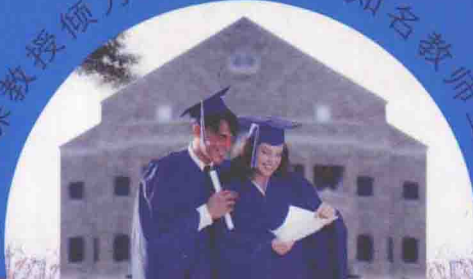


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国外高校电子信息类优秀教材

# 电 路

(第六版)

Electric Circuits

(Sixth Edition)

(英文影印版)



James W. Nilsson Susan A. Riedel 著

 科学出版社  
www.sciencep.com

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北 京

## 内 容 简 介

本书为国外高校电子信息类优秀教材(英文影印版)之一。

本书介绍了线性电路分析和基础电路。包括电路基础,简单电阻电路,电路分析技术,运算放大器,电感、电容和互感,一级 RL、RC 电路的响应,RLC 电路的自然响应和阶跃响应,正弦静态分析,正弦静态功率计算,平衡三相电路,拉普拉斯变换介绍,电路分析中的拉普拉斯变换,选频电路介绍,动态滤波器电路,傅里叶序列,傅里叶变换,二端电路等内容。

本书可作为电子工程、计算机专业本科生教材,也可作为工程技术人员的参考书。

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**Electric Circuits, 6<sup>th</sup>ed.** by James W. Nilsson, Susan A. Riedel, Copyright ©2001

ISBN 0-13-032120-6

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Published by arrangement with the original publisher, Pearson Education, Inc., publishing as PRENTICE HALL, INC.

For sale and distribution in the People's Republic of China exclusively (except Taiwan, Hong Kong SAR and Macau SAR).

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**图字:01-2002-5978**

### 图书在版编目(CIP)数据

电路/(美)尼尔森(Nilsson, J. W.), 里德尔(Riedel, S. A.)著. —影印本.

—北京:科学出版社,2003

(国外高校电子信息类优秀教材)

ISBN 7-03-011383-7

I. 电… II. ①尼… ②里… III. 电路-高等学校-教材-英文  
IV. TM13

中国版本图书馆 CIP 数据核字(2003)第 026684 号

责任编辑:巴建芬 李 宇/封面设计:黄华斌 陈 敬/责任印制:刘秀平

**科 学 出 版 社 出 版**

北京东黄城根北街16号

邮政编码:100717

<http://www.sciencep.com>

源海印刷有限责任公司 印刷

科学出版社发行 各地新华书店经销

\*

2003年6月第 一 版 开本:787×1092 1/16

2003年6月第一次印刷 印张:66 1/4

印数:1—3 000 字数:1 518 000

**定价:88.00元(含手册、光盘)**

(如有印装质量问题,我社负责调换〈环伟〉)

# 国外高校电子信息类优秀教材(英文影印版)

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**To ANNA**

# Preface

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The sixth edition of *Electric Circuits* is an incremental revision to the most widely used introductory circuits text of the past fifteen years. Importantly, the underlying teaching approaches and philosophies remain unchanged. The goals are:

- *To build an understanding of concepts and ideas explicitly in terms of previous learning.* The learning challenges faced by students of engineering circuit analysis are prodigious; each new concept is built on a foundation of many other concepts. In *Electric Circuits*, much attention is paid to helping students recognize how new concepts and ideas fit together with those previously learned.
- *To emphasize the relationship between conceptual understanding and problem-solving approaches.* Developing the students' problem-solving skills continues to be the central challenge in this course. To address this challenge, *Electric Circuits* uses examples and simple drill exercises to demonstrate problem-solving approaches and to offer students practice opportunities. We do so not with the primary aim of giving students procedural models for solving problems; rather, we emphasize problem solving as a thought process in which one applies conceptual understanding to the solution of a practical problem. As such, in both the textual development and in the worked-out examples, we place great emphasis on a problem-solving process based on concepts rather than the use of rote procedures. Students are encouraged to think through problems before attacking them, and we often pause to consider the broader implications of a specific problem-solving situation.
- *To provide students with a strong foundation of engineering practices.* There are limited opportunities in a sophomore-year circuit analysis course to introduce students to real-world engineering experiences. We continue to emphasize the opportunities that do exist by making a strong effort to develop problems and exercises that use realistic values and represent realizable physical situations. We have included many application-type

problems and exercises to help stimulate students' interest in engineering. Many of these problems require the kind of insight an engineer is expected to display when solving problems.

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## WHAT'S NEW IN THE SIXTH EDITION

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We have come to regard each revision of *Electric Circuits* as an opportunity to make improvements in the book, many of which are based on suggestions from our colleagues and our students. The sixth edition of *Electric Circuits* continues to support the major learning styles of students in the 1990s as well as to support the major teaching challenges these students present. We increased our focus on motivating the students with examples of practical circuits they have encountered and may have been curious about, and provide more explicit direction in the text for using computer tools such as PSpice and MATLAB to support the study of circuit analysis. The major areas of change are as follows:

### Content and Organizational Changes

The most significant change to the sixth edition is the elimination of a separate chapter on mutually coupled coils, with the material being integrated into other chapters. This allows us to present the time-domain equations for mutually-coupled coils as a simple extension of the time-domain equations for single inductors in an attempt to “de-mystify” mutually-coupled coils. The applications of mutual-coupling, namely linear and ideal transformers, come later, once phasor techniques have been presented. The modifications are summarized as follows:

- The introductory material on mutually-coupled coils, including the time-domain equations and a presentation of the dot convention, has been moved to Chapter 6, which is now entitled “Inductance, Capacitance, and Mutual Inductance”.
- The Practical Perspective relating to mutual inductance has been moved to Chapter 8, as this material can be presented once the natural and step response to second-order circuits has been covered.
- The material on linear and ideal transformers has been added to Chapter 9, after the phasor techniques have been developed. Chapter problems exploring transformers have been added to Chapter 9, while problems dealing with power and transformers have been added to Chapter 10.

- Chapters 13–19 in the fifth edition have been renumbered as Chapters 12–18 in the sixth edition.
- The material describing the design of active broadband bandpass and bandreject filters using combinations of active low-pass and high-pass filters in Chapter 15 has been revised and expanded.
- The material pertaining to pi- and tee-equivalent circuits for mutually-coupled coils and the need for ideal transformers in certain equivalent circuits has become Appendix C. The material covering circuit topology, which was in Appendix C in the fifth edition, has been eliminated.

## Practical Perspectives

The fifth edition of *Electric Circuits* introduced six Practical Perspectives that offered examples of real-world circuits, taken from real-world devices such as telephones, hair dryers, and automobiles. The sixth edition doubles the number of Practical Perspectives, adding them to Chapters 4, 5, 7, 8, 9, and 15. Now, a total of twelve chapters begin with a brief description of a practical application of the material to follow. Once the chapter material is presented, the chapter concludes with a quantitative analysis of the application. Several problems pertaining to the Practical Perspective are included in the chapter problems and are identified with the icon  $\blacklozenge$ . The Practical Perspectives are designed to stimulate students' interest in applying circuit analysis to the design of useful circuits and devices, and to consider some of the complexities associated with making a working circuit. The following chart shows where to find the opening description, quantitative analysis, and related homework problems for each Practical Perspective:



DESCRIPTION	QUANTITATIVE ANALYSIS	RELATED HOMEWORK PROBLEMS
<i>Electric Safety</i> Chapter 2, Page 26	Pages 50–51	Pages 62–63
<i>A Rear Window Defroster</i> Chapter 3, Page 64	Pages 83–86	Pages 107
<i>Circuit with Realistic Resistors</i> Chapter 4, Page 108	Pages 156–160	Pages 187
<i>Strain Gages</i> Chapter 5, Page 188	Pages 208–210	Pages 226–227
<i>Proximity Switches</i> Chapter 6, Page 228	Pages 258–260	Pages 274–275



<i>A Flashing Light Circuit</i>		
Chapter 7, Page 276	Pages 319–321	Pages 348–349
<i>An Ignition Circuit</i>		
Chapter 8, Page 350	Pages 389–393	Pages 407
<i>A Household Distribution Circuit</i>		
Chapter 9, Page 408	Pages 462–463	Pages 486–487
<i>Heating Appliances</i>		
Chapter 10, Page 488	Pages 520–522	Pages 539
<i>Transmission and Distribution of Electric Power</i>		
Chapter 11, Page 540	Pages 568–571	Pages 583
<i>Pushbutton Telephone Circuits</i>		
Chapter 14, Page 698	Pages 757–759	Pages 769
<i>Bass Volume Control</i>		
Chapter 15, Page 770	Pages 814–818	Pages 830–831

## Integration of Computer Tools


Computer tools cannot replace the traditional methods for mastering the study of electric circuits. They can, however, assist students in the learning process by providing a visual representation of a circuit's behavior, validating a calculated solution, reducing the computational burden of more complex circuits, and iterating toward a desired solution using parameter variation. This computational support is often invaluable in the design process.

The sixth edition merges the support for two popular computer tools, PSpice and MATLAB, into the main text with the addition of icons identifying chapter problems suited for exploration with one or both of these tools. The icon  identifies those problems to investigate with PSpice, while the icon  identifies problems to investigate with MATLAB. Instructors are provided with computer files containing the PSpice or MATLAB simulation of the problems so marked.

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## DESIGN EMPHASIS

We continue to support the emphasis on design of circuits in several ways. First, several of the new practical perspective discussions focus on the design aspects of the circuits. The accompanying chapter problems continue the discussion of the design issues in these practical examples. Second, design oriented chapter problems have been ex-

licity labeled with the icon , enabling students and instructors to identify those problems with a design focus. Third, the identification of problems suited to exploration with PSpice or MATLAB suggests design opportunities using one or both of these computer tools.

## Text Design and Pedagogical Features

The sixth edition continues the successful design introduced in the fifth edition, including the following features:

- *Practical Perspective introductions* are located opposite twelve chapter opening pages and are highlighted with a second-color background.
- *Practical Perspective examples* at the end of these twelve chapters are set apart in an easy-to-identify separate section.
- *Practical Perspective problems* in the Chapter Problem sets are indicated with a  icon for easy reference.
- *Key terms* are set in boldface when they are first defined. They also appear in boldface in the chapter summaries. This makes it easier for students to find the definitions of important terms.
- *Design problems* in the Chapter Problem sets are indicated with a  icon for easy reference.
- *PSpice problems* in the Chapter Problem sets are indicated with a  icon for easy reference.
- *MATLAB problems* in the Chapter Problem sets are indicated with a  icon for easy reference.

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## EXAMPLES, DRILL EXERCISES, AND HOMEWORK PROBLEMS

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### Solved Numerical Examples

Solved numerical examples are used extensively throughout the text to help students understand how theory is applied to circuit analysis. Because many students value worked examples more than any other aspect of the text, these examples represent an important opportunity to influence the development of student's problem-solving behavior. The nature and format of the examples in *Electric Circuits* are a reflection of the overall teaching approach of the text. When presenting a solution, we place great emphasis on the importance of

problem solving as a thought process that applies underlying concepts, as we discussed earlier. By emphasizing this idea—even in the solution of simple problems—we hope to communicate that this approach to problem solving can help students handle the more complex problems they will encounter later on. Some characteristics of the examples include:

- encouraging the student to study the problem or the circuit and to make initial observations before diving into a solution pathway;
- emphasizing the individual stages of the solution as part of solving the problem systematically, without suggesting that there are rote procedures for problem solving;
- exploring decision making, that is, the idea that we are often faced with choosing among many different solution approaches; and
- suggesting that students challenge their results by emphasizing the importance of checking and testing answers based on their knowledge of circuit theory and the real world.

## Drill Exercises

Drill exercises are included in the text to give students an opportunity to test their understanding of the material they have just read. The drill exercises are presented in a double-column format as a way of signaling to students that they should stop and solve the exercises before proceeding to the next section. Nearly half of the drill exercises are new or revised.

## Homework Problems

Users of *Electric Circuits* have consistently rated the homework problems as one of the book's most attractive features. In the sixth edition, there are nearly 1000 problems. The problems are designed around the following objectives (in parentheses are the corresponding problem categories identified in the *Instructor's Manual* and an illustrative problem number):

- To give students practice in using the analytical techniques developed in the text (Practice; see Problem 4.7)
- To show students that analytical techniques are tools, not objectives (Analytical Tool; see Problem 4.2)
- To give students practice in choosing the analytical method to be used in obtaining a solution (Open Method; see Problem 4.49)

- To show students how the results from one solution can be used to find other information about a circuit's operation (Additional Information; see Problem 4.76)
- To encourage students to challenge the solution either by using an alternate method or by testing the solution to see if it makes sense in terms of known circuit behavior (Solution Check; see Problem 4.52)
- To introduce students to design oriented problems (Design; see Problem 10.66)
- To give students practice in deriving and manipulating equations where quantities of interest are expressed as functions of circuit variables such as  $R$ ,  $L$ ,  $C$ ,  $\omega$ , and so forth; this type of problem also supports the design process (Derivation; see Problem 9.27)
- To challenge students with problems that will stimulate their interest in both electrical and computer engineering (Practical; see Problem 3.68)

---

## PREREQUISITES

In writing the first twelve chapters of the text, we have assumed that the reader has taken a course in elementary differential and integral calculus. We have also assumed that the reader has had an introductory physics course, at either the high school or university level, that introduces the concepts of energy, power, electric charge, electric current, electric potential, and electromagnetic fields. In writing the final six chapters, we have assumed the student has had, or is enrolled in, an introductory course in differential equations.

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## COURSE OPTIONS

The text has been designed for use in a one-semester, two-semester or a three-quarter sequence.

- *Single-semester course:* After covering Chapters 1-4 and Chapters 6-10 (omitting Sections 7.7 and 8.5) the instructor can choose from Chapter 5 (operational amplifiers), Chapter 11 (three-phase circuits), Chapters 13 and 14 (Laplace methods), and Chapter 18 (Two-Port Circuits) to develop the desired emphasis.

- *Two-semester sequence:* Assuming three lectures per week, the first nine chapters can be covered during the first semester, leaving Chapters 10–18 for the second semester.
- *Academic quarter schedule:* The book can be subdivided into three parts: Chapters 1–6, Chapters 7–12, and Chapters 13–18.

The introduction to operational amplifier circuits can be omitted without interference by the reader going to the subsequent chapters. For example, if Chapter 5 is omitted, the instructor can simply skip Section 7.7, Section 8.5, Chapter 15, and those problems and drill exercises in the chapters following Chapter 5 that pertain to operational amplifiers.

There are several appendixes at the end of the book to help readers make effective use of their mathematical background. Appendix A reviews Cramer's method of solving simultaneous linear equations and simple matrix algebra; complex numbers are reviewed in Appendix B; Appendix C contains additional material on mutually-coupled coils and ideal transformers; Appendix D contains a brief discussion of the decibel; Appendix E is devoted to an abbreviated table of trigonometric identities that are useful in circuit analysis; and an abbreviated table of useful integrals is given in Appendix F.

On page xix there is a comprehensive list of the examples with titles and corresponding page numbers.

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## SUPPLEMENTS

We have put effort into the development of supplements that capitalize and extend the many strengths of the sixth edition. Students and professors are constantly challenged in terms of time and energy by the confines of the classroom and the importance of integrating new information and technologies into an electric circuits course. Through the following supplements, we believe we have succeeded in making some of these challenges more manageable.

### **PSpice for *Electric Circuits***

This supplement is published as a separate booklet, to facilitate its use at a computer. It has been revised extensively from the fifth edition, most importantly to eliminate the “programming language” aspect of the original Spice. Now, circuits are described to PSpice using a circuit schematic, and techniques for developing such schematics are presented in the supplement. This supplement continues to present topics in PSpice in the same order as those topics are presented in

the text, so the content has undergone minor revision to reflect the revisions in the text.

## **Instructor's Manual**

The Instructor's Manual enables professors to orient themselves quickly to this text and the supplement package. For easy reference, the following information is organized for each chapter:

- a chapter overview
- problem categorizations
- problem references by chapter section
- a list of examples

## **Solutions Manual**

The solutions manual contains solutions with supporting figures to all of the 900-plus end-of-chapter problems in the sixth edition. Volume I covers Chapters 1-9, and Volume II covers Chapters 11-18. These supplements, available free to all adopting faculty, were checked for accuracy by several instructors. The manuals are not available for sale to students. A disk containing files for PSpice solution and MATLAB solution for all indicated problems is attached to the solutions manual.

## **Acknowledgments**

We continue to express our appreciation for the contributions of Norman Wittels of Worcester Polytechnic Institute. His contributions to the Practical Perspectives greatly enhanced both this edition and the previous one.

There were many hard-working people behind the scenes at both of our publishers who deserve our thanks and gratitude for their efforts on behalf of the sixth edition. At Addison-Wesley, we would like to thank Paul Becker, Anna Eberhard Friedlander, and Royden Tonomura, and hope that they are proud of the finished product. At Prentice Hall, we thank Tom Robbins and Scott Disanno, who eased the transition to our new publisher with humor, graciousness, understanding, and a ton of really hard work.

The many revisions of the text were guided by careful and thorough reviews from professors. Our heartfelt thanks to Bill Eccles, Rose-Hulman Institute; Major Bob Yahn, US Air Force; Thomas Schubert, University of San Diego; Norman Wittles, WPI; Mahmoud A. Abdallah, Central State University; Nadipuram (Ram) Prasad,

New Mexico State University; Terry Martin, University of Arkansas; Belle Sheno, Wright State University; Nurgun Erdol, Florida Atlantic University; Ezz I. El-Masry, DalTech Dalhousie University; John Naber, University of Louisville; Charles P. Neuman, Carnegie Mellon University; David Grow, South Dakota School of Mines and Technology; Dan Moore, Rose-Hulman Institute.

Susan would like to thank Professor James Nilsson for the opportunity to share the work and the rewards of *Electric Circuits*. She doesn't know a more patient, gracious, and hard-working person, and she continues to learn from him in the process of each revision. Thanks also to her team teachers and colleagues, Susan Schneider and Jeff Hock, who help her to stay focused and sane. Thanks to the sophomore classes of 1997-98 and 1998-99 in Electrical Engineering at Marquette University who helped her rewrite many of the Chapter Problems, often unknowingly. Most important, she thanks her sons David and Jason, who continue to tolerate the long hours and the late meals, and give her hugs when she needs to be re-energized.

James would like to thank Susan for accepting the challenge of becoming a coauthor of *Electric Circuits*. Her willingness to suggest both pedagogical and content changes and at the same time graciously accept constructive criticism when offered has made the transition to the fifth and sixth editions possible. She brings to the text an expertise in computer use and a genuine interest in and enthusiasm for teaching.

James also thanks Robert Yahn (USAF) and Stephen O'Conner (USAF) for their continued interest in the book. He thanks Professor emeriti Thomas Scott and C. J. Triska at Iowa State University who continue to make valuable suggestions concerning the content and pedagogy of the text. Finally, he acknowledges the cooperation of Jacob Chacko, a transmission and distribution engineer at the Ames Municipal Electric System.

We are deeply indebted to the many instructors and students who have offered positive feedback, suggestions for improvement, and pointed to mistakes in the first and second printing of the sixth edition. We are especially grateful to the following individuals who spent considerable time and effort proofreading and verifying the accuracy of the content in the revised edition: Bob Mayhan, Bob Strum, Dennis Tyner, Bill Oliver, William Eccles, Gary YBarra, and Ron Prasad.

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