PREFACE

This book provides material for an undergraduate course covering the basic concepts of electric energy conversion and transport, which is a fundamental part of electrical engineering. Every electrical engineer should know why a motor rotates and how energy is generated and transported. In addition, electric energy generation and transport is a major component of the national infrastructure. The maintenance and development of this essential industry requires well-trained engineers who are able to use modern computation techniques to analyze electric systems and understand the theory of electrical energy conversion.

Engineering education has improved significantly during the last decade because of advancements in technology and the increasing use of personal computers. Engineering educators have also recognized the need to transform students from passive listeners in the classroom to active learners. The paradigm shift is from a teacher-centered delivery approach to that of a learner-centered environment.

Computer-equipped classrooms and the computer aptitude of students open up new possibilities to improve engineering education by changing the delivery method. We suggest the interactive presentation of the material, where the students are actively engaged in the lectures. This book is designed to support active learning, especially in a computer-based classroom environment. The computer-assisted teaching method increases student mastery of the course material because they participate in its development. The primary goal of this approach is to increase student learning through their active involvement; secondarily, students' interest in power engineering is enhanced because of their own attraction to computer technologies. This interactive approach provides students with a better understanding of the theory and the development of solid problem-solving skills.

As many universities and instructors firmly favor the use of one software package versus another, this book applies Mathcad, MATLAB and Pspice throughout;

thus allowing the instructor to choose the software employed. Appendices introduce the basic use of these three programs. The extensive computer use permits the solution of complex problems that are not easily solvable by hand computations with calculators. In fact, the experienced instructor will find that their students are able to solve complicated problems that were previously too difficult at this level. This is a significant modernization of the classical topic of energy conversion. Students familiar with the application of modern computational techniques to electrical power applications are better prepared to meet the needs of industry.

The authors suggest a presentation ordering in the classroom that parallels the textbook. Specifically, the course material may be divided into topical units. The typical time for a unit is about one week in the case of a three-credit-hour course. A suggested one-semester timeline is

Week	Chapter	Topical Unit
1	1	Power system components
2	2	Single-phase circuits
3	3	Three-phase circuits
4	3	Per unit system
5	4	Transmission lines: resistance, inductance, capacitance
6	4	Short and medium line voltage models
7	4	AC magnetic circuits
8	5	Single-phase transformers
9	5	Three-phase transformers
10	6	Synchronous machines
11	6	Rotating flux, induced voltage and torque
12	7	Induction motors
13	8	DC machines
14	9	Introduction to power electronics
15	9	Concept of motor control using rectifiers and inverters
16	10	Electromechanical energy conversion

Here, we present a brief overview of the suggested instructional technique for a representative day in the classroom. The basis of the approach is that after introducing the hardware and theory, the basic equations and their practical application are developed jointly with the students using computers. Having divided the particular topic into sections, the instructor outlines each step of the analysis, and students then proceed to develop the equation(s) using her/his computer. While students are working together, the instructor is free to move about the classroom, answer student questions and assess the student understanding. After allowing students sufficient time to complete the process and reach conclusions, the instructor confirms the results and the students make corrections, if needed. This procedure leads to student theory development and analysis of performance—learner centered education.

Through the computer utilization, a seamless integration of theory and application is achieved, thereby increasing student interest in the subject material. The textbook derivation of the system equations and the operational analyses are presented using numerical examples. The numerical examples support the theory and provide deeper understanding of the physical phenomena. In addition, the use of the computer provides immediate feedback to the student.

Again, paralleling the classroom activities, each chapter first describes the hardware associated with that topic, for example, the construction and components are presented using drawings and photographs. This is followed by the theory and the physics of the material of that chapter together with the development of an equivalent circuit. The major emphasis of the chapters is the operation analyses. The questions at the end of each chapter are open-ended to promote deeper investigation by the reader.

The interactive method is also applicable in a self-learning environment. In this case, the text outlines each step. The reader is encouraged to initially ignore the solution given in the text, but instead derive the equation and calculate the value using his/her computer. The reader then compares his/her equation with the correct answers. This process is continued until the completion of the unit.

This textbook facilitates interactive teaching of the material. Through the students' active participation, learning is enhanced. The advantages of method are:

1. Better understanding of the material because the students participate in the development;
2. Development of problem solving ability;
3. Simultaneously learning the practical engineering application of the material using computerized methods accepted by industry;
4. Extending the students' attention span and maintaining their interest during the lecture. This method eliminates the boredom, which inhibits students at the end of most lectures;
5. The students analyze the results and draw the conclusions, which enhance learning;
6. The students gain experience with the general-purpose calculation programs that are frequently used by industry.

The authors recommend the book to faculty who want to modernize their electric power curriculum. The book is also intended for engineers interested in increasing their knowledge of electrical power and computer-based problem solving skills. Such knowledge may open up or expand employment opportunities in the electrical power industry.

HOW TO USE THIS BOOK EFFECTIVELY

This textbook differs noticeably from others in that the classical derivations are combined with numerical examples. In doing so, the reader is not only provided

with the general analytical expressions as the theoretical development proceeds, but in addition, the concurrent numerical results assist the student in developing a feel for the correct magnitude of various parameters and variables. The authors have found Mathcad particularly well suited to this approach. Regardless of which software the reader chooses to use, we recommend that the reader first familiarize herself/himself with the material in Appendix A (*Introduction to Mathcad*), since Mathcad expressions are used throughout the text. This will allow the reader to reap the full benefit of this delivery method.