work of Elizabeth J. Sanford in putting this manuscript in a better shape than I was able to produce. My continuing association with the IEEE Press and Wiley staff have been valuable through out the many stages of preparing this text. I wish to express my appreciation for their work.

I owe a debt of gratitude to many of my colleagues who reviewed this manuscript and provided many valuable comments that improved this work considerably: It is always a great pleasure to acknowledge with thanks the continuing support of Dalhousie University during the course of preparing this text. As always, my wife, Dr. Ferial El-Hawary's patience and understanding have made this project another joy to look forward to completing.

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Halifax, Nova Scotia
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