全国电力职业教育规划教材
职业教育电力技术类专业培训用书

电气工程专业英语

张　弘　刘乔玲　编

中国电力出版社
http://jc.cepp.com.cn

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内 容 提 要

本书为全国电力职业教育规划教材。

全书共分为12个单元，内容多选自原版英文书籍，涉及面广、难度适中。主要内容包括电力系统概述、交流电路、电子、电机、电气测量、电气设备、电力传输、直流输电、继电保护、可编程控制器、电气安全和新能源；每篇课文后附有难点注解、练习及课堂活动建议，增强学习的针对性和趣味性；并有阅读材料供教师和学生选择使用。

本书可作为高职高专电气工程专业英语课程的教学用书，也可作为相关专业工程技术人员的参考书。

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前言

“电气工程专业英语”旨在培养学生的英语语言运用能力。通过本课程的学习，使学生不仅掌握一定的专业英语词汇和电气工程的基本概念，同时掌握用英语表达专业知识的方法，提高阅读及理解专业英文资料的能力，为今后在工作中应用专业英语解决相关问题提供必要的知识保障。

本书分为12个单元，涵盖了电气工程专业基础知识、专业知识及新技术应用等方面的内容；每个单元包括两篇课文和一篇阅读材料，每篇课文后均附有重点词汇及课文难点注释、课堂活动建议、练习，书末附有词汇表和参考译文。

本书有以下几个特点：内容丰富，注意与其它电气工程专业课程内容的衔接和补充；注重内容的实践性、实用性、开放性和趣味性，拓展学生知识面，培养学生的语言应用能力；文章难度适中，符合高职高专学生特点；附有课堂活动建议供教师参考，有助于活跃课堂气氛，提高学生的学习兴趣和教学效果。

本书由保定电力职业技术学院张弘和刘乔玲合编，其中第二、七、八、十、十一单元由张弘编写，第一、三、四、五、六、九、十二单元由刘乔玲编写，张弘承担全书统稿工作。

本书由沈阳工程学院刘然主审。

由于编者水平有限，不当之处敬请读者批评指正。

编　者

2010年5月

Contents

Outline of Power System

Part A The History and Principle of Electricity

Electricity is a form of energy involving the flow of electrons. All matter is made up of atoms, and an atom has a center, called a nucleus. The nucleus contains positively charged particles called protons and uncharged particles called neutrons. The nucleus of an atom is surrounded by negatively charged particles called electrons①. The negative charge of an electron is equal to the positive charge of a proton, and the number of electrons in an atom is usually equal to the number of protons. When the balancing force between protons and electrons is upset by an outside force, an atom may gain or lose an electron. When electrons are "lost" from an atom, the free movement of these electrons constitutes an electric current.

Electricity is a basic part of nature and it is one of our most widely used forms of energy. We get electricity, which is a secondary energy source, from the conversion of other sources of energy, like coal, natural gas, oil, nuclear power and other natural sources, which are called primary energy sources②. Many cities and towns were built alongside waterfalls (a primary source of mechanical energy) that turned water wheels to perform work. Before electricity generation began slightly over 100 years ago, houses were lit with kerosene lamps, food was cooled in iceboxes, and rooms were warmed by wood-burning or coal-burning stoves. Beginning with Benjamin Franklin's experiment with a kite one stormy night in Philadelphia, the principles of electricity gradually became understood. In the mid-1800s, everyone's life changed with the invention of the electric light bulb. Prior to 1879, electricity had been used in arc lights for outdoor lighting. The light bulb's invention used electricity brings indoor lighting to our homes.

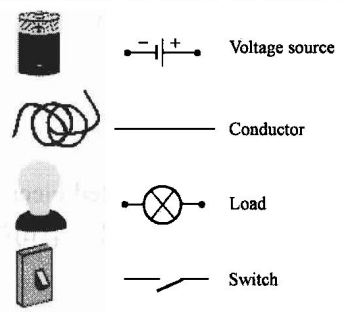


Fig.1.1 The circuit elements

An electric generator (Long ago, a machine that generated electricity was named "dynamo" when today's preferred term is "generator".) is a device for converting mechanical energy into electrical energy. The process is based on the relationship between magnetism and electricity. When a wire or any other electrically conductive material moves across a magnetic field, an electric current occurs in the wire. The large generators used by the electric utility industry have a stationary conductor. A magnet attached to the end of a rotating shaft is positioned inside a stationary conducting ring that is wrapped with a long, continuous piece of wire. When the magnet rotates, it induces a small electric current in each section of wire as it passes. Each section of wire constitutes a small, separate electric conductor. All the small currents of individual sections add up to one current of considerable size. This current is what is used for electric power.

New Words

electron [ɪ'lektrɒn] *n.* 电子
atom ['ætəm] *n.* 原子
nucleus ['nju:klɪəs] *n.* （原子）核
proton ['prəu,tɒn] *n.* 质子
neutron ['nju:trɒn] *n.* 中子
kerosene ['kerəsi: n] *n.* 煤油，火油
generator ['dʒenəreɪtə] *n.* 发电机
magnetism ['mægnɪtɪzəm] *n.* 磁性
stationary ['steɪʃənərɪ] *adj.* 静止的

Phrases and Expressions

secondary energy source 二次能源
primary energy source 一次能源
light bulb 灯泡

Notes

① 此句中，called electrons 是过去分词短语作定语，修饰 particles；be surrounded by 意思是：被……所包围。全句的意思是：原子的原子核周围被带负电的粒子包围着，我们称之为电子。

② 此句包含两个从句，which is a secondary energy source 是定语从句，修饰 electricity，指出电能是二次能源；which are called primary energy sources，修饰 coal，natural gas，oil，nuclear power and other natural sources，指出煤、天然气、石油、核能及其它自然能源属于一次能源。全句的意思是：我们通常把称为一次能源的煤、天然气、核能和其它自然能源等转化成电能，称为二次能源。

Suggested Activity

[Translation Activity]

***Materials*:** Any brief passages from the students' textbooks.

***Instructions*:**

1. Select two short passages from the text that do not contain new vocabulary.

2. Divide the class into pairs, and give each student different passages of similar difficulty to translate into Chinese.

3. After finishing translation, students exchange their translated texts with partners.

4. The main task is to retranslate their peers' work back into English. Make sure students

do not have original English texts at this stage.

5. Finally, students compare their translations with the original texts.

Exercises

1. Translate the following words or phrases into English:

（1）电能

（2）发电机

（3）电流

（4）感应

（5）磁场

（6）核能

（7）导体

（8）不带电粒子

2. Complete the following statements (choose the correct word):

(1) The nucleus contains (positively /negatively) charged particles called (protons or neutrons).

(2) An electric generator is a device for converting (mechanical /electrical) energy into (mechanical /electrical) energy.

(3) The large generators used by the electric utility industry have a (stationary/moving) conductor. When the magnet rotates, it induces a small electric current in each section of wire.

(4) We get electricity, which is a (primary /secondary) energy source.

3. Read the text and complete the following tasks:

(1) List primary energy sources that you know.

(2) Describe the function of a generator.

(3) Describe how an electric current occurs in the wire.

Part B Electricity-Generation and Transport

How Does a Power Station Work?

The heart of a power station is a large generator that extracts energy from the fuel. Some power stations burn fossil fuels such as coal, oil, or gas (Nuclear power stations produce energy by splitting apart atoms of heavy materials such as uranium).The heat produced is used to turn water into steam at high pressure in a boiler. This steam turns a windmill-like device called a turbine connected to an electricity generator where big magnets spin round and produce electric current in coils of wire[①]. After doing this, the steam is then piped to cooling towers, in which it condenses to water. The warm water flows from the cooling tower and returns to the boiler. In that way both water and fuel are saved.

Generating electricity does not always mean burning fuel. In a hydroelectric power station, the energy of rushing water is directed at a large vaned water turbine connected to an electricity generator. The water may be released from a large dammed reservoir to satisfy peak electricity demand during the year.

How Does Electricity Reach Homes?

From the generator, the electricity flows through the wires to a step-up transformer. The transformer raises the pressure of the electricity so it can travel long distances. Voltage is raised up as high as 400,000 volts in order to reduce line losses.

As the current travels through wires to the transmission lines, these high voltage lines can carry large amounts of electricity and send the power to a substation transformer. A substation lowers the pressure so the electricity can be used by the community.

From the substations, the current travels through cables beneath the streets. In country areas overhead wires may be used②. Electricity is transmitted long distances at a voltage higher than the voltage your appliances can use, the voltage would drop otherwise your appliances would not work properly. The electricity is then sent to a distribution substation transformer near your home, where it is stepped down in voltage to suitable value. You will also find regulator banked located along the line. They regulate the voltage on the line to prevent under-voltage and over-voltage conditions.

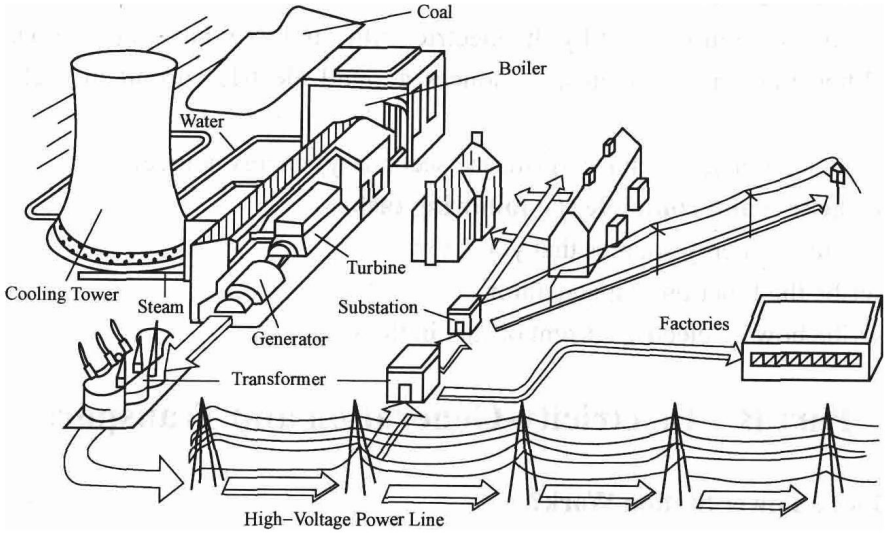


Fig.1.2 Electricity-Generation and Transport

New Words

turbine ['tɜ:bɪn] *n.* 涡轮机
hydroelectric [ˌhaɪdrəʊɪ'lektrɪk] *adj.* 水力发电的
boiler ['bɔɪlə] *n.* 锅炉；烧水器；水壶

condense [kən'dens] *vt. & vi.* （使）变稠或变浓；浓缩
transformer [træns'fɔ:mə] *n.* 变压器
cable ['keɪbl] *n.* 电缆
overhead ['əʊvəhed] *adj.* 离地面的；头顶上的；上空的，架空的
distribute [dɪs'trɪbju:t] *vt.* 分配
distribution n. 分配

Phrases and Expressions

power station= power plant 发电厂
cooling tower 冷却塔
water turbine 水轮机

Notes

① where big magnets spin round and produce electric current in coils of wire 是一个从句，修饰 generator；called a turbine 是过去分词短语作定语，修饰 device；connected to an electricity generator 是过去分词短语作定语，修饰 turbine，表示汽轮机与发电机相连。全句的意思是：蒸汽推动一个类似风车的设备旋转，我们称它为汽轮机，汽轮机与发电机相连，在发电机内部，通过磁极的旋转，在线圈中产生电能。

② 此句中，后面一句省略了 when the current travels，意思是：在农村地区，使用架空线路传输电能。全句的意思是：电能从变电站出来，通过街道下的电缆进行输送。在农村地区，也可以采用架空线路输送电能。

Suggested Activity

[Vocabulary Activity]

***Materials*:** A list of technical words in Part B (such as generator, turbine, boiler, transformer, cable and so on)

***Instructions*:**

1. Put students in pairs or groups of three.

2. Choose one student to describe the word（he or she should not tell the words）, then the partners write the correct spelling of it.

3. After a certain time (5~10 minutes depending on the numbers of the words) ask the teams to swap roles, so the person writing becomes the speaker.

Exercises

1. Translate the following words or phrases into English:

（1）燃料

（2）核电站
（3）调压器
（4）叶片
（5）线损
（6）变电站
（7）架空线路
（8）传输线

2. Read the text and complete the following tasks:

(1) Describe how the electricity goes to our house.

(2) List the power plants that you know.

(3) Name out the important equipment and describe their functions in the power plant.

(4) Describe the advantages and disadvantages of underground cables and overhead wires.

3. Fill in the blanks with suitable words or phases given below, changing the form where necessary:

step travel drop send high suit proper

From the substations, the current_____through cables beneath the streets. In country areas overhead wires may be used. Electricity is transmitted long distances at a voltage_____than the voltage your appliances can use, the voltage would_____otherwise your appliances would not work_____. The electricity is then_____to a distribution substation transformer near your home, where it is_____down in voltage to_____value.

Reading Material

Brief Introduction on Power Industry in China

1. History of Reform for Power Industry in China (see Table 1.1)

Table 1.1 History of Reform for Power Industry in China

1988	Dissolved the Ministry of Water Resources and Electric Power, the Ministry of Coal and the Ministry of Petroleum, and established the Ministry of Energy 撤消水利电力部、煤炭部和石油部，成立能源部
1993	Dissolved the Ministry of Energy and established the Ministry of Electric Power 撤消能源部，成立电力部
1997	Established the State Power Corporation 成立国家电力公司
1998	Dissolved the Ministry of Electricity 撤消电力部
2002	The State Council approved the reform program for the power system 国务院批准了电力体制改革 China power newly established (restructured) company was established 中国电力新组建（改组）公司正式挂牌
2003/02	The State Council approved the State Electricity Regulatory Commission 国务院批准了中国国家电力监管委员会
目前	The reform program for the power system is being carried out continuously 正在继续实施电力体制改革

2. Present Organisation Structure (see Table 1.2)

Table 1.2 Present Organisation Structure

两家电网公司 Two power grid companies	国家电网公司 State Grid Corporation of China 中国南方电网有限责任公司 South China Power Grid Co., Ltd.
五家全国性发电公司及其它独立发电企业 Five national generating companies and other independent generating enterprises	中国华能集团公司、中国大唐集团公司、中国华电集团公司、中国国电集团公司、中国电力投资集团公司以及其它地方、合资、外资发电企业 China Hua Neng (Group) Corporation, China Da Tang (Group) Corporation, China Hua Dian (Group) Corporation, China Guo Dian (Group) Corporation, China Electric Power Investment (Group) Corporation, and other local, jointed or foreign invested generating enterprises
非核心业务集团 None-core project groups	工程设计、咨询、施工 Design,consultancy and construction for projects groups
一个监管部门 One regulatory department	中国国家电力监管委员会 State Electricity Regulatory Commission

Alternating Current Principles

Part A Three-Phase System

A three-phase system has three voltages, each out of phase with the other two①. The ideal spread of these voltages occurs when the three phases are spread uniformly through the cycle. To achieve this, the phases must start one-third of a cycle apart, or 360°/3=120°E apart. Fig.2.1 illustrates three phases U, V and W starting at 120°E intervals. At 360°E, phase U is starting again and the sequence continues.

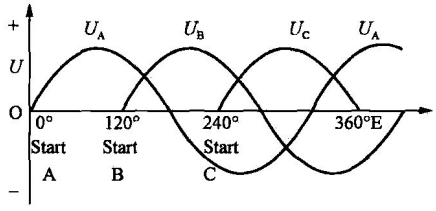


Fig.2.1 Three voltages at 120° phase displacement to one another

To show such a system as this by phasors, the three phasors must be shown 120° apart, as in Fig.2.2. The phasor of voltage $\dot{U}_U$ has been shown as the reference phasor, drawn horizontally to the right. If the phasor is rotated through 120° in a clock-wise direction, another phasor is in line with the reference axis. This second phasor must represent the voltage, which starts its cycle next after $\dot{U}_U$ (i.e. voltage $\dot{U}_V$). After another 120° rotation, phasor $\dot{U}_W$ is now in line with the reference axis.

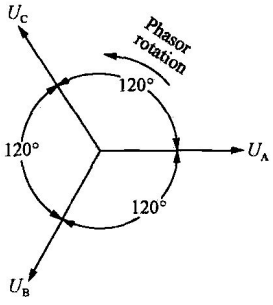


Fig.2.2 Phasor diagram for a three-phase system

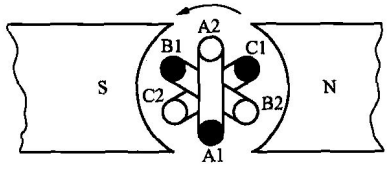


Fig.2.3 Elementary three-phase alternator

Generating a three-phase supply

A three-phase supply may be produced with three alternators locked together; more commonly, however, one machine contains three windings, as shown in Fig.2.3. The positions of the three coils correspond to the voltages at the left-hand end of the graph of Fig.2.1②. The corresponding coil sides of the windings in Fig.2.3 have been blocked in, and it can be seen that these are 120° apart.

Coil U is in the magnetic neutral plane and its voltage is zero. This corresponds with 0° in

Fig.2.1. Coil V is 120° behind coil U, and is approaching a maximum negative value of voltage under the south pole. Coil W is lagging a further 120° and is just leaving the position of maximum positive voltage—the centre of the north pole.

In some applications the letters U, V and W are used, while for general-purpose supply and distribution, the phases are given the colors coding yellow, green and red.

Advantages of a three-phase system

The advantages of a three-phase system are as follows:

1. The one size of machine can produce higher outputs as the number of phase increases. For example, for anyone machine frame the available output is:

Phases	Output
1	64 percent
2	90 percent
3	96 percent
n	100 percent

where n = infinite number of phases.

In economic terms, the three-phase system gives the biggest increase for the addition of only one extra conductor, when compared to a single-phase system. When compared to the two-phase system there is no extra conductor needed.

2. Another advantage is that the power delivered to or taken from a three-phase system is a more constant value③. In a single-system the power curve "pulses" at twice the line frequency. With three phases, the pulses are six times the line frequency and do not cross the zero axis like the single-phase system. Since the power is more constant, the torque of a rotating machine is more constant and this results in less vibration from the machine.

3. With one type of three-phase connection there are two voltages available—a selection can be made depending on the type of load.

4. A three-phase machine can be smaller than a single-phase one for the same power output.

5. In a distribution system the total quantity of material needed for three conductors is less than that required for the equivalent single-phase system.

New Words

voltage ['vəʊltɪdʒ] *n.* 电压，伏特数
phasor ['feɪzə] *n.* 相位复（数）矢量，相量
winding 绕组
coil 线圈
magnetic [mæg'netɪk] *adj.* 磁性的

conductor [kən'dʌktə] *n.* 导体
pulse [pʌls] *v.* 脉动
frequency ['fri:kwənsɪ] *n.* 频率
power 功率
torque [tɔ:k] *n.* 力矩
vibration [vaɪ'breɪʃən] *n.* 震动

Phrases and Expressions

three-phase system 三相制系统
reference phasor 参考相量
three-phase supply 三相电源
single-phase 单相
distribution system 配电系统

Notes

① 此句中，each out of phase with the other two 作状语，修饰全句。此句的意思是：三相制系统有三个电压，每相电压与其它两相电压不同相。

② 此句中，at the left-hand end of the graph of Fig.2.1 是介词短语作定语，修饰 the voltages。此句的意思是：三个线圈的位置与图 2. 1 中最左端的电压值相对应。

③ 此句中，delivered to or taken from a three-phase system 是过去分词短语作定语，修饰 the power。此句的意思是：另一个优点是三相制系统传输或接收的功率比单相制系统传输或接收的功率更稳定。

Suggested Activity

[Vocabulary Activity]

This type of activity is useful for helping students not only practice new vocabulary but also develop speaking and listening skills.

Time: 15~30 minutes

Materials: A list of vocabulary that has recently been introduced to, and used by the students.

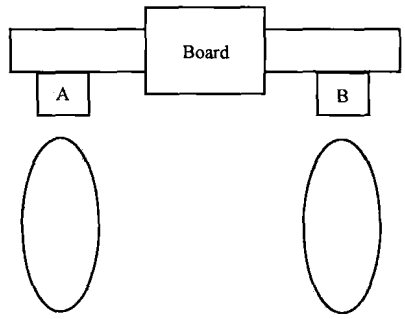
Instructions:

1. Ask the students to write down 5~8 new words that they have used in class this week. Tell them that they must know what these words mean!

2. Collect the words from your students and then break the class into two even teams; Team A and Team B.

3. Position two chairs in front of the board at either end, with their backs facing away

from the board. This is so a member of Team A and a member of Team B can sit in each chair facing the rest of the class, unable to see what is written on the board. Teamates face their seated members so that they are able to see what the teacher writes on the board.



4. Choose a word from one of your student's lists and write it on the board. Instruct teams that they must give hints about the word so that the seated member may guess what the word is.

Example: Atom

Teamates may say:

- "It's the smallest particle to which an element can be reduced."
- "It has a positively charged nucleus."
- "It is electrically neutral."

5. The first team member who identify the word correctly scores 1 point for their team.

6. When the word has been guessed both seated members get up and exchange with another member of their team.

7. Depending on how the students are enjoying this task, you can make it the first team to 10 or 20 points.

Exercises

1. Translate the following words or phrases into English:

(1) 三相制系统

(2) 单相制系统

(3) 电压相量

(4) 三相电源的连接

(5) 相序

(6) 磁场

(7) 导体

(8) 配电系统

2. Identify the following statements to be true or false according to the text:

(1) A three-phase system has three voltages, which usually have the same phase angle.

(2) The phasor of voltage $\dot{U}_U$ has been shown as the reference phasor, drawn vertically up.