高职高专电气自动化技术专业规划教材

GAOZHI GAOZHUAN DIANQI ZIDONGHUA JISHU ZHUANYE GUIHUA JIAOCAI

电气自动化专业英语

王 琳 主编 夏 怡 副主编

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内 容 提 要

本书为高职高专电气自动化技术专业规划教材。

全书分为5章，共计26课。第1章电工电子技术基础，主要介绍电路元器件、电路网络分析、二极管、运算放大器、逻辑电路等；第2章电机和电机控制，主要介绍直流电动机、交流异步电动机、电动机控制电路、脉宽调制理论、变频器等；第3章工业计算机控制技术，主要介绍PLC、单片机、现场总线等；第4章传感器，主要介绍温度传感器、霍尔传感器、光电传感器及红外线传感器等；第5章自动控制系统，主要介绍自动控制系统简介、传递函数、波德图、过程控制等。本书所有课文均精心选自国外相关网站和教材，具有专业性和实用性强、难度适宜等特点，有助于培养学生阅读电类英文资料的能力。

本书可作为高职高专电气自动化技术等相关专业的教材，也可供中等职业学校相关专业使用及专业英语爱好者学习参考。

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前 言

随着新技术革命的发展及经济全球化的到来，社会对专业人才的外语能力要求越来越高。理工科的学生除了应具有一定的听说读写能力外，还应掌握一定的本专业基本词汇，具有基本的阅读本专业外文资料和进行专业交流的能力。为了更好地培养学生的专业外语应用能力，编者编写了这本《电气自动化专业英语》。

本书由电工电子技术基础、电机和电机控制、工业计算机控制技术、传感器和自动控制系统五章组成，共计 26 课。电工电子技术基础主要介绍电路元器件、电路网络分析、二极管、运算放大器、逻辑电路等；电机和电机控制主要介绍直流电动机、交流异步电动机、电动机控制电路、脉宽调制理论、变频器等；工业计算机控制技术主要介绍 PLC、单片机、现场总线等；传感器主要介绍温度传感器、霍尔传感器、光电传感器及红外线传感器等；自动控制系统主要介绍自动控制系统简介、传递函数、波德图、过程控制等。

本书所有课文均精心选自国外相关网站和教材，具有专业性和实用性强的特点，难度适宜等特点，有助于培养学生阅读电类英文资料的能力。为了便于学生自学，所有课文都附有参考译文。

本书由王琳主编、夏怡副主编，其中王琳编写第一章，夏怡编写第二、三章，张金红编写第四章，徐志成编写第五章。本书承蒙南京师范大学陈雪丽教授审阅，提出了宝贵的修改意见，在此表示衷心感谢。

由于编者水平有限，书中难免存在疏漏和错误之处，敬请读者批评指正。

编　者

2009 年 6 月

Contents

Electric and Electronic Technology Fundamentals

Unit 1 Electrical Elements and Network

The concept of electrical elements is used in the analysis of electrical networks. Any electrical network can be modeled by decomposing it down to multiple, interconnected electrical elements in a schematic diagram or circuit diagram[1]. Each electrical element affects the voltage in the network or current through the network in a particular way. By analyzing the way a network is affected by its individual elements, it is possible to estimate how a real network will behave on a macro scale.

Elements vs. components

There is a distinction between real, physical electrical or electronic components and the ideal electrical elements by which they are represented.

- Electrical elements do not exist physically, and are assumed to have ideal properties according to a lumped element model.
- Conversely, components do exist, have less than ideal properties, their values always have a degree of uncertainty, they always include some degree of nonlinearity and typically require a combination of multiple electrical elements to approximate their functions.

Circuit analysis using electric elements is useful for understanding many practical electrical networks using components.

The elements

The four fundamental circuit variables are current, I; voltage, U; charge, Q; and magnetic flux, Φ_m. Only 5 elements are required to represent any component or network by manipulating these four variables.

Two sources:

- Current source, measured in amperes —— produces a current in a conductor. Affects charge according to the relation $dQ = -Idt$.
- Voltage source, measured in volts —— produces a potential difference between two points. Affects magnetic flux according to the relation $d\Phi_m = Udt$.

Three passive elements:

- Resistance R, measured in ohms —— produces a voltage proportional to the current flowing through it. Relates voltage and current according to the relation $dU = RdI$.
- Capacitance C, measured in farads —— produces a current proportional to the rate of change of voltage across it. Relates charge and voltage according to the relation $dQ = CdU$.

- Inductance L, measured in henries —— produces a voltage proportional to the rate of change of current through it. Relates flux and current according to the relation $d\Phi_m = LdI$.

Examples

The following are examples of representation of components by way of electrical elements.

- On a first degree of approximation, a battery is represented by a voltage source. A more refined model also includes a resistance in series with the voltage source, to represent the battery's internal resistance (which results in the battery heating and the voltage dropping when in use). A current source in parallel may be added to represent its leakage (which discharges the battery over a long period of time).
- On a first degree of approximation, a resistor is represented by a resistance. A more refined model also includes a series inductance, to represent the effects of its lead inductance[2] (resistors constructed as a spiral have more significant inductance). A capacitance in parallel may be added to represent the capacitive effect of the proximity of the resistor leads to each other. A wire can be represented as a low-value resistor.
- Current sources are more often used when representing semiconductors. For example, on a first degree of approximation, a bipolar transistor may be represented by a variable current source that is controlled by the input voltage.

Electrical network

An electrical network is an interconnection of electrical elements such as resistors, inductors, capacitors, transmission lines, voltage sources, current sources, and switches.

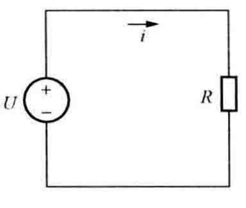

Fig.1.1 A simple electric circuit

An electrical circuit is a network that has a closed loop, giving a return path for the current (Fig.1.1). A network is a connection of two or more components, and may not necessarily be a circuit.

Electrical networks that consist only of sources (voltage or current), linear lumped elements (resistors, capacitors, inductors), and linear distributed elements (transmission lines) can be analyzed by algebraic and transform methods to determine DC response, AC response, and transient response.

A network that also contains active electronic components is known as an electronic circuit. Such networks are generally nonlinear and require more complex design and analysis tools.

Technical Words and Expressions

electronic	[ilek'trɔnik]	adj.	电子的
electrical	[i'lektrik(ə)l]	adj.	电的，有关电的

element	['elimənt]	n.	元件
network	['netwəːk]	n.	网络，网状物
model	['mɔdl]	n.&v.	样式，模型；作……的模型
decompose	[ˌdiːkəm'pəuz]	vt.	分解
multiple	['mʌltipl]	adj.	多样的，多重的
schematic	[ski'mætik]	adj.	示意性的
diagram	['daiəgræm]	n.	图样，图表，图像，示图
circuit	['səːkit]	n.	电路
schematic diagram			示意图
circuit diagram			电路图
macro	['mækrəu]	adj.	巨大的，大量使用的
component	[kəm'pəunənt]	n.	元件，组（部）件
lumped element model			集总元件模型
nonlinearity	[ˌnɔnlini'æriti]	n.	非线性
approximate	[ə'prɔksimeit]	adj. & v.	近似的，大约的；近似，接近
variable	['vεəriəbl]	n.	变量
current	['kʌrənt]	n.	电流
voltage	['vəʊltidʒ]	n.	［电工］电压，伏特数
charge	[tʃɑːdʒ]	n.	电荷，充电
magnetic	[mæg'netik]	adj.	磁的，有磁性的，有吸引力的
flux	[flʌks]	n.	［物］流量，通量
current source			电流源
ampere	['æmpeə(r)]	n.	安培
conductor	[kən'dʌktə]	n.	［物］导体
voltage source			电压源
potential	[pə'tenʃ(ə)l]	adj. & n.	势的，位的；电位
potential difference			电位差
passive	['pæsiv]	adj.	无源的
resistance	[ri'zistəns]	n.	电阻，阻抗
ohm	[əum]	n.	［物］欧姆
proportional	[prə'pɔːʃənl]	adj.	（成）适当比例的，（与……）相称的（to）
capacitance	[kə'pæsitəns]	n.	容量，电容
farad	['færəd]	n.	［电］法拉（电容单位）
across	[ə'krɔs]	prep.	跨接
inductance	[in'dʌktəns]	n.	电感
henry	['henri]	n.	亨利（电感单位）
representation	[ˌreprizen'teiʃən]	n.	表示法
approximation	[əˌprɔksi'meiʃən]	n.	（数）近似值；近似法

battery	['bætəri]	n.	电池
series	['siəri:z]	n.	（电）串联（接）
parallel	['pærəlel]	n.	（电）并联
leakage	['li:kidʒ]	n.	漏，泄漏，渗漏
discharge	[dis'tʃɑ:dʒ]	v.	（电）放（电）
lead	[li:d]	n.	导线
spiral	['spaiərəl]	n.	螺线
capacitive	[kə'pæsitiv]	adj.	电容的
proximity	[prɔk'simiti]	n.	近似
semiconductor	['semikən'dʌktə]	n.	[物] 半导体
bipolar	[bai'pəulə]	adj.	有两极的，双极的
transistor	[træn'zistə]	n.	[电子] 晶体管
switch	[switʃ]	n.	开关
loop	[lu:p]	n.	回路
distributed	[dis'tribju:tid]	adj.	分布式的
algebraic	[ˌældʒi'breiik]	adj.	代数的
transform method			变换法
response	[ris'pɔns]	n.	响应
transient	['trænziənt]	adj.	瞬时的
active	['æktiv]	adj.	有源的

Notes

[1] Any electrical network can be modeled by decomposing it down to multiple, interconnected electrical elements in a schematic diagram or circuit diagram.

译文为：任何电网络都可通过分解为原理图或电路图中多个相互连接的电气元件，来建立模型。

此句中 any electrical network 译为任何电网络。

[2] A more refined model also includes a series inductance, to represent the effects of its lead inductance.

译文为：更精确的模型中含有串联电感，可用来表示电阻导线中的电感效应。

句中 to represent…为目的状语。

Exercises

Ⅰ. Mark the following statements with T (true) or F (false) according to the text.

1. Each electrical element affects the voltage in the network or current through the network in a particular way. (　　)

2. There isn't a distinction between real, physical electrical or electronic components and the ideal electrical elements by which they are represented. (　　)

3. Components do exist, have some ideal properties. (　　)

4. Voltage source, measured in volts——produces a potential difference between two points. ( )

5. Current sources are more often used when representing conductors. ( )

Ⅱ. Complete the following sentences.

1. The concept of ______ is used in the analysis of ______.

2. Each electrical element affects the ______ in the network or ______ through the network in a particular way.

3. Resistance *R*, measured in ______ —— produces a voltage ______ the current flowing through it.

4. On a first degree of approximation, a bipolar transistor may be represented by a ______ that is controlled by the ______.

5. A network is a connection of ______ or ______ components, and may not necessarily be a ______.

Reading 1 Circuit Diagram

A circuit diagram (also known as an electrical diagram, wiring diagram, elementary diagram, or electronic schematic) is a simplified conventional pictorial representation of an electrical circuit. It shows the components of the circuit as simplified standard symbols, and the power and signal connections between the devices. Arrangement of the components interconnections on the diagram does not correspond to their physical locations in the finished device.

Unlike a block diagram or layout diagram, a circuit diagram shows the actual wire connections being used. The diagram does not show the physical arrangement of components. A drawing meant to depict what the physical arrangement of the wires and the components they connect is called "artwork" or "layout" or the "physical design".

Circuit diagrams are used for the design (circuit design), construction (such as PCB layout), and maintenance of electrical and electronic equipment.

Legends

On a circuit diagram, the symbols for components are labelled with a descriptor (or reference designator) matching that on the list of parts. For example, C1 is the first capacitor, L1 is the first inductor, Q1 is the first transistor, and R1 is the first resistor (note that it isn't written R1, L1,...). The letters that precede the numbers were chosen in the early days of the electrical industry, even before the vacuum tube (thermionic valve), so "Q" was the only one available for semiconductor devices in the mid-twentieth century. Often the value or type designation of the component is given on the diagram beside the part, but detailed specifications would go on the parts list.

Symbols (Fig.1.2)

Circuit diagram symbols have differed from country to country and have changed over time, but are now to a large extent internationally standardized. Simple components often had symbols intended to represent some feature of the physical construction of the device. For example, the symbol for a resistor shown here dates back to the days when that component was made from a long piece of wire wrapped in such a manner as to not produce inductance, which would have made it a coil. These wire-wound resistors are now used only in high-power applications, smaller resistors being cast from carbon composition (a mixture of carbon and filler) or fabricated as an insulating tube or chip coated with a metal film. The internationally standardized symbol for a resistor is therefore now simplified to an oblong, sometimes with the value in ohms written inside, instead of the zigzag symbol. A less common symbol is simply a series of peaks on one side of the line representing the conductor, rather than back-and-forth as shown here.

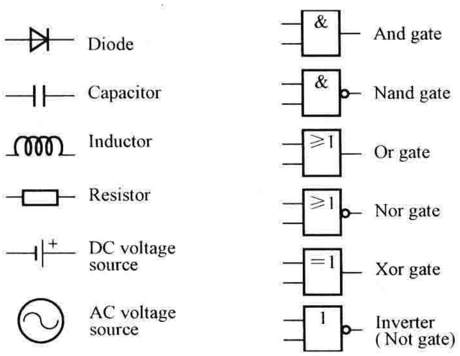

Fig.1.2 Circuit element symbols

Linkages

The linkages between leads were once simple crossings of lines; one wire insulated from and "jumping over" another was indicated by it making a little semicircle over the other line. With the arrival of computerized drafting, a connection of two intersecting wires was shown by a crossing with a dot or "blob", and a crossover of insulated wires by a simple crossing without a dot. However, there was a danger of confusing these two representations if the dot was drawn too small or omitted. Modern practice is to avoid using the "crossover with dot" symbol, and to draw the wires meeting at two points instead of one. It is also common to use a hybrid style, showing connections as a cross with a dot while insulated crossings use the semicircle. Several styles of schematic wire junctions are shown in Fig.1.3.

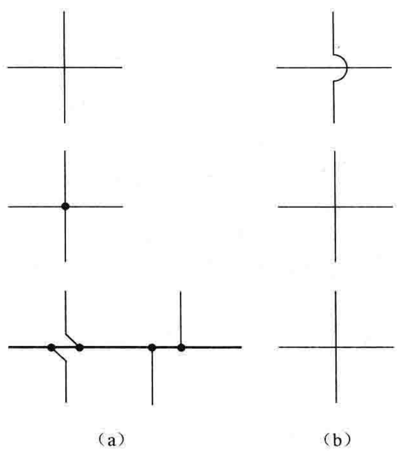

Fig.1.3 Schematic wire junctions
(a) connection; (b) no connection

Technical Words and Expressions

wiring diagram 接线图

elementary diagram		原理图
pictorial	adj.	图示的
power	n.	电源
arrangement	n.	排列，布局
layout diagram		布置图
depict	vt.	描述，描写
artwork		布线图
physical design		布图设计
construction	n.	建造
legend	n.	图例
descriptor	n.	描述符
vacuum tube		真空管
thermionic valve		热离子管，热阴极电子管
specification	n.	规格，说明书
wrap	v.	卷，缠绕
cast	v.	浇铸
carbon composition		碳组分
filler	n.	填充剂
fabricate	v.	制造
insulating tube		绝缘管
metal film		金属膜
oblong	n.	长方形
zigzag	n.	锯齿形
peak	n.	波峰
back-and-forth		来回地，往复地
linkage	n.	连接
crossing	n.	交叉，相交
draft	vt.	设计
blob	n.	圆点
crossover	n.	交叉
hybrid	adj.	混合的
semicircle	n.	半圆形
junction	n.	连接，接合，交叉点，汇合处

Comprehension

1. A circuit diagram is also known as an electrical diagram, ______.
   A. wiring diagram　　B. elementary diagram
   C. electronic schematic　　D. all

2. Unlike a block diagram or layout diagram, a circuit diagram shows the ______ wire connections being used.
   A. virtual　　B. actual　　C. approximate　　D. physical

3. According to the text, the distinction between a block diagram and a circuit diagram is that ______.

A. a block diagram can show the physical arrangement of components

B. a circuit diagram can show the physical arrangement of components

C. a circuit diagram shows the actual wire connections being used

D. a block diagram shows the actual wire connections being used

4. According to the text, which of the following description about circuit diagram is right? ______.

A. Arrangement of the components interconnections on the diagram does correspond to their physical locations in the finished device.

B. There is no distinction between a circuit diagram and a layout diagram.

C. A circuit diagram can show the physical arrangement of components.

D. Circuit diagrams are used for the design (circuit design), construction (such as PCB layout), and maintenance of electrical and electronic equipments.

5. The internationally standardized symbol for a resistor is therefore now simplified to ______, sometimes with the value in ohms written inside.

A. a semicircle　　B. an oblong

C. a triangle　　D. a circle

Unit 2 Network Analysis

A network, in the context of electronics, is a collection of interconnected components. Network analysis is the process of finding the voltages across, and the currents through, every component in the network. There are a number of different techniques for achieving this. However, for the most part, they assume that the components of the network are all linear. The methods described in this article are only applicable to linear network analysis except where explicitly stated.

Definitions

Component: A device with two or more terminals into which, or out of which, charge may flow.

Node: A point at which terminals of more than two components are joined. A conductor with a substantially zero resistance is considered to be a node for the purpose of analysis.

Branch: The component (s) joining two nodes.

Mesh: A group of branches within a network joined so as to form a complete loop.

Port: Two terminals where the current into one is identical to the current out of the other.

Equivalent circuits

A useful procedure in network analysis is to simplify the network by reducing the number of components. This can be done by replacing the actual components with other notional components that have the same effect. A particular technique might directly reduce the number of components, for instance by combining impedances in series. On the other hand it might merely change the form in to one in which the components can be reduced in a later operation. For instance, one might transform a voltage generator into a current generator using Norton's theorem in order to be able to later combine the internal resistance of the generator with a parallel impedance load.

A resistive circuit is a circuit containing only resistors, ideal current sources, and ideal voltage sources. If the sources are constant (DC) sources, the result is a DC circuit. The analysis of a circuit refers to the process of solving for the voltages and currents present in the circuit. The solution principles outlined here also apply to phasor analysis of AC circuits.

Two circuits (see circuit 1 and circuit 2 in Fig.1.4) are said to be equivalent with respect to a pair of terminals if the voltage across the terminals and current through the terminals for one network have the same relationship as the voltage and current at the terminals of the other network [1].

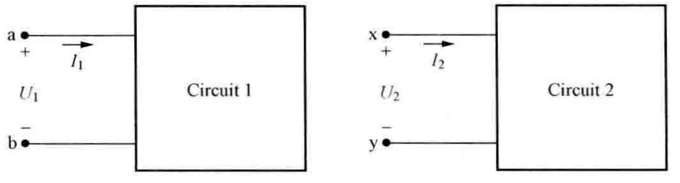

Fig.1.4 Circuit equivalence

If $U_2 = U_1$ implies $I_2 = I_1$ for all (real) values of U_1, then with respect to terminals ab and xy, circuit 1 and circuit 2 are equivalent.

The above is a sufficient definition for a one-port network. For more than one port, then it must be defined that the currents and voltages between all pairs of corresponding ports must bear the same relationship[2]. For instance, star and delta networks are effectively three port networks and hence require three simultaneous equations to fully specify their equivalence.

Impedances in series and in parallel

Any two terminal network of impedances can eventually be reduced to a single impedance by successive applications of impedances in series or impedances in parallel.

Impedances in series: $Z_{eq}=Z_1+Z_2+\cdots+Z_n$

Impedances in parallel: $\frac{1}{Z_{eq}}=\frac{1}{Z_1}+\frac{1}{Z_2}+\cdots+\frac{1}{Z_n}$

The above simplified for only two impedances in parallel: $Z_{eq}=\frac{Z_1 Z_2}{Z_1+Z_2}$

Source transformation

A generator with an internal impedance (ie non-ideal generator) can be represented as