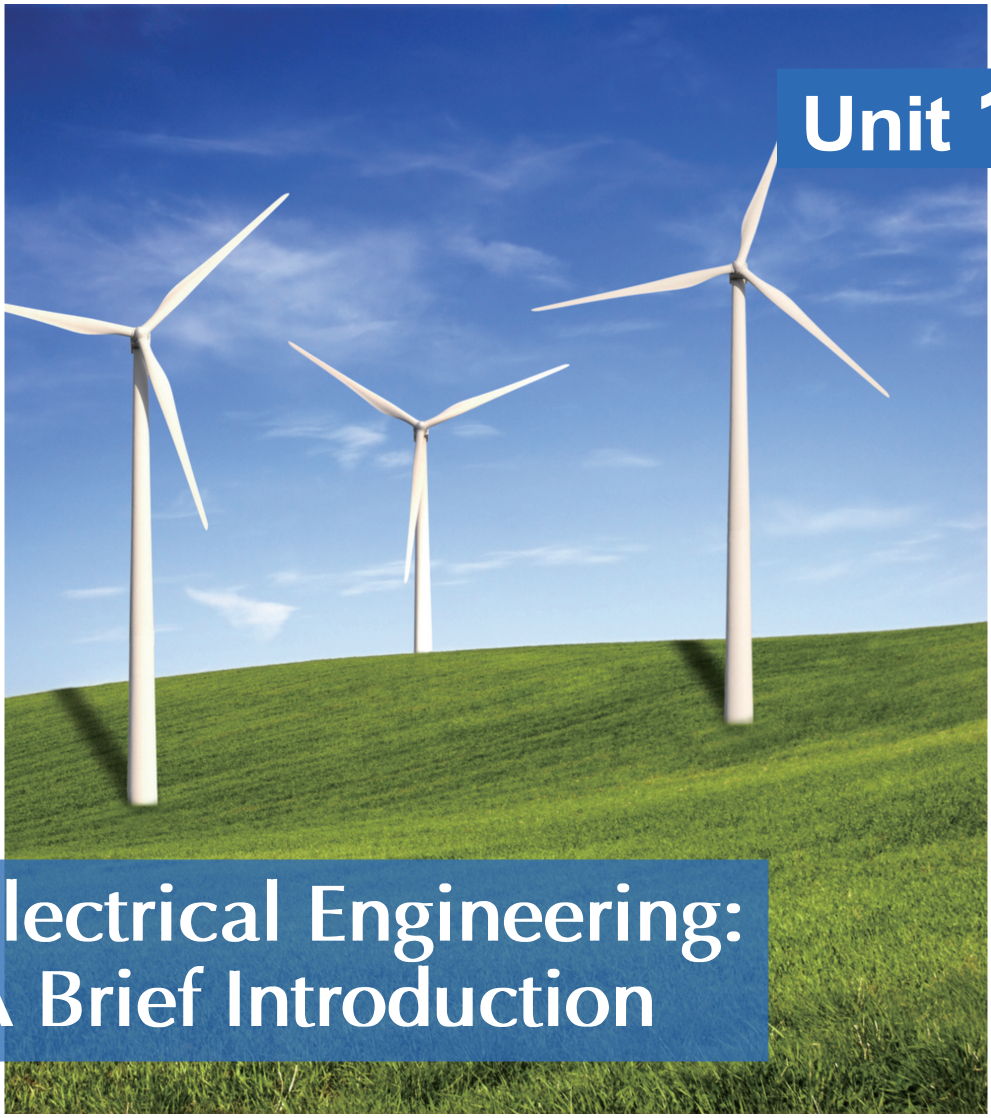


Unit 1

Electrical Engineering: A Brief Introduction

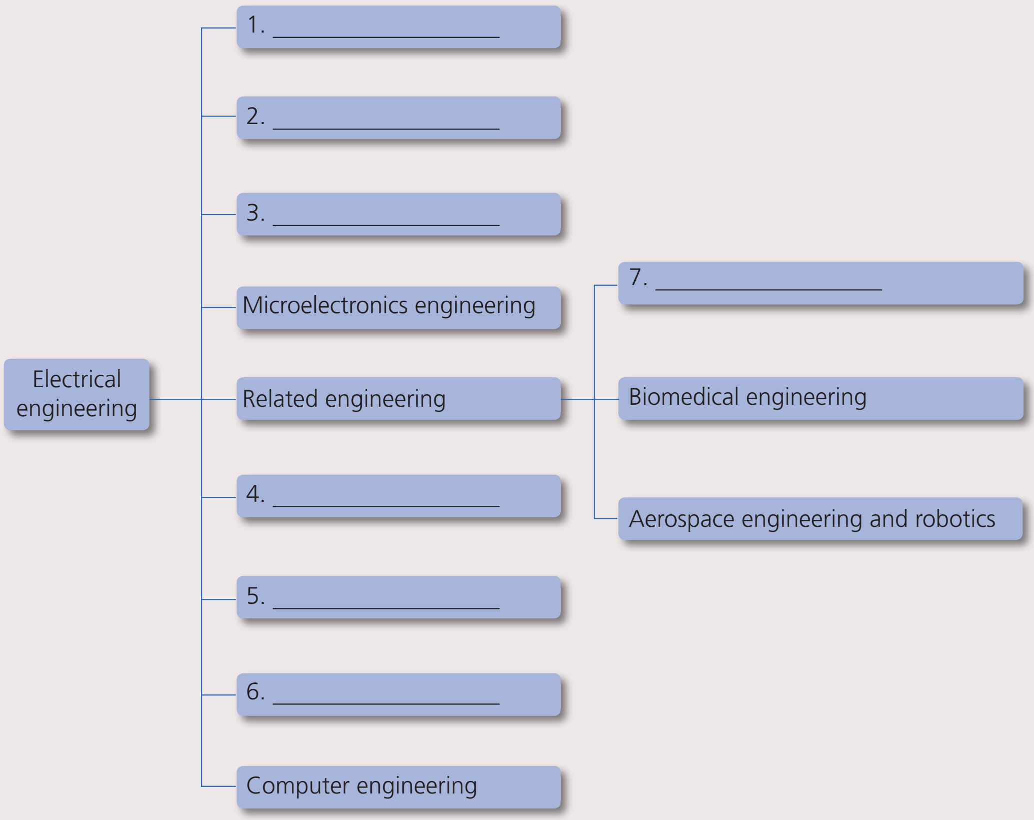
In this unit, you will learn:

- **Subject-related knowledge:** The definition of electrical engineering
  A brief history of electrical engineering
- **Academic skill:** Searching for information
- **Reading strategy:** Dealing with unknown words (Part I)

Section A

Pre-reading

1 Electrical engineering has many sub-disciplines, the most common of which are listed below. Work in groups and fill in the blanks.



2 Discuss the following questions with your partner.

1. What is electricity? What would your life be without electricity?
2. The applications of electrical engineering are very common in our daily life. List at least five of them.

What Is Electrical Engineering?

Text A

1 Electrical engineering is one of the newer branches of engineering, and dates back to the late 19th century. It is the branch of engineering that deals with the technology of electricity. Electrical engineers work on a wide range of components, devices and systems, from tiny microchips to huge power station generators.

2 Early experiments with electricity included primitive batteries and static charges. However, the actual design, construction and manufacturing of useful devices and systems began with the implementation of Michael Faraday's Law of Induction, which essentially states that the voltage in a circuit is proportional to the rate of change in the magnetic field through the circuit. This law applies to the basic principles of the electric generator, the electric motor and the transformer. The advent of the modern age is marked by the introduction of electricity to homes, businesses and industry, all of which were made possible by electrical engineers.

3 Some of the most prominent pioneers in electrical engineering include Thomas Edison (electric light bulb), George Westinghouse (alternating current, AC), Nikola Tesla (induction motor), Guglielmo Marconi (radio) and Philo T. Farnsworth (television). These innovators turned ideas and concepts about electricity into practical devices and systems that ushered in the modern age.

4 Since its early beginnings, the field of electrical engineering has grown and branched out into a number of specialized categories, including power generation and transmission systems, motors, batteries, digital computers and control systems. Electrical engineering also includes electronics, which

has itself branched into an even greater number of subcategories, such as radio frequency (RF) systems, telecommunications, remote sensing, signal processing, digital circuits, microelectronics, instrumentation, audio, video and optoelectronics.

5 The field of electronics was born with the invention of the thermionic valve diode vacuum tube in 1904 by John Ambrose Fleming. The vacuum tube basically acts as a current amplifier by outputting a multiple of its input current. It was the foundation of all electronics, including radios, television and radar, until the mid-20th century. It was largely supplanted by the transistor, which was developed in 1947 at AT&T's Bell Laboratories by William Shockley, John Bardeen and Walter Brattain, for which they received the 1956 Nobel Prize in physics.

What does an electrical engineer do?

6 "Electrical engineers design, develop, test and supervise the manufacturing of electrical equipment, such as electric motors, radar and navigation systems, communications systems and power generation equipment," states the U.S. Bureau of Labor Statistics (BLS). "Electronics engineers design and develop electronic equipment, such as broadcast and communications systems – from portable music players to global positioning systems (GPS)."

7 If it's a practical, real-world device that produces, conducts or uses electricity, in all likelihood, it was designed by an electrical engineer. Additionally, engineers may conduct or write the specifications for destructive or nondestructive testing of the performance, reliability and long-term durability of devices and components.

8 Today's electrical engineers design electrical devices and systems using basic components such as conductors, coils, magnets, batteries, switches, resistors, capacitors, inductors, diodes and transistors. Nearly all electrical and electronic devices, from the generators at an electric power plant to the microprocessors in your phone, use these few basic components.

9 Critical skills needed in electrical engineering include an in-depth understanding of electrical and electronic theory, mathematics and materials. This knowledge allows engineers to design circuits to perform specific functions and meet requirements for safety, reliability and energy efficiency, and to predict how they will behave, before a hardware design is implemented. Sometimes, though, circuits are constructed on "breadboards", or prototype circuit boards made on computer numeric controlled (CNC) machines for testing before they are put into production.

10 Electrical engineers are increasingly relying on computer-aided design (CAD) systems to create schematics and lay out circuits. They also use computers to simulate how electrical devices and systems will function. Computer

simulations can be used to model a national power grid or a microprocessor; therefore, proficiency with computers is essential for electrical engineers. In addition to speeding up the process of drafting schematics, printed circuit board (PCB) layouts and blueprints for electrical and electronic devices, CAD systems allow for quick and easy modifications of designs and rapid prototyping using CNC machines. A comprehensive list of necessary skills and abilities for electrical and electronics engineers can be found at MyMajors.com.

Electrical engineering jobs and salaries

11 Electrical and electronics engineers work primarily in research and development industries, engineering services firms, manufacturing and the federal government, according to the BLS. They generally work indoors, in offices, but they may have to visit sites to observe a problem or a piece of complex equipment, the BLS says.

12 Manufacturing industries that employ electrical engineers include automotive, marine, railroad, aerospace, defense, consumer electronics, commercial construction, lighting, computers and components, telecommunications and traffic control. Government institutions that employ electrical engineers include transportation departments, national laboratories and the military.

13 Most electrical engineering jobs require at least a bachelor's degree in engineering. Many employers, particularly those that offer engineering consulting services, also require state certification as a professional engineer. Additionally, many employers require certification from the Institute of Electrical and Electronics Engineers (IEEE) or the Institution of Engineering and Technology (IET). A master's degree is often required for promotion to management, and ongoing education and training are needed to keep up with advances in technology, testing equipment, computer hardware and software, and government regulations.

14 As of July 2014, the salary range for a newly graduated electrical engineer with a bachelor's degree is $55,570 to $73,908, according to Salary.com. The range for a mid-level engineer with a master's degree and five to 10 years of experience is $74,007 to $108,640, and the range for a senior engineer with a master's or doctorate and more than 15 years of experience is $97,434 to $138,296. Many experienced engineers with advanced degrees are promoted to management positions or start their own businesses where they can earn even more.

The future of electrical engineering

15 Employment of electrical and electronics engineers is projected to grow by 4% between now and 2022, because of these professionals' "versatility in developing and applying emerging technologies" as the BLS says.

16 The applications for these emerging technologies include studying red electrical flashes, called sprites, which hover above some thunderstorms. Victor Pasko, an electrical engineer at Penn State, and his colleagues have developed a model for how the strange lightning evolves and disappears.

17 Another electrical engineer, Andrea Alù, of the University of Texas at Austin, is studying sound waves and has developed a one-way sound machine. "I can listen to you, but you cannot detect me back; you cannot hear my presence." Alù told LiveScience in a 2014 article.

18 And Michel Maharbiz, an electrical engineer at the University of California, Berkeley, is exploring ways to communicate with the brain wirelessly.

19 The BLS states, "The rapid pace of technological innovation and development will likely drive demand for electrical and electronics engineers in research and development, an area in which engineering expertise will be needed to develop distribution systems related to new technologies."

New words and expressions

component /kəm'pəʊnənt/ *n.*
one of several parts that together make up a whole machine 零件

generator /'dʒenəreɪtə(r)/ *n.*
an engine that converts mechanical energy into electrical energy by electromagnetic induction 发电机

charge /tʃɑːdʒ/ *n.*
the amount of electricity that is put into a battery or carried by a substance 电荷；电量

implementation /ˌɪmplɪmen'teɪʃən/ *n.*
the act of accomplishing some aim or executing some order 履行；执行；实施

voltage /'vəʊltɪdʒ/ *n.*
electrical force measured in volts 电压；伏特数

circuit /'sɜːkɪt/ *n.*
the complete path of wires and equipment along which an electric circuit flows 电路

transformer /træns'fɔːmə(r)/ *n.*
a piece of electrical equipment which changes a voltage to a higher or lower voltage 变压器

advent /'ædvənt/ *n.*
the coming of an important event, person, invention, etc. 出现；到来

prominent /'prɒmɪnənt/ *adj.*
conspicuous in position and importance 显著的；突出的；著名的

AC abbr. (alternating current) 直流电

usher /'ʌʃə(r)/ *vt.*
to cause sth. new to start, or to be at the start of sth. new 宣告；开创

transmission /trænz'mɪʃən/ *n.* 传输

instrumentation /ˌɪnstrʊmen'teɪʃən/ *n.*
the set of instruments used to help in controlling a machine 使用仪器；仪器仪表

optoelectronics /'ɒptəʊɪˌlek'trɒnɪks/ *n.*
光电子学

thermionic /ˌθɜːmɪ'ɒnɪk/ *adj.*
热电子的；热离子的

valve /vælv/ *n.*
a closed glass tube used to control the flow of electricity in old radios, television, etc. 电子管；真空管

diode /'daɪəʊd/ *n.*
an electric device in which the electric current passes in one direction only （电子）二极管

vacuum /'vækjuəm/ *n.*
a space that is completely empty of all gas, especially one from which all the air has been taken away 真空

current /'kʌrənt/ *n.*
a flow of electricity through a conductor 电流

supplant /sə'plɑːnt/ *vt.*
to take the place of, or move into the position of 代替；取代；把……排挤掉

transistor /træn'sɪstə(r)/ *n.*
a semiconductor device capable of controlling the flow of electricity 晶体管

capacitor /kə'pæsɪtə(r)/ *n.*
an electrical device characterized by its capacity to store an electric charge 电容器

inductor /ɪn'dʌktə(r)/ *n.*
an electrical device (typically a conducting coil) that introduces inductance into a circuit 感应器

prototype /ˈprəʊtəʊtaɪp/ *n.*
a standard or typical example 原型；蓝本

numeric /njuːˈmerɪk/ *adj.*
measured or expressed in numbers 数字的；数值的

schematic /skɪˈmætɪk/ *n.* 图表；电路图

simulate /ˈsɪmjʊleɪt/ *vt.*
to create a representation or model, or reproduce someone's behavior or looks 模拟；模仿

amplifier /ˈæmplɪfaɪə(r)/ *n.*
electronic equipment that increases the strength of signals passing through it 放大器

grid /grɪd/ *n.*
a system of high tension cables by which electrical power is distributed throughout a region 输电网

prototyping /ˌprəʊtəʊˈtaɪpɪŋ/ *n.*
样机（原型机）制造；样机研究；原型机设计

versatility /ˌvɜːsəˈtɪlətɪ/ *n.*
having a wide variety of skills 多用途；多才多艺

emerging /ɪˈmɜːdʒɪŋ/ *adj.*
coming into existence 新兴的

hover /ˈhɒvə(r)/ *vi.*
to hang in the air, or to move to and fro 盘旋；徘徊

expertise /ˌekspɜːˈtiːz/ *n.*
special skill or knowledge that is acquired by training, study or practice 专门知识或技能

distribution /ˌdɪstrɪˈbjuːʃən/ *n.*
the act of distributing or spreading or apportioning 分配；分布

branch out (into) 涉足；拓展

lay out 展示；设计；安排

Reading comprehension

Fill in the blanks based on the information from Text A with the help of the initial letters given and figure out the paragraphs.

1. Electrical engineering is about the technology of e___________ which dates back to the late 19th century. (Para. ___)
2. Law of Induction, written by Michael Faraday, states that the v___________ in a circuit is proportional to the rate of change in the magnetic field through the circuit. (Para. ___)
3. Electrical engineering has itself branched into an even greater number of subcategories, such as r___________ frequency (RF) systems, telecommunications, remote sensing, signal processing and digital circuits. (Para. ___)
4. It was the invention of the v___________ tube that made electronics widespread and practical in the first half of the 20th century. (Para. ___)
5. The t___________, an IEEE milestone, revolutionized the field of electronics and paved the way for smaller and cheaper radios, calculators and computers. (Para. ___)

Language focus

1 Match the items in Column A with appropriate items in Column B to make fixed phrases in the field of electrical engineering and translate them into Chinese in Column C. Then fill in the blanks of the following sentences with these fixed phrases.

Column A	Column B	Column C
___ 1. electric	A. system	____________
___ 2. static	B. processing	____________
___ 3. current	C. generator	____________
___ 4. transmission	D. charge	____________
___ 5. signal	E. field	____________
___ 6. magnetic	F. amplifier	____________

1. The electricity that is collected on insulators is called ___________ because the electricity is at rest.
2. The technology of detecting weak ___________ represents the highest level of today's magnetic measurement.
3. A(n) ___________ is usually driven by a steam turbine (涡轮机), and this is how most electricity is produced today.
4. A method and apparatus (装置) for ___________ which enables data compression and recovery with high transmission efficiency is disclosed.
5. A control circuit which is composed of a capacitor and a ___________ is connected in a coil circuit in series.
6. The faults of HVDC power ___________ make the electrical characteristics of AC system more complex.

2 Figure out the exact meanings of words in bold in the following groups of sentences, and pay attention to their exact meanings in specialized subject areas.

1. circuit

1) During the car racing, the two cars finished up in a run-off area, clear of

the **circuit**, and that was a mercy. ____________

2) There is an internal **circuit** breaker to protect the instrument from overload. ____________

3) It is a common problem, the one I'm asked about most when I'm on the lecture **circuit**. ____________

2. generator

1) Wicked environment and exceeding use has high requirements to corrosion protection of the wind power **generator** set. ____________

2) The results and analysis in this paper provide useful basis for the design and running of once-through steam **generator**. ____________

3) Among the top 10 electric power companies in China, State Grid Corporation of China is the largest electricity **generator**. ____________

3. versatility

1) Its **versatility**, flexibility, and wide range of implementations and environments make it difficult to describe procedures to cover all cases. ____________

2) **Versatility** is another of your strong points, but don't overdo it by having too many irons in the fire. ____________

4. branch

1) After the storm last week there were **branches** and twigs all over the ground along the streets of the old town. ____________

2) Electrical engineering is a **branch** of engineering science that studies the uses of electricity and the equipment for power generation and distribution and the control of machines and communication. ____________

3) Coincident with the talks, Industrial & Commercial Bank was permitted to open a **branch** in another country. ____________

3 Fill the blanks with the words and phrases below. Change the form if necessary. Each word or phrase can be used only once.

optoelectronics **advent** **branch out** **simulate**
instrumentation **supplant** **schematics** **lay out**

1. With the ____________ of cloud computing we quickly realized that this metered resource usage had another important management perspective – costing.

2. The field of electrical engineering has ___________ into many specialized categories, such as power generation and transmission systems, batteries, digital computers and control systems.
3. The development of microcomputers and automatic technologies has greatly promoted the intelligent functions and automatization of industrial ___________.
4. You can bypass this limitation by using the techniques to ___________ responsive communication between the server and client.
5. If, in the next century, electronic markets begin to ___________ companies as the organizing force behind economic exchange, we will confront these dilemmas anew.
6. When we ___________ the power supply system of the town, we reckoned on one transformer per four blocks.
7. Subjects of the study include Ohm's law (欧姆定律), reading electrical ___________, using test equipment, as well as the maintenance and troubleshooting of electrical equipment.
8. Microelectronics (微电子学), ___________ and photonics play an important role in the modern optical communication and optical sensor (传感器) industry.

4 Translate the following paragraph into English.

电气工程是现代科技领域中的核心学科之一。电气工程的发达程度代表着国家的科技进步水平，因此电气工程的教育和科研一直在发达国家的大学中占据十分重要的地位。电力是发展生产和提高人类生活水平的重要物质基础，电力的应用在不断深化和发展。就目前国际水平而言，在今后相当长的时期内，电力的需求将不断增长，社会对电气工程及其自动化科技工作者的需求将呈上升态势。

Critical thinking

1 Transistors were invented in New Jersey in 1947. The invention was the culmination of a long-running effort to develop a viable alternative to the vacuum tube using semiconductor (半导体) technology. What is a transistor? Compared to vacuum tubes, what are the advantages of transistors?

2 Work in groups to discuss what the life is likely to be in the future with the rapid development of electrical engineering and its automation, and then each group gives a short report to the class.

Research task

Academic skill: Searching for information

Information can come from virtually anywhere – media, blogs, personal experiences, books, journal and magazine articles, expert opinions, encyclopedias, and web pages, etc.

1. Types of information

Type	Use
Magazine	• To find information or opinions about popular culture. • To find up-to-date information about current events. • To find non-scholarly articles about topics of interest within the subject of the magazine.
Academic journal	• To get help for your scholarly research. • To find out what has been studied on your topic. • To find bibliographies that point to other relevant research.
Database	• To find articles on specific topics. • To find online journals or news articles.
Newspaper	• To find editorials, commentaries, expert or popular opinions. • To find current local, national or world news.
Library catalog	• To find virtually any topic. • To find hard copies of current or back issue of journals, books, newspapers or magazines.
Website	• To find information from all levels of government – central to local. • To find expert or popular opinions. • To find information of various types of media, e.g. illustrations, audio and video information.

2. Searching for information

Author / Title search

Searching by author and / or title obviously assumes that you are searching for a particular author, book or article, probably in either a database or a library catalog. Here are some tips:

- When searching by author, put the author's last name first, e.g. "Kotler, Philip", not "Philip Kotler", if he is from an English-speaking country. Search the author's full name in Chinese order if he is a Chinese. Sometimes, the author could be an organization, so give the full name of the organization as it commonly appears, e.g. "World Bank".

- When searching by title, it helps if you enter the title as correctly as possible.

Keyword search

It is basically a way of searching through subject or topic. Most library catalogs and databases will include an option to search by keyword as an alternative to author and title. The first step of keyword search is to decide the key word(s) or phrase(s). Normally, the word(s) or phrase(s) which can cover the topic you search can be selected as keyword(s). A good research topic usually contains two or three concepts. For example, you need to write a paper on "The Impact of Cognitive Styles on Design Students' Spatial Knowledge". We can break the topic into concepts, like "cognitive styles" and "spatial knowledge", which can be used as keywords. Then type them in a search bar in a database, EBSCOhost for instance. In a database, there are usually two ways of search, i.e. basic search and advanced search.

Basic search (see Fig. 1) generates a large number of sources for you to differentiate, which is an exhausting task. But advanced search (see Fig. 2), which provides more choices for further conditioning, can make the work lighter. There are many variables that can be chosen to refine the search. And you can define the relationship between the keywords by choosing "and", "or" or "not" based on the results you intend to obtain.

Fig. 1 Basic search

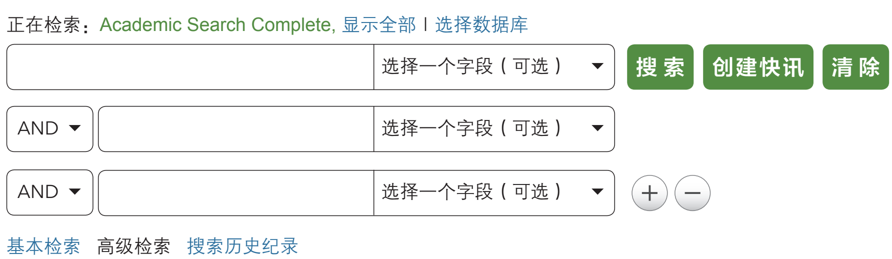


Fig. 2 Advanced search

As "cognitive styles" is a broader topic and "spatial knowledge" is more specific, they can be typed in the upper and middle search bars respectively. More relevant results will appear. You can then refine the search by selecting a specific variable. In this case, “subject” (主题语) can be chosen to filter the results (See Fig. 3).

Fig. 3

Snowball search

It is a good way if your topic has a key work or author. You can trace the citations of that author using a specialized citation database, such as the Social Science Citation Index to obtain other key works or authors. You will follow the stream of research up to the near present and see the way in which the work or the author has influenced the subsequent studies.

3. Evaluating information

Once you have found information that satisfies the requirements of your research, you should evaluate it. Evaluating information encourages you to think critically about the reliability, validity, accuracy, authority, timeliness, point of view or bias of information.

When evaluating information, you can use the five criteria AAOCC, namely, Authority, Accuracy, Objectivity, Currency and Coverage. They can be applied to check all information.

1) Authority of information
   - Who published it?
   - What institution published it?
   - Does the publisher list his or her qualifications?
2) Accuracy of information
   - Who provided it, and can you contact him or her?
   - Does it provide enough details?
   - Has it been cited correctly?

3) Objectivity of information
   - What is the purpose of it, or why was it published?
   - Is it biased?
   - What opinions (if any) are expressed by the author?
4) Currency of information
   - When was it published?
   - When was it updated?
   - How up-to-date is it?
5) Coverage of information
   - Do citations in it complement the research?
   - Is it all text or a balance of text and image?
   - Is it free or is there a fee to obtain it?

Task

Now you know what electrical engineering is and what an electrical engineer does. Work in groups and search some information on the **electrical supply system of high-speed rail.** Evaluate the information using the AAOCC criteria. Then write down where, how and what you have found and share them in groups.

	Where did you search?	How did you search?	What have you found?
1			
2			
3			

Section B

Reading strategy

Dealing with unknown words (Part I)

The ability to deal with unknown words is a key reading skill in the reading process. It is a vital skill because you are almost certain to find unknown or unfamiliar words in any text. The skill is not necessarily to "know" the words, but to guess the meaning of them so that you can read and understand the whole text. Here are several different ways that can help you guess the meaning of an unknown word.

Guessing by explanation

Sometimes, you will find that the meaning of an unfamiliar word is given to you in the text. In this case, what you need to do is do not stop at the moment you find an unfamiliar word and keep on reading. Typically, you can get the meaning from a phrase immediately after the unfamiliar word. For example:

> *The Intel 4004 was a four-bit processor released in 1971, but in 1973 the Intel 8080, an eight-bit processor, made the first personal computer, the Altair 8800, possible.*

Here you should understand that meaning of "Intel 8080" by reading following "an eight-bit processor".

Guessing by synonyms and antonyms

This is a very useful skill to learn. What you should do here is look at other words which relate to that word and work out what it may mean. These words may be either synonyms (words with a similar meaning) or antonyms (words with an opposite meaning). For example:

> *Victor Pasko, an electrical engineer at Penn State, and his colleagues have developed a model for how the strange lightning evolves and disappears.*

Here you can work out the meaning of "evolve" by antonym "disappear". All you need to do is to read the rest part of the sentence and think of the meaning of it.

Guessing by common sense and experience

Sometimes, when you come across an unknown word, besides guessing it, you can also ignore the word, especially when the word starts with a capital letter or is in italics, which means that it is in all probability a proper name or a loanword. In this case, you should waste no time in trying to understand the exact meaning of the word. For example:

> *"Electrical engineers design, develop, test and supervise the manufacturing of electrical equipment, such as electric motors, radar and navigation systems, communications systems and power generation equipment," states the U.S. Bureau of Labor Statistics (BLS).*

Here the word "bureau" is a word that you should learn to ignore because it starts with a capital letter and is therefore a word may not influence the overall meaning of the sentence.

Task

Read Text B and apply the skills above to deal with the underlined words.

Text B

A Brief History of Electrical Engineering

1 Electricity has been a subject of scientific interest since at least the early 17th century. A prominent early electrical scientist was William Gilbert who was the first to draw a clear distinction between magnetism and static electricity and is credited with establishing the term electricity. He also designed the versorium: a device that detected the presence of statically charged objects. Then in 1762 Swedish professor Johan Carl Wilcke invented, and in 1775 Alessandro Volta improved, a device (for which Volta coined the name electrophorus) that produced a static electric charge, and by 1800 Volta had developed the voltaic pile, a forerunner of the electric battery.

2 In the 19th century, research into the subject started to intensify. Notable developments in this century include the work of Georg Ohm, who in 1827 quantified the relationship between the electric current and potential difference in a conductor, of Michael Faraday, the discoverer of electromagnetic induction in 1831, and of James Clerk Maxwell, who in 1873 published a unified theory of electricity and magnetism in his treatise *Electricity and Magnetism*.

3 Electrical engineering became a profession in the later 19th century. Practitioners had created a global electric telegraph network and the first professional electrical engineering institutions were founded in the U.K. and U.S.A. to support the new discipline. Although it is impossible to precisely pinpoint a first electrical engineer, Francis Ronalds stands ahead of the field, who created the first working electric telegraph system in 1816 and documented his vision of how the world could be transformed by electricity.

electromagnetic *adj.* 电磁的

Over 50 years later, he joined the new Society of Telegraph Engineers (soon to be renamed the Institution of Electrical Engineers) where he was regarded by other members as the first of their cohort. By the end of the 19th century, the world had been forever changed by the rapid communication made possible by the engineering development of land-lines, submarine cables, and, from about 1890, wireless telegraphy.

4 Practical applications and advances in such fields created an increasing need for standardized units of measure. They led to the international standardization of the units of volt, ampere, coulomb, ohm, farad, and henry. This was achieved at an international conference in Chicago in 1893. The publication of these standards formed the basis of future advances in standardization in various industries, and in many countries the definitions were immediately recognized in relevant legislation.

5 During these years, the study of electricity was largely considered to be a subfield of physics. That's because early electrical technology was electromechanical in nature. The Technische Universität Darmstadt founded the world's first department of electrical engineering in 1882. The first electrical engineering degree program was started at Massachusetts Institute of Technology (MIT) in the physics department under Professor Charles Cross, though it was Cornell University to produce the world's first electrical engineering graduates in 1885. The first course in electrical engineering was taught in 1883 in Cornell's Sibley College of Mechanical Engineering and Mechanic Arts. It was not until about 1885 that Cornell President Andrew Dickson White established the first Department of Electrical Engineering in the United States. In the same year, University College London founded the first chair of electrical engineering in Great Britain. Professor Mendell P. Weinbach at University of Missouri soon followed suit by establishing the electrical engineering department in 1886. Afterwards, universities and institutes of technology gradually started to offer electrical engineering programs to their students all over the world.

6 During these decades, the use of electrical engineering increased dramatically. In 1882, Thomas Edison switched on the world's first large-scale electric power network that provided 110 volts – direct current (DC) – to 59 customers on Manhattan Island in New York City. In 1884, Sir Charles Parsons invented the steam turbine allowing for more efficient electric power generation. Alternating current with its ability to transmit power more efficiently over long distances via the use of transformers, developed rapidly in the 1880s and 1890s with transformer designs by Károly Zipernowsky, Ottó Bláthy and Miksa Déri (later called ZBD transformers), Lucien Gaulard, John Dixon Gibbs and William Stanley, Jr. Practical AC motor designs including induction motors were independently invented by Galileo Ferraris and Nikola Tesla and further developed into a practical three-phase form by Mikhail Dolivo-Dobrovolsky and Charles Eugene Lancelot Brown. Charles Steinmetz and Oliver Heaviside contributed to the theoretical basis of alternating current engineering. The spread in the use of AC set off in the United States, which has been called the "War of Currents" between a George Westinghouse backed AC system and a Thomas Edison backed DC power system, with AC being adopted as the overall standard.

7 During the development of radio, many scientists and inventors contributed to radio technology and electronics. The mathematical work of James Clerk Maxwell during the 1850s had shown the relationship of different forms of electromagnetic radiation including possibility of invisible airborne waves (later called "radio waves"). In his classic physics experiments of 1888, Heinrich Hertz proved Maxwell's theory by transmitting radio waves with a spark-gap transmitter, and detected them by using simple electrical devices. Other physicists experimented with these new waves and in the process developed devices for transmitting and detecting them. In 1895, Guglielmo Marconi began work on a way to adapt the known methods of transmitting and detecting these

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DC *abbr.* (direct current) 直流电
power system 电力系统

"Hertzian waves" into a purpose-built commercial wireless telegraphic system. Early on, he sent wireless signals over a distance of one and a half miles. In December 1901, he sent wireless waves that were not affected by the curvature of the Earth. Marconi later transmitted the wireless signals across the Atlantic between Poldhu, Cornwall, and St. John's, Newfoundland, a distance of 2,100 miles (3,400 km).

8 In 1897, Karl Ferdinand Braun introduced the cathode ray tube as part of an oscilloscope, a crucial enabling technology for electronic television. John Fleming invented the first radio tube, the diode, in 1904. Two years later, Robert von Lieben and Lee De Forest independently developed the amplifier tube, called the triode.

9 In 1920, Albert Hull developed the magnetron which would eventually lead to the development of the microwave oven in 1946 by Percy Spencer. In 1934, the British military began to make strides toward radar (which also uses the magnetron) under the direction of Dr. Wimperis, culminating in the operation of the first radar station at Bawdsey in August 1936.

10 In 1941, Konrad Zuse presented the Z3, the world's first fully functional and programmable computer using electromechanical parts. In 1943, Tommy Flowers designed and built the Colossus, the world's first fully functional, electronic, digital and programmable computer. In 1946, the ENIAC (Electronic Numerical Integrator and Computer) of John Presper Eckert and John Mauchly followed, beginning the computing era. The arithmetic performance of these machines allowed engineers to develop completely new technologies and achieve new objectives, including the Apollo program which culminated in landing astronauts on the Moon.

cathode *n.* 负极
enabling technology 促成技术

11 The invention of the transistor in late 1947 by William B. Shockley, John Bardeen, and Walter Brattain of the Bell Telephone Laboratories opened the door for more compact devices and led to the development of the integrated circuit in 1958 by Jack Kilby and independently in 1959 by Robert Noyce. Starting in 1968, Ted Hoff and a team at the Intel Corporation invented the first commercial microprocessor, which foreshadowed the personal computer. The Intel 4004 was a four-bit processor released in 1971, but in 1973 the Intel 8080, an eight-bit processor, made the first personal computer, the Altair 8800, possible.