Subject-Based English

普通高等教育"十三五"规划教材

高等学校专业英语教材

自动化专业英语

（第2版）

☆姜书艳　主编☆

☆刘　珊　张昌华　何　芳　徐心皓　编著☆

中国工信出版集团　電子工業出版社

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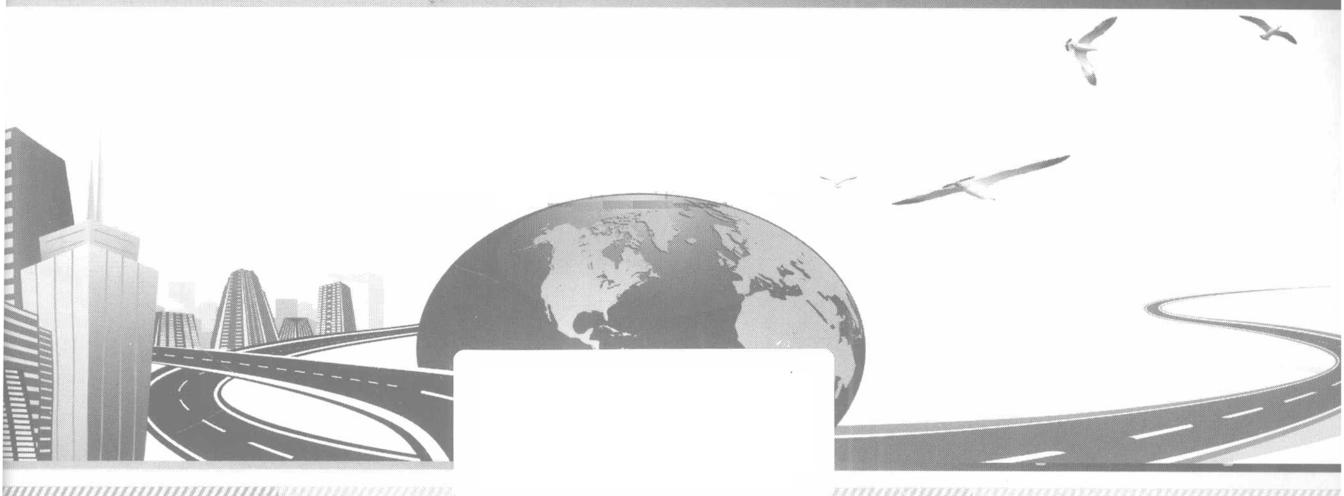

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内 容 简 介

本书以掌握自动化英语的一般特点、常见表达方式和大量专业词汇，提高阅读和检索英文文献资料的能力及撰写英文论文的能力为目的，主要内容包括电子电气工程基础、控制理论、自动控制技术及应用三部分，共15个单元，精选了电路分析、数字电路、模拟电路、微机原理、电机、自动控制理论、过程控制、智能控制、专家系统及专家控制等方面的科技文献。每个单元由A、B、C三部分组成，A、B为两篇文章，以一个问题开始或围绕一个主题进行，包括正文、单词、术语、注释和习题，C部分主要介绍专业英语的词汇、语法、文体特点、科技文献的阅读和翻译、科技论文的写作方法等科技英语学习中的实用基础知识，以及如何向国际会议、期刊投稿，如何诵读专业英语中的公式，常见国内外文献索引及常用数据库介绍，创新的途径和方法，如何开展研究等实用内容。

本书提供配套电子课件、习题参考答案和课文朗读录音等。

本书既可作为自动化、电子信息工程、电气工程、机电一体化等专业本科生和研究生专业英语课程的教材，也可作为具有一定英语基础的电子、电气工程、自动化和机电等相关专业人员的参考书。

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第 2 版　前言

我国自动化专业人才对英语能力的要求越来越高，自动化领域优秀的仿真软件、前沿学科的研究论文、优秀教材、互联网上大量的专业技术信息、进口设备的使用手册及说明书等多数为英文，因此，专业英语的学习对自动化专业学生来说越来越重要了。作者一直认为，一本好的教材，不仅应该是一本好的教学用书，更应该是一本内容丰富、涵盖面广、有利于开拓学生眼界、引导学生走近学科前沿的参考书。作为一本自动化专业英语的教材，更应该对学科前沿课题和内容有所反映。

本书自 2012 年出版以来，承蒙读者厚爱，数十所高等学校采用它作为自动化专业英语课程的教材。对于在使用过程中发现的问题和错误，广大读者和教师提出了很多宝贵意见。作者衷心感谢广大读者和教师对本书的关心，并欢迎继续提出宝贵意见。

在第 2 版中，本书做了以下修订：对 Unit 1、Unit 3、Unit 7、Unit 9、Unit 12 和 Unit 14 中 C 部分的内容进行了改动，充实了内容，增强了实用性；对各个单元中的 A 部分和 B 部分的习题都进行了适当的增补。另外，对第 1 版中一些印刷上的错漏，也进行了较仔细的校正。

本次修订由刘珊副教授执笔、姜书艳教授审定，何芳、张昌华和徐心皓老师参与了内容讨论和校阅工作。在本书修订过程中，王羽佳编辑起了很大的推动作用。作者的许多同事和朋友、本书的编辑等都提出了许多有益的意见，在此向他们表示诚挚的谢意！

第 2 版的修订过程中，作者尽可能地引入新的观点和方法，力求能反映当代技术水平，但学识有限，必有许多不足之处，诚恳希望读者批评指正！

作　者

2016 年 7 月

前　言

自动化是目前国际和国内发展迅速、技术更新活跃的工程领域之一。面对日趋激烈的国际化竞争，我国迫切需要用自动化技术来提升比例巨大而又相对落后的传统产业。所以，培养大批专业技术精、英语能力强、具有国际竞争力的应用型自动化技术人才就成为高等学校的当务之急。信息技术、计算机技术、电子技术、通信技术的发展，有力地推动了自动化学科相关研究领域的深入和应用范围的拓宽。为了追踪国外自动化领域的研究进展，促进我国相关领域的科技进步，以自动化为背景的专业英语已成为科研和学习的重要工具。

编著本书的主要目的是扩充自动化专业英语词汇量，提高阅读和翻译科技英语资料的能力，扩展和深化对本学科关键技术的认识，增强对专业英语的实际应用能力。本书主要内容包括电子电气工程基础、控制理论、自动控制技术及应用三部分，共 15 个单元，精选了电路分析、数字电路、模拟电路、微机原理、电机、自动控制理论、过程控制、智能控制、专家系统及专家控制等方面的科技文献，涵盖了自动化专业的各个发展方向，并概况介绍自动化专业的最新发展。内容组织具有系统、全面、新颖、精炼的特点。每个单元，由 A、B、C 三部分组成，以一个问题开始或者围绕一个主题。A、B 两篇文章可能是并列关系，也可能是递进关系，或者 A 篇是概述，B 篇是举例。这两篇文章难度递增，在学时有限的情况下，可以采用 A 篇课堂教学，B 篇学生自学的形式。每篇文章后面附有词汇表、注释和培养学生读写能力的练习题。练习题分为英译汉、汉译英、文章归纳和讨论问题等。全书另外精心组织了 15 篇文章，介绍如何翻译专业英语资料，如何投稿，如何撰写英语科技论文，如何开展科学研究、培养创新意识等，作为 C 部分，使用中文叙述。这部分是希望读者在学习和掌握专业词汇和翻译技能的同时，开阔视野，获得对自动化专业更加全面和深入的认识，也使得本书兼具了工具书的价值。

本书在编写上具有以下特点：

（1）编排力求系统性，较好地贯穿自动化专业的全部专业课程，适合本科生及研究生学习使用；

（2）选材注重先进性和趣味性，适当增加当前科技前沿新知识；

（3）增加科技英语知识的介绍，加强学生科技英语技能的培养；

（4）从研究型教学角度出发，增加了如何开展科学研究方面的内容。

本书可作为高等学校自动化类和电气工程类学科本科生及研究生专业英语课程的教材，也可作为具有一定英语基础的电子、电气工程、自动化和机电等相关科技工作者的参考书。

教学中，可以根据教学对象和学时等具体情况对书中的内容进行删减和组合，也可以进行适当扩展，参考学时为 32～48 学时。为适应教学模式、教学方法和手段的改革，**本教材配套多媒体电子课件、习题参考答案和课文朗读录音等教学资源，请登录华信教育资源网（http://www.hxedu.com.cn）注册下载。**

本书由姜书艳主编并统稿。第 1、2、3 单元和附录 A、B 由姜书艳编写，第 4、5、9 单元和附录 C 由何芳编写，第 6、7、8、10、11、12、13、14、15 单元由张昌华编写，每个单元的 C 部分由徐心皓编写。本书的编写参考了大量近年来出版的相关技术资料，汲取了许多专家和同仁的宝贵经验，在此向他们深表谢意！

由于作者学识有限，书中误漏之处难免，望广大读者批评指正。

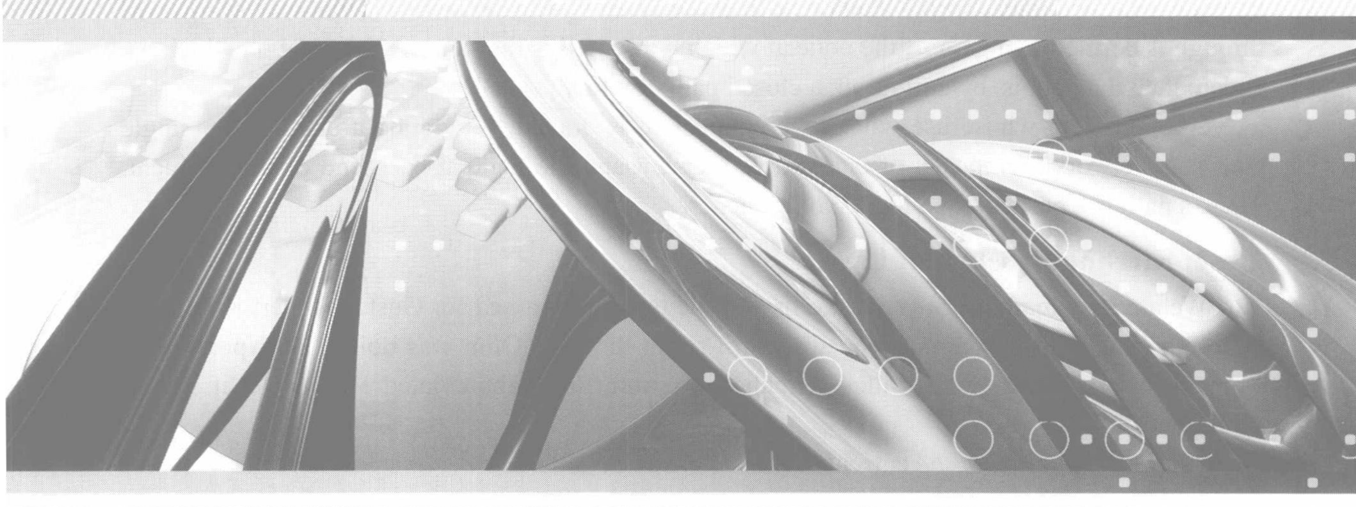
作　者

2012 年 1 月

目　　录

Part Ⅰ

Electrical and Electronic Engineering Basis



Unit 1

We are ready to investigate the behavior of basic electric circuits in this unit. Two simple laws, Kirchhoff's current law and Kirchhoff's voltage law, form the foundation for circuit analysis procedures.

Section A Basic Laws of Electrical Networks

1. Nodes, Paths, Loops, and Branches

We are now ready to determine the current-voltage relationship in simple networks of two or more circuit elements. The elements will be connected together by wires, which have zero resistance. **Since the network then appears as a number of simple elements and a set of connecting leads, it is called a lumped-parameter network.**[1]

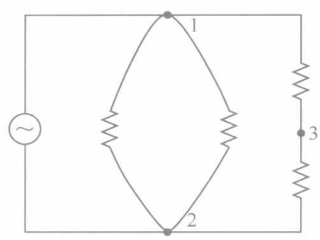


Fig. 1-A-1 A circuit containing three nodes and five branches.

A point at which two or more elements have a common connection is called a node. For example, Fig. 1-A-1 shows a circuit containing three nodes. **We must necessarily consider all of the perfectly conducting leads or portions of leads attached to the node as part of the node.**[2] Note also that every element has a node at each of its ends.

Suppose that we start at one node in a network and move through a simple element to the node at the other end. We then continue from that node through a different element to the next node, and continue this movement until we have gone through as many elements as we wish. If no node was encountered more than once, then the set of nodes and elements that we have passed through is defined as a path. If the node at which we started is the same as the node on which we ended, then the path is, by definition, a closed path or a loop.

Another term whose use will prove convenient is branch. We define a branch as a single path in a network, composed of one simple element and the node at each end of that element. Thus, a path is a particular collection of branches.

2. Kirchhoff's Current Law

We are now ready to consider the first of the two laws named for Gustav Robert Kirchhoff, a German university professor who was born about the time Ohm was doing his experimental work. This axiomatic law is called Kirchhoff's current law (abbreviated KCL), and it simply states that.

The algebraic sum of the currents *entering any node is zero.*

This law represents a mathematical statement of the fact that charge cannot accumulate at a node. **A node is not a circuit element, and it certainly cannot store, destroy, or generate charge.**[3] Hence, the currents must sum to zero. A hydraulic analogy is sometimes useful here: for example, consider three water pipes joined in the shape of a Y. We define three "current" as flowing into each of the three pipes. If we insist that water is always flowing, then obviously we cannot have three positive water currents, or the pipes would burst. This is a result of our define currents independent of the direction that water is actually flowing. Therefore, the value of either one or two of the currents as defined must be negative.

Consider the node shown in Fig. 1-A-2. The algebraic sum of the four currents entering the node must be zero,

$$i_A + i_B(-i_C) + (-i_D) = 0 \qquad (1\text{-A-}1)$$

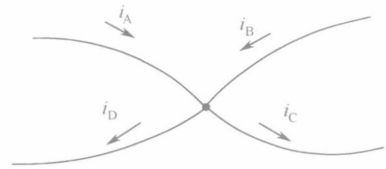


Fig. 1-A-2 Example node to illustrate the application of Kirchhoff's current law.

It is evident that the law could be equally well applied to the algebraic sum of the currents leaving the nod

$$(-i_A) + (-i_B) + i_C + i_D = 0 \qquad (1\text{-A-}2)$$

A compact expression for Kirchhoff's current law is

$$\sum_{n=1}^{N} i_n = 0 \qquad (1\text{-A-}3)$$

3. Kirchhoff's Voltage Law

We now turn to Kirchhoff's voltage law (abbreviated KVL). This law states that

The algebraic sum of the voltage *around any closed path is zero*.

Current is related to the charge flowing through a circuit element, whereas voltage is a measure of potential energy difference across the element.[4] There is a single unique value for voltage in circuit theory. Thus the energy required to move a unit charge from point A to point B in a circuit must have a value that is independent of the path taken from A to B.

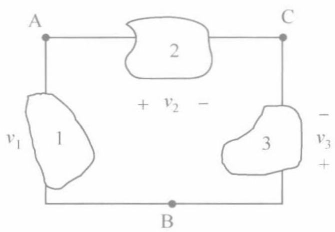


Fig. 1-A-3 The potential difference between point A and B is independent of the path select.

In Fig. 1-A-3, if we carry a charge of 1 C from A to B through element 1, the reference polarity signs for v_1 show that we do v_1 joules of work. Now if, instead, we choose to proceed from A to B via node C, then we expend v_2-v_3 joules of energy. The work done, however, is independent of the path in a circuit, and these values must be equal. Any route must lead to the same value for the voltage. Thus,

$$v_1 = v_2 - v_3 \qquad (1\text{-A-}4)$$

It follows that if we trace out a closed path, the algebraic sum of the voltages across the individual elements around it must be zero. Thus, we may write

$$\sum_{n=1}^{N} v_n = 0 \qquad (1\text{-A-}5)$$

We may apply KVL to a circuit in several different ways. One method that leads to fewer equation-writing errors than others consists of moving mentally around the closed path in a clockwise direction and writing down directly the voltage of each element whose (+) terminal is entered, and writing down the negative of every voltage first met at the (−) sign. Applying this to the single loop of Fig. 1-A-3, we have

$$-v_1 + v_2 - v_3 = 0 \tag{1-A-6}$$

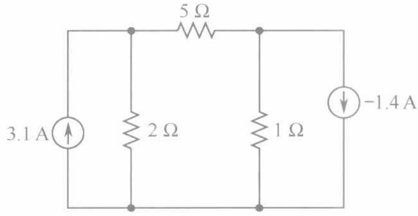
Which agrees with our previous result, Eq. (1-A-4).

4. Nodal Analysis

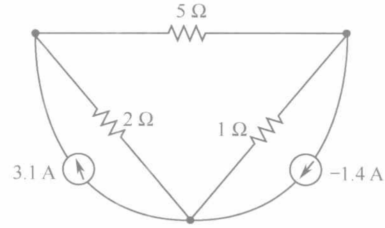
We will begin studying methods of simplifying circuit analysis by considering a powerful general method, that of nodal analysis.

In the previous chapter we considered the analysis of a simple circuit containing only two nodes. We will now let the number of nodes increase, and corresponding provide one additional unknown quantity and one additional equation for each added node. Thus, a three-node circuit should have two unknown voltages and two equations; an *N*-node circuit will need (*N*−1) voltages and (*N*−1) equations.

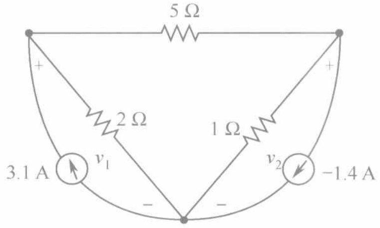
We consider the mechanics of node analysis in this section. As an example, let us consider the three-node circuit shown in Fig. 1-A-4(a).



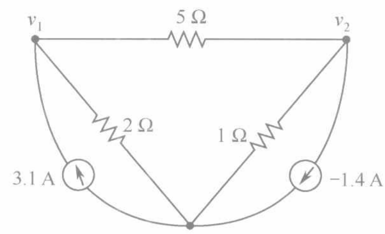
(a) A simple three-node circuit



(b) Redrawn circuit to emphasize nodes



(c) Reference node selected a voltage assigned



(d) Shorthand voltage reference. If desired, an appropriate ground symbol may be substituted for 'Ref

Fig. 1-A-4 The mechanics of node analysis.

As a first step, we redraw the circuit as in Figure1-A-4(b) to emphasize the fact that there are only three nodes. We now associate a voltage with each node, but we must remember that a voltage has to be defined as existing between two nodes in a network. We thus select one node as a reference node and then define a voltage between each remaining node and the reference node. Hence, we note again that there will be only (*N*−1) voltage defined in an *N*-node circuit.

A little simplification in the resultant equations is obtained if the node connected to the greatest number of branches is identified as the reference node. **If there is a ground node, it is usually most convenient to select it as the reference node; more often than not, the ground**

node appears as a common lead across the bottom of a circuit diagram.[5] For this example, we choose node 3 as the reference node.

The voltage of node 1 relative to the reference node as v_1, and v_2 is defined as the voltage of node 2 with respect to the reference node. These two voltages are sufficient, as the voltage between any other pair of nodes may be found in terms of them. For example, the voltage of node 1 with respect to node 2 is $(v_1 - v_2)$. The voltage v_1 and v_2 their reference signs are shown in Fig. 1-A-4(c). It is common practice once a reference node has been labeled to omit the reference signs for the sake of clarity; the node labeled with the voltage is taken to be the positive terminal (Fig. 1-A-4(d)). This is understood to be a type of shorthand voltage notation. We now apply KCL to nodes 1 and 2. We do this by equating the total current leaving the node through the several resistors to the total source current entering the node. Thus,

$$\frac{v_1}{2} + \frac{v_1 - v_2}{5} = 3.1 \tag{1-A-7}$$

or

$$0.7v_1 - 0.2v_2 = 3.1 \tag{1-A-8}$$

At node 2 we obtain

$$\frac{v_2}{1} + \frac{v_2 - v_1}{5} = -(-1.4)a \tag{1-A-9}$$

or

$$-0.2v_1 + 1.2v_2 = 1.4 \tag{1-A-10}$$

Eqs (1-A-8) and (1-A-10) are the desired two equations in two unknowns, and they may be solved easily. The results are $v_1 = 5$ V and $v_2 = 2$ V.

From this, it is straight forward to determine the voltage across the 5-Ω resistor: $v_{5\Omega} = v_1 - v_2 = 3$ V. The currents and absorbed powers may also be computed in one step.

New Words

investigate [in'vestigeit] *v.* 调查，研究

assemble [ə'sembəl] *v.* 集合，聚集，装配

resistance [ri'zistəns] *n.* 电阻，阻力

significant [sig'nifikənt] *adj.* 重要的，相当数量的，有意义的

node [nəud] *n.* 节点，结节

portion ['pɔ:ʃən] *n.* 部分，份，命运；*v.* 将……分配，分配

term [tə:m] *n.* 术语，名词，学期，期限；*v.* 称，呼

branch [brɑ:ntʃ] *n.* 分支，支线；支路

axiomatic *adj.* 公理的；格言的，自明的

algebraic [ældʒi'breiik] *adj.* 代数的；算术运算中的数目有限的

accumulate [ə'kju:mjuleit] *v.* 积聚，堆积

hydraulic [hai'drɔ:lik] *adj.* 水力的，水压的

analogy [ə'nælədʒi] *n.* 相似，类似

polarity [pəu'læriti] *n.* 有两极，磁性引力，极性；两极分化，极端性

joule [dʒu:l] *n.*〈物〉焦耳（米千克秒制中热量、能量和功的单位）

mentally [ˈmentli]　*adv.* 精神上，在内心，智力上

nodal [ˈnəudl]　*adj.* 节点的，节的

corresponding [ˌkɔrisˈpɔndiŋ]　*adj.* 符合的，一致的，相同的，相应的，相当的

mechanics [miˈkæniks]　*n.* 结构，构成法，技巧，机械学，力学

equation [iˈkwei，ʃən]　*n.* 〈数〉方程式，等式

convenient [kənˈviːnjənt]　*adj.* 方便的，便利的

sufficient [səˈfiʃənt]　*adj.* 足够的，充分的

Phrases

circuit analysis　电路分析

lumped-parameter　集总参数

apply … to …　将应用于……

consist of …　由……组成

lead to　导致，引起，通向

compact expression　简介表达式

be related to　与……相关

associate … with …　把……与……联系起来

be identified as　被定义为

in terms of　依据，按照，在……方面，以……措辞

for the sake of　为了，为了……的利益

Abbreviations

KVL (Kirchhoff's Voltage Law)　基尔霍夫电压定律

KCL (Kirchhoff's Current Law)　基尔霍夫电流定律

Notes

1. Since the network then appears as a number of simple elements and a set of connecting leads, it is called a lumped-parameter network.

由于接下来的网络是以一系列简单的元件和连线出现的，因此被称为集总参数网络。

2. We must necessarily consider all of the perfectly conducting leads or portions of leads attached to the node as part of the node.

我们必须把连线本身或者与元件相连的连线部分作为该节点的一部分。

3. A node is not a circuit element, and it certainly cannot store, destroy, or generate charge.

节点不是电路元件，显然不能存储、消灭或产生电荷。

4. Current is related to the charge flowing through a circuit element, whereas voltage is a measure of potential energy difference across the element.

电流与电路元件中的电荷有关，而电压是元件两端电势能量的度量。

5. If there is a ground node, it is usually most convenient to select it as the reference node; more often than not, the ground node appears as a common lead across the bottom of a circuit diagram.

如果电路中包含接地节点，通常将该节点选择为参考节点，但是很多人喜欢将电路最下端的节点作为参考节点。

Exercises

[EX.1] Comprehension.

1. Briefly introduce the KCL and KVL.

2. Summarize the concept of node, branches, path and loop.

3. In Fig. 1-E-1, How many nodes are there? How many branches are there? If we move from A to B to E to D to C to B, have we formed a path or a loop?

4. In the circuit of Fig. 1-E-2，there are right circuit elements, voltages with plus-minus pairs are shown across each element. Find v_{R2} (the voltage across R_2) and the voltage labeled v_x .

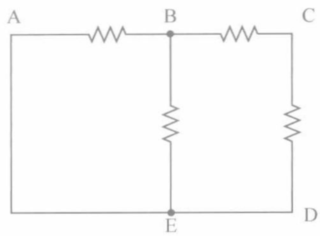


Fig. 1-E-1

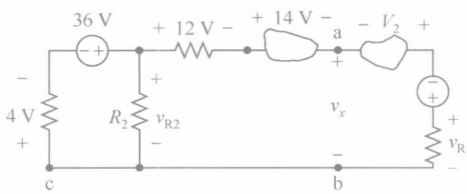


Fig. 1-E-2

[EX.2] Translate the following passages into Chinese.

1. A little simplification in the resultant equations is obtained if the node connected to the greatest number of branches is identified as the reference node.

2. We found that the major step of the analysis was when we obtained a single equation in terms of a single unknown quantity, the voltage between the pair of nodes.

3. However, this resistance is typically so small compared to other resistances in the circuit that we can neglect it without introducing significant error.

4. One method that leads to fewer equation-writing errors than others consists of moving mentally around the closed path in a clockwise direction and writing down directly the voltage of each element whose (+) terminal is entered, and writing down the negative of every voltage first met at the (−) sign.

5. The key to correctly analyzing a circuit is to first methodically label all voltages and currents on the diagram.

6. Carefully written KCL or KVL equations will yield correct relationships, and Ohm's law can be applied as necessary if more unknowns than equations are obtained initially.

7. Nodal analysis is based on KCL, and allows us to construct equations for a wide variety of circuits.

8. Note that in an effort to be consistent, we have placed all the current sources (defined flowing into node 1) on the left-hand side, and all the currents flowing out of node 1 through resistors on the right-hand side.

9. In an electric circuit, the voltages across the resistors (called voltage drops) always have polarities opposite to the source voltage polarities.

10. As the electrons flow through a resistor, they lose energy and are therefore at a lower energy level when they emerge.

[EX.3] Translate the following passages into English.

1. 特别需要强调的是，电压不能定义在单个点上——它定义为两点之间的电位差。

2. 并不是所有的地均为大地，这样一个事实会引起很多的安全和电噪声问题。

3. 但是随着这些具有腐蚀性的管道被更现代和更低成本的非导电 PVC 管道系统所取代，这些到大地的低阻抗路径将不复存在。
4. 基尔霍夫电流定律基于电荷守恒原理，而基尔霍夫电压定律基于能量守恒原理，它们都是基本的物理定律。
5. 如果电路的公共端没有通过某些低阻抗的路径与大地相接，则可能导致潜在的危险。
6. 流过每个电阻的电流一定，因此压降与电阻的阻值成正比。
7. 将一个封闭回路中所有压降相加，再减去电压源的电压值，得到的结果应该为零。
8. 当所有电阻的电压加在一起，其总和将等于电源电压。电阻器的数量可以任意添加。
9. 可以通过连接电路并测量各个分支电流和从电流源中流出的总电流来验证 KCL 定理。
10. 额外并联电阻将进一步减少阻值并增加总电流。
11. 电流的大小与电压成正比，与电阻成反比。

[EX.4] Fill out the spaces after the record.

In a nodal__1__the variables in the circuit are selected to be the node voltage. The node voltages are defined with respect to a__2__point in the circuit. One node is selected as the__3__node, and all other node voltages are__4__with respect to that node. Quite often this node is the one to which the largest number of __5__are connected. It is commonly called__6__because it is said to be at ground-zero__7__, and it sometimes represents the chassis or ground line in an__8__circuit. We will select our variables as being __9__with respect to the reference node. If one or more of the node voltages are actually negative with respect to the reference node, the analysis will__10__it.

Section B The Characteristics of Basic Electronic Elements

1. Introduction

We define an active element as an element that is capable of furnishing an average power greater than zero to some external device, where the average is taken over an infinite time interval.[1] A passive element, however, is defined as an element that cannot supply an average power that is greater than zero over an infinite time interval.

Technically speaking, any material (except for superconductor) will provide resistance to current flow. **As in all introductory circuits' texts, however, we will tacitly assume that wires appearing in circuit diagrams have zero resistance.**[2] This implies that there is no potential difference between the ends of a wire, and hence no power absorbed or heat generated.

Resistance is determined by the inherent resistivity of a material and the device geometry. Resistivity, represented by the symbol ρ, is a measure of the ease with which electrons can travel through a certain material. The resistance of a particular object is obtained by multiplying the resistivity by the length L of the resistor, and dividing by the cross-sectional area (A) as in Eq. (1-B-1); these parameters are illustrated in Fig. 1-B-1.

$$R = \rho \frac{l}{A} \tag{1-B-1}$$

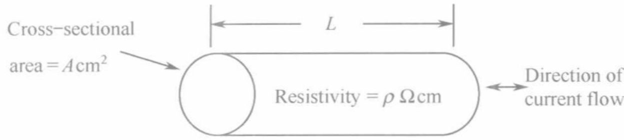


Fig. 1-B-1 The illustration of parameters.

2. Conductance

For a linear resistor the ratio of current to voltage is also a constant,

$$\frac{i}{v} = \frac{1}{R} = G \tag{1-B-2}$$

where G is called the conductance. The SI unit of conductance is the siemens(S), 1 A/V. The same circuit symbol (Fig. 1-B-1) is used to represent both resistance and conductance. The absorbed power is again necessarily positive and may be expressed in terms of the conductance by

$$p = vi = v^2 G = \frac{i^2}{G} \tag{1-B-3}$$

Thus a 2 Ω resistor has a conductance of $\frac{1}{2}$ S, and if a current of 5 A is flowing through it, then voltage of 10 V is present across the terminals and a power of 50 W is being absorbed.

3. Capacitor

We now introduce a new passive circuit element, the capacitor. We define capacitance C by the voltage-current relationship

$$i = C\frac{\mathrm{d}v}{\mathrm{d}t} \tag{1-B-4}$$

where v and i satisfy the conventions for a passive element, as shown in Fig. 1-B-2. We should bear in mind that v and i are functions of time.

Fig. 1-B-2 Circuit symbol for the resistor.

Several important characteristics of our new mathematical model can be discovered from the defining equation, Eq. (1-B-4). **A constant voltage across a capacitor results in zero current passing through it; a capacitor is thus an "open circuit to DC."** [3] This fact is pictorially represented by the capacitor symbol. It is also apparent that a sudden jump in the voltage requires an infinite current. Since this is physically impossible, we will therefore prohibit the voltage across a capacitor to change in zero time.

4. Energy Storage

The power delivered to a capacitor is

$$p = vi = Cv\frac{\mathrm{d}v}{\mathrm{d}t} \tag{1-B-5}$$

and the energy stored in its electric flied is therefore