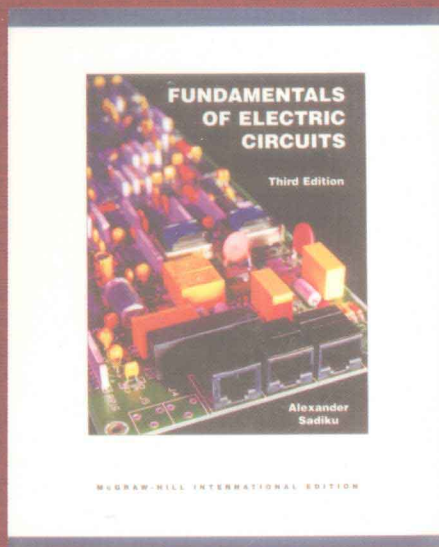


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清华版双语教学用书



(改编版)

电路基础 (第3版)

Fundamentals of Electric Circuits

(Third Edition)

原著

Charles K. Alexander
Matthew N. O. Sadiku

改编 高 歌

清华大学出版社

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《Fundamentals of Electric Circuits》 (Third Edition) 改编说明

《Fundamentals of Electric Circuits》(电路基础)这本书,是由美国 Cleveland State University Charles K. Alexander 教授和 Prairie View A&M University Matthew N. O. Sadiku 教授合著的,被国外著名大学广泛使用。2000 年由 The McGraw-Hill Companies, Inc 出版、清华大学出版社引进,作为国内高等学校工科电类专业的双语教材已使用多年,是最早引入的国外原版教材之一,也是国内一部具有广泛影响的优秀的英文版教材。

《Fundamentals of Electric Circuits》作为一部电路理论本科教材,有许多鲜明的特色。该教材思路清晰、层次分明、容易理解、示例有趣且习题丰富,是一本值得推荐的英文版教材。但是,由于原版教材的篇幅较大,与国内电路教学课时缩短相冲突,编者受清华大学出版社委托对该教材进行改编。

1. 原版教材的特色

《Fundamentals of Electric Circuits》(第3版)教材划分为三大部分。

第一部分:直流电路(DC Circuits)。叙述了电路的基本概念、基本分析方法和基本理论。这部分内容包含了电路分析的理论依据。

第二部分:交流电路(AC Circuits)。介绍交流电路的概念、特点及分析方法和实际应用,涉及更多重要的工程概念。

第三部分:深入分析(Advanced Circuit Analysis)。借助更多的数学方法,对电路进行系统的分析,上升到更高的理论层次。这部分对数学能力要求较高,对培养学生抽象逻辑思维和数学工具运用能力都极有帮助。

上述划分与国内电路课程教学大纲要求比较吻合,内容完整,符合由浅入深、循序渐进的教学规律。并且语言简明流畅,比较适合做为国内电路课程的双语教材。

使用英文原版教材可以借鉴国外的教材特点,了解国际知名大学的教学要求,同时有助于专业外语的学习。但考虑到非英语国家学生的语言障碍和对教学内容的理解困难,对原版内容有必要加以精简和筛选。在不影响教学大纲规定内容和教材完整性的前提下,对其改编还应考虑课时安排和与前后课程的衔接问题。

这种改编,完全是因为电路课程的课时压缩以及考虑读者的经济承受力不得已而为之,其中删除的部分仍然是非常优秀的。另外,我们尽量保持原版的风格和版式,以尊重所有喜爱她、熟悉她的读者。改编后的教材更强调了课程的主要内容和数学分析的连贯性,突显了电路课程的整体结构,加强了与前期和后续课程的衔接,更适合国内工科电类专业电路课教学的使用,同时也便于相关专业的教师和读者学习专业用语及了解国外教学的特点。

2. 改编后的教材状况

改编后的内容为原第3版篇幅的60%,包括了电路分析的基础内容,适合安排90学时左右。如

果有条件进行计算机操作,可以增加 10 课时的上机时间。

改编后教材仍分为三部分,其中第一部分包括 Chapter 1 ~ Chapter 7; 第二部分包括 Chapter 8 ~ Chapter 13; 第三部分包括 Chapter 14 ~ Chapter 16。各章节如下:

- Chapter 1 Basic Concepts
- Chapter 2 Basic Laws
- Chapter 3 Methods of Analysis
- Chapter 4 Circuit Theorems
- Chapter 5 Capacitors and Inductors
- Chapter 6 First-Order Circuits
- Chapter 7 Second-Order Circuits
- Chapter 8 Sinusoids and Phasors
- Chapter 9 Sinusoidal Steady-State Analysis
- Chapter 10 AC Power Analysis
- Chapter 11 Three-Phase Circuit
- Chapter 12 Magnetically Coupled Circuits
- Chapter 13 Frequency Response
- Chapter 14 The Laplace Transform
- Chapter 15 The Fourier Series
- Chapter 16 Two-Port Networks

按教育部电子电气基础课程教学指导分委员会制定的电路课程教学基本要求,课时分配如下:

电路理论基础

基本内容 90 学时 + 课外实验 20 学时 + 可选内容(20 学时 + 课外实验 10 学时)。

电路分析基础

基本内容 70 学时 + 课外实验 20 学时 + 可选内容(20 学时 + 课外实验 10 学时)。

电路分析

基本内容 60 学时 + 课外实验 10 学时。

对于少课时教学,可以不讲第三部分内容。

3. 改编教材的原则与思路

1) 教材改编原则

对教材的改编主要遵循如下原则:篇幅适当、章节编排逻辑清晰、层次分明、贯穿主线、结构紧凑、语意明确、叙述凝练。

2) 删除、合并章节

原版教材正篇共 19 章,附录共 7 项,改编后全书正篇共 16 章,附录共 4 项。

原版中的 Chapter 5(Operational Amplifiers)和 Chapter 18(Fourier Transform)全部删除,Chapter 15(Introduction to the Laplace Transform)与 Chapter 16(Applications of the Laplace Transform)合并为一章,名为“The Laplace Transform”。

删除、合并理由如下:

- Chapter 5 中介绍的运算放大器是由电子电路构成、用于信号处理的有源器件,其分析方法需

结合器件的特性而进行,与电路分析中涉及的器件有本质不同。在对运放器件特性没有深入了解的情况下,对运放电路进行分析,无法真正领会其意义。因此建议将运算放大器章节从电路分析中删去,在后续电子电路课程中将有详细讲述。

- Chapter 18 中傅里叶变换侧重数学推导,在后续课程,如“信号与系统”中对各种信号的表示、变换及特点分析将有系统介绍,在此也可以删去。

上述两章内容与电路基本分析相关度不大,在课时越来越少的现状下可以不要,且不会影响电路课程的连贯性和完整性。

- Chapter 15 关于拉普拉斯变换的介绍和 Chapter 16 拉普拉斯变换的应用属于相关内容,放在同一章中。

3) 关于每章首页

改编版将原第 3 版正文中人物介绍和学科背景部分经选择后放在各章首页,每章 1~2 位人物介绍。

首页的名言警句是原教材的特色,有必要保留。

每章首页增加专业术语(Technical terms)的中英文对照,便于读者准确地理解专业概念。

4) 关于“Application”

各章中的“Application”作为选择内容或自学部分,保留 1~2 例,加以星号“*”标注。

5) 关于计算机分析

《Fundamentals of Electric Circuits》(第 3 版)中着重介绍了 Pspice 软件,这是原教材的重要特色之一。另外,又提到 MATLAB 和 KCIDE 两款电路分析设计软件,内容略显太多、太分散,不利于读者熟练掌握。对三款软件做对比后,选择保留 MATLAB 内容。原因如下:

电路课的数学基础是高等数学、工程数学,后续是电子技术、信号与系统、控制工程、电力系统等专业课。从专业的连贯性来看,应使学生在本科学习期间,学好用活、真正掌握好一种科学计算方法,并在多门课程中反复实践效果更好。而 MATLAB 除了用于电路分析,还可以进行信号与系统分析、数字信号处理以及控制系统的分析,是一种适用面较广且具有通用性的科学计算语言。原作者也考虑到这一点,因此在第 3 版中增加了 MATLAB 的介绍和应用。鉴于此,改编版特保留了 MATLAB 计算机辅助分析的内容。

改编版因篇幅所限,将每章中的 PSpice 解题部分删除,但并不表示对 PSpice 不重视。

6) 关于“Problems”

原版教材中章后习题非常丰富,有 1609 例。考虑到教材篇幅和课外做习题的分配时间,将原版章后习题加以选择性删除,保留 511 题,平均每章 30 题左右。

7) 关于“Comprehensive Problems”

由于篇幅限制和课时压缩,各章中“Comprehensive Problems”不做保留。

8) 关于教材课件

为了方便国内高校老师进行双语教学,本人基于改编版内容开发了电子课件。本课件标题醒目,重点突出,定律定理、公式推导及电路图表达完整,并注明每章中重要专业术语的中文含义,便于学生准确理解。

对《Fundamentals of Electric Circuits》这部优秀教材进行改编,需采取非常慎重的态度。我们征求了对电路教学内容非常熟悉、多年从事相关课程教学并对专业前景、学科发展及工程需要有一定思考的专家们的意见,组织了具有编写教材及书写论文经历、有较强外语和计算机相关能力的教师对教材

加以改编,力图对教材的组织结构、逻辑主线、繁简取舍、内容深浅等把握准确。通过改编教材,对国外教材的选择性引进和适当改编做了一定的尝试,对国内的课程建设、教材建设也是一种借鉴。希望能在兼存并蓄的基础上,将我们的各种特色教材建设得更加出色。

希望本书改编版能够得到广大读者的采用。改编如有不当之处,欢迎广大读者提出宝贵意见。

此书在改编过程中,得到了西安交通大学罗先觉教授、西安电子科技大学陈怀琛教授和华南理工大学林土胜教授、西安理工大学林魁明教授等的热情关注;上海工程技术大学熊洁老师对习题校勘给予了大量的帮助,上海交通大学马聪对文字编辑工作做了一定的工作。在此对他们表示深深的敬意与感谢。清华大学出版社王一玲编辑为此书的改编出版付出了辛苦的工作,在此一并表示感谢。

另外,对我家人的理解和关心也表示真切感激。

编 者

2008.5



A Note to the Student

This may be your first course in electrical engineering. Although electrical engineering is an exciting and challenging discipline, the course may intimidate you. This book was written to prevent that. A good textbook and a good professor are an advantage—but you are the one who does the learning. If you keep the following ideas in mind, you will do very well in this course.

- This course is the foundation on which most other courses in the electrical engineering curriculum rest. For this reason, put in as much effort as you can. Study the course regularly.
- Problem solving is an essential part of the learning process. Solve as many problems as you can. Begin by solving the practice problem following each example, and then proceed to the end-of-chapter problems. The best way to learn is to solve a lot of problems. An asterisk in front of a problem indicates a challenging problem.
- *MATLAB* is a software that is very useful in circuit analysis and other courses you will be taking. A brief tutorial on *MATLAB* is given in Appendix C to get you started. The best way to learn *MATLAB* is to start working with it once you know a few commands.
- Each chapter ends with a section on how the material covered in the chapter can be applied to real-life situations. The concepts in this section may be new and advanced to you. No doubt, you will learn more of the details in other courses. We are mainly interested in gaining a general familiarity with these ideas.
- Attempt the review questions at the end of each chapter. They will help you discover some “tricks” not revealed in class or in the textbook.
- Clearly a lot of effort has gone into making the technical details in this book easy to understand. It also contains all the mathematics and physics necessary to understand the theory and will be very useful in your other engineering courses. However, we have also focused on creating a reference for you to use both in school as well as when working in industry or seeking a graduate degree.
- It is very tempting to sell your book after you have completed your classroom experience; however, our advice to you is *DO NOT SELL YOUR ENGINEERING BOOKS!* Books have always been expensive, however, the cost of this book is virtually the same as I paid for my circuits text back in the early 60s in terms of real dollars. In fact, it is actually cheaper. In addition, engineering books of the past are no where near as complete as what is available now.

When I was a student, I did not sell any of my engineering textbooks and was very glad I did not! I found that I needed most of them throughout my career.

A short review on finding determinants is covered in Appendix A, complex numbers in Appendix B, and answers to odd-numbered problems are given in Appendix D.

Have fun!

C. K. A. and M. N. O. S.

About the Authors

Charles K. Alexander is dean and professor of electrical and computer engineering of the Fenn College of Engineering at Cleveland State University, Cleveland, Ohio. He is also the Director of two research centers: The Center for Research in Electronics and Aerospace Technology (CREATE), and Ohio ICE, a research center in instrumentation, controls, electronics, and sensors (a coalition of CSU, Case, and the University of Akron).

Dr. Alexander has been a consultant to 23 companies and governmental organizations, including the Air Force and Navy and several law firms. He has received over \$10 million in research and development funds for projects ranging from solar energy to software engineering. He has authored 40 publications, including a workbook and a videotape lecture series, and is coauthor of *Fundamentals of Electric Circuits*, *Problem Solving Made Almost Easy*, and the fifth edition of the *Standard Handbook of Electronic Engineering*, with McGraw-Hill. He has made more than 500 paper, professional, and technical presentations.

Dr. Alexander is a fellow of the IEEE and served as its president and CEO in 1997. In 1993 and 1994 he was IEEE vice president, professional activities, and chair of the United States Activities Board (USAB). In 1991–1992 he was region 2 director, serving on the Regional Activities Board (RAB) and USAB. He has also been a member of the Educational Activities Board. He served as chair of the USAB Member Activities Council and vice chair of the USAB Professional Activities Council for Engineers, and he chaired the RAB Student Activities Committee and the USAB Student Professional Awareness Committee. In 1998 he received the Distinguished Engineering Education Achievement Award from the Engineering Council, and in 1996 he received the Distinguished Engineering Education Leadership Award from the same group.

Matthew N. O. Sadiku is presently a professor at Prairie View A&M University. Prior to joining Prairie View, he taught at Florida Atlantic University, Boca Raton, and Temple University, Philadelphia. He has also worked for Lucent/Avaya and Boeing Satellite Systems.

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Charles K. Alexander



Matthew N. O. Sadiku

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Fundamentals of

Electric Circuits

DC Circuits

OUTLINE

- 1 Basic Concepts
- 2 Basic Laws
- 3 Methods of Analysis
- 4 Circuit Theorems
- 5 Capacitors and Inductors
- 6 First-Order Circuits
- 7 Second-Order Circuits



Basic Concepts

One thing I have learned in a long life: that all our science, measured against reality, is primitive and childlike—and yet is the most precious thing we have.

—Albert Einstein

Historical Profiles

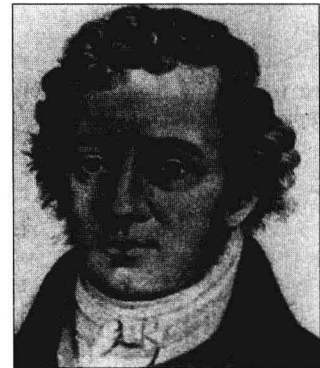
Alessandro Antonio Volta (1745–1827), an Italian physicist, invented the electric battery—which provided the first continuous flow of electricity—and the capacitor.

Born into a noble family in Como, Italy, Volta was performing electrical experiments at age 18. His invention of the battery in 1796 revolutionized the use of electricity. The publication of his work in 1800 marked the beginning of electric circuit theory. Volta received many honors during his lifetime. The unit of voltage or potential difference, the volt, was named in his honor.



Andre-Marie Ampere (1775–1836), a French mathematician and physicist, laid the foundation of electrodynamics. He defined the electric current and developed a way to measure it in the 1820s.

Born in Lyons, France, Ampere at age 12 mastered Latin in a few weeks, as he was intensely interested in mathematics and many of the best mathematical works were in Latin. He was a brilliant scientist and a prolific writer. He formulated the laws of electromagnetics. He invented the electromagnet and the ammeter. The unit of electric current, the ampere, was named after him.



Technical terms:

- | | | |
|----------------|---------------------------|----------------------------------|
| 1. source [电源] | 6. current [电流] | 11. passive element [无源元件] |
| 2. load [负载] | 7. voltage [电压] | 12. independent source [独立源] |
| 3. wire [导线] | 8. power [功率] | 13. dependent source [受控源, 非独立源] |
| 4. switch [开关] | 9. energy [能量] | |
| 5. charge [电荷] | 10. active element [有源元件] | |