МИНИСТЕРСТВО СЕЛЬСКОГО ХОЗЯЙСТВА РОССИЙСКОЙ ФЕДЕРАЦИИ
ДЕПАРТАМЕНТ НАУЧНО-ТЕХНОЛОГИЧЕСКОЙ ПОЛИТИКИ И ОБРАЗОВАНИЯ

ФЕДЕРАЛЬНОЕ ГОСУДАРСТВЕННОЕ БЮДЖЕТНОЕ ОБРАЗОВАТЕЛЬНОЕ
УЧРЕЖДЕНИЕ ВЫСШЕГО ОБРАЗОВАНИЯ
«ДОНСКОЙ ГОСУДАРСТВЕННЫЙ АГРАРНЫЙ УНИВЕРСИТЕТ»
(ФГБОУ ВО Донской ГАУ)

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ФЕДЕРАЛЬНОГО ГОСУДАРСТВЕННОГО БЮДЖЕТНОГО ОБРАЗОВАТЕЛЬНОГО
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Кафедра гуманитарных дисциплин
и иностранных языков

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ENGLISH FOR STUDENTS OF ENERGY SPECIALTIES

Учебно-методическое пособие по английскому языку
для студентов энергетических специальностей

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INTRODUCTION (ВВЕДЕНИЕ)

Целью настоящего учебного пособия является развитие у студентов коммуникативной компетенции, достаточной для осуществления общения в соответствии с программой обучения, а так же обеспечение развития умений и навыков эффективной работы с текстами профессиональной направленности на английском языке.

При разработке системы заданий в основу положен принцип интегративности обучения иностранному языку, предполагающий комплексную тематическую организацию учебного материала для взаимосвязанного обучения всем видам речевой деятельности. Выполнение ряда упражнений предполагает развитие навыков говорения на профессиональные темы, что, безусловно, поможет проводить обоснование тех или иных предлагаемых проектных решений в области энергетики и электротехники на английском языке.

Каждый из разделов содержит необходимый лексический минимум по теме, аутентичные тексты профессиональной направленности, упражнения, часть которых выполняется во время чтения, а часть – на послетекстовом этапе. Выбор тем коммуникации обуславливается возможностью формирования навыков и умений, лежащих в основе развития навыков профессионально ориентированного иноязычного общения.

Раздел Supplementary reading направлен на развитие навыков чтения, обогащения словарного запаса и переводческих навыков студентов.

ELECTRICITY

Vocabulary:

property	свойство
network	сеть
consumption	потребление
indicator	показатель
improved	улучшенный
reduced	уменьшенный
advantage	преимущество
beam	луч
transmission shaft	трансмиссионный вал
gearwheel	зубчатое колесо
belt	ремень
pulley	блок, барабан
labor saving appliance	электроприбор, экономящий труд
induction motor	асинхронный двигатель
per capita	на человека
by-product	побочный продукт
truly	поистине

I. Read and translate the text below.

It is impossible to imagine our civilization without electricity: economic and social progress will be turned to the past and our daily lives completely transformed.

Electrical power has become universal. Thousands of applications of electricity such as lighting, electrochemistry and electrometallurgy are longstanding and unquestionable.

With the appearance of the electrical motor, power cables replaced transmission such things as shafts, gear wheels, belts and pulleys in the 19-th century workshops. And in the home a whole range of various time and labor saving appliances have become a part of our everyday lives.

Other devices are based on specific properties of electricity: electrostatics in the case of photocopying machine and electromagnetism in the case of radar and television. These applications have made electricity most widely used. The first industrial application was in the silver workshops in Paris. The generator – a new compact source of electricity – was also developed there. The generator replaced the batteries and other devices that had been used before.

Electric lighting came into wide use at the end of the last century with the development of the electric lamp by Thomas Edison. Then the transformer was invented, the first electric lines and networks were set up, dynamos and induction motors were designed.

Since the beginning of the 20-th century the successful development of electricity has begun throughout the industrial world. The consumption of electricity has doubled every ten years.

Today consumption of electricity per capita is an indicator of the state of development and economic health of a nation. Electricity has replaced other sources of energy as it has been realized that it offers improved service and reduced cost.

One of the greatest advantages of electricity is that it is clean, easily regulated and generates no by-products. Applications of electricity now cover all fields of human activity from house washing machines to the latest laser devices. Electricity is the efficient source of some of the most recent technological advances such as the laser and electron beams. Truly electricity provides mankind with the energy of the future.

II. Answer the questions on the text.

1. What industrial applications of electricity do you know?
2. What home applications of electricity do you know?
3. Where was the generator developed?
4. Who invented the electric lamp?
5. Do you know who invented the dynamo?
6. Can you imagine our life without electricity? Why?

Make up dialogues on the following topics:

a) important inventions in the field of electrical engineering;
b) areas of application of electricity in the national economy and human life;
c) importance of the invention of electricity.

HISTORY OF ELECTRICITY

Vocabulary:

to give vent to smth	давать выход чему-либо
to set the ball rolling	начать новую страницу
to credit smb with smth	называть кого-либо кем-либо
to dawn on smb	осенять кого-либо
to win a day	одержать победу
on the spur of the	экспромтом
to become all the rage	стать очень модными
voltaic pile	гальваническая батарея
now and then	время от времени
to begin to tackle smth	взяться за решение чего-либо
with the systematic energy	со всей серьёзностью
to slump	упасть в цене
to stake smth	рискнуть чем-либо
to throw a switch	включить рубильник
to come to stay	получить признание
squirrel-cage motor	короткозамкнутый двигатель
a great deal	значительно
to have smb's eyes on smth	обратиться к чему-либо
to be very much "in the air"	давно витать в воздухе
to appeal most	нравиться больше всего
bucket-shaped blade	ковшеобразная лопасть
by overhead cable	по воздушному кабелю
to step down	понижаться
diehard	консерватор
a good deal of justification	большие основания
to catch on	привиться
to gain ground	шагнуть вперёд
by no means	ни в коей мере
to outstay welcome	устаревать
as long ago as	ещё в какое-либо время
to work "cold"	не нагреваться во время работы
would-be	мечтающий сделать что-либо
to raise funds	извлечь выгоду

I. Read and translate the text below.

There is electricity everywhere in the world. It is present in the atom, whose particles are held together by its forces; it reaches us from the most distant parts of the universe in the form of electro-magnetic waves. Yet we have no organs that

could recognize it as we see light, hear sound. We have to make it visible, tangible or audible; we have to make it perform work to become aware of its presence. There is only one natural phenomenon which demonstrates it unmistakably to our senses of seeing and hearing – thunder and lightning; but we recognize only the effects – not the force which causes them.

Small wonder, then, that Man lived for ages on this earth without knowing anything about electricity. He tried to explain the phenomenon of the thunderstorm to himself by imagining that some gods or other supernatural creatures were giving vent to their heavenly anger, or were fighting battles in the sky. Thunderstorms frightened our primitive ancestors; they should have been grateful to them instead because lightning gave them their first fires, and thus opened to them the road to civilization. It is a fascinating question how differently life on earth would have developed if we had an organ for electricity.

We cannot blame the ancient Greeks for failing to recognize that the force which causes a thunderstorm is the same which they observed when rubbing a piece of amber: it attracted straw, feathers, and other light materials. Thales of Miletus, the Greek philosopher who lived about 600 BC, was the first who noticed this. The Greek word for amber is “electron”, and therefore Thales called that mysterious force electric. For a long time it was thought to be of the same nature as the magnetic power of the lodestone since the effect of attraction seems similar, and in fact there are many links between electricity and magnetism.

There is just a chance, although a somewhat remote one, that the ancient Jews knew something of the secret of electricity. Perhaps the Israelites did know something about electricity; this theory is supported by the fact that the Temple at Jerusalem had metal rods on the roof which must have acted as lightning-conductors. In fact, during the thousand years of its existence it was never struck by lightning although thunderstorms abound in Palestine.

There is no other evidence that electricity was put to any use at all in antiquity, except that the Greek women decorated their spinning-wheels with pieces of amber: as the woolen threads rubbed against the amber it first attracted and then repelled them – a pretty little spectacle which relieved the boredom of spinning.

More than two thousand years passed after Thales’s discovery without any research work being done in this field. It was Dr. William Gilbert, Elizabeth the First’s physician-in-ordinary, who set the ball rolling. He experimented with amber and lodestone and found the essential difference between electric and magnetic attraction. For substances which behaved like amber – such as glass, sculpture, and sealing wax – he coined the term “electrica”, and for the phenomenon as such the word “electricity”. In his famous work “De magnete”, published in 1666, he gave an account of his studies. Although some sources credit him with the invention of the first electric machine, this was a later achievement by Otto von Guericke, inventor of the air pump. Von Guericke’s electric machine consisted of large, disc spinning between brushes; this made sparks leap across a gap between two metal balls. It became a favorite toy in polite society but nothing more than that. In 1700, an Englishman by the name of Francis Hawksbee produced the first electric light:

he exhausted a glass bulb by means of a vacuum pump and rotated it at high speed while rubbing it with his hand until it emitted faint glow of light.

A major advance was the invention of the first electrical condenser, now called the Leyden jar, by a Dutch scientist, a water-filled glass bottle coated inside and out with metallic surfaces, separated by the non-conducting glass; a metal rod with a knob at the top reached down into the water. When charged by an electric machine it stored enough electricity to give anyone who touched the knob a powerful shock. More and more scientists took up electric research. A Russian scientist Professor Reichmann from St. Petersburg was killed when he worked on the same problem.

Benjamin Franklin, born in Boston, was the fifteenth child of poor soap boiler from England. He was well over 30 when he looked up the study of natural phenomena. "We had for some time been of opinion, that the electrical fire was not created by friction, but collected, being really an element diffused among, and attracted by other matter, particularly by water and metals", – wrote Franklin in 1747. Here was at last a plausible theory of the nature of electricity, namely, that it was some kind of "fluid". It dawned on him, that thunderstorms were merely a discharge of electricity between two objects with different.

He saw that the discharging spark, the lightning, tended to strike high buildings and trees, which gave him an idea of trying to attract the electrical "fluid" deliberately to the earth in a way that the discharge would do no harm.

In order to work this idea out he undertook his famous kite-and-key experiment in the summer of 1755. It was much more dangerous than he realized. During the approach of thunderstorm he sent up a silken kite with an iron tip; he rubbed the end of the kite string, which he had soaked in water to make it a good conductor of electricity, with a large iron key until sparks sprang from the string – which proved his theory. Had the lightning struck his kite he, and his small son whom he had taken along, might have lost their lives.

On the next experiment he fixed an iron bar to the outer wall of his house, and through it charged a Leyden jar with atmospheric electricity. Soon after this he was appointed Postmaster General of Britain's American colonies, and had to interrupt his research work. Taking it up again in 1760, he put up the first effective lightning conductor on the house of a Philadelphia businessman.

His theory was that during a thunderstorm a continual radiation of electricity from the earth through the metal of the lightning-conductor would take place, thus equalizing the different potentials of the air and the earth so that the violent discharge of the lightning would be avoided. The modern theory, however, is that the lightning-conductor simply offers to the electric tension a path of low resistance for quiet neutralization. At any rate – even if Franklin's theory was wrong – his invention worked.

Yet its general introduction in America and Europe was delayed by all kinds of superstitions and objections: if God warned to punish someone by making the lightning strike his house, how could Man dare to interfere? By 1782, however, all the public buildings in Philadelphia, first capital of the USA, had been equipped

with Franklin lightning-conductors, except the French Embassy. In that year this house was struck by lightning and an official killed.

Franklin had won the day.

It was he who introduced the idea of "positive" and "negative" electricity, based on the attraction and repulsion of electrified objects. A French physicist, Charles Augustin de Coulomb, studied these forces between charged objects, which are proportional to the charge and the distance between the objects; he invented the torsion balance for measuring the force of electric and magnetic at1raction. In his honor, the practical unit of quantity of electricity was named after him.

To scientists and laymen alike, however, this phenomenon of action at a distance caused by electric and magnetic forces was still rather mysterious.

What was it really? In 1780, one of the greatest scientific fallacies of all times seemed to provide the answer. Aloisio Galvani, professor of medicine at Bologna, was lecturing to his students at his home while his wife was skinning frogs, the professor's favorite dish, for dinner with his scalpel in the adjoining kitchen. As she listened to the lecture the scalpel fell from her hand on to the frog's thigh, touching the zinc plate at the same time. The dead frog jerked violently as though trying to jump off the plate. The signora screamed. The professor, very indignant about this interruption of his lecture, strode into the kitchen. His wife told him what had happened, and again let the scalpel drop on the frog. Again it twitched.

No doubt the professor was as much perplexed by this occurrence as his wife. But there were his students, anxious to know what it was all about. Galvani could not admit that he was unable to explain the jerking frog. So, probably on the spur of the moment he explained: "I have made a great discovery – animal electricity, the primary source of life".

"An intelligent woman had made an interesting observation, but the not so-intelligent husband drew the wrong conclusions, was the judgment of a scientific author a few years later. Galvani made numerous and unsystematic experiments with frogs' thighs, most of which failed to prove anything at all; in fact, the professor did not know what to look for, except his animal electricity.

These experiments became all the rage in Italian society, and everybody talked about galvanic electricity currents – terms which are still in use although Professor Galvani certainly did not deserve the honor.

A greater scientist than he, Alessandro Volta of Pavia, solved the mystery and found the right explanation for the jerking frogs. Far from being the "primary source of life", they played the very modest part of electric conductors while the steel of the scalpel and the zinc of the plate were, in fact, the important things. Volta showed that an electric current begins to flow when two different metals are separated by moisture (the frog had been soaked in salt water), and the frog's muscles had merely demonstrated the presence of the current by contracting under its influence. Professor Volta went one step further – a most important step, because he invented the first electrical battery, the "Voltaic pile". He built it by using discs of different metals separated by layers of felt which he soaked in acid. A "pile" of these elements produced usable electric current, and for many decades

this remained the only practical source of electricity. From 1800, when Volta announced his invention, electrical research became widespread among the world's scientists in innumerable laboratories.

II. Answer the questions on the text.

1. Which phenomenon demonstrates our senses?
2. Did Jews know anything about the secret of electricity?
3. Who set the ball rolling?
4. Why was Russian scientist Professor Reichmann from St. Petersburg killed?
5. What experiments did Galvani make numerous and unsystematic?

III. Complete the following sentences.

1. He tried to explain the phenomenon of the thunderstorm to himself by imagining that….
2. More than two thousand years passed after Thales's discovery without any….
3. No doubt the professor was as much perplexed by….
4. Volta showed that an electric current begins to….
5. From 1800, when Volta announced his invention…

ELECTRIC CURRENT

Vocabulary:

to be certain	быть уверенным
as well	также, тоже
to consider	рассматривать
to decrease	уменьшать
to determine direct current	измерять постоянный ток
direction	направление
to increase	увеличивать
to appear	появляться
to meet requirements	удовлетворять требованиям
particle	частица
to require statement	требовать констатации
subject	предмет
terminal	клемма
to pass through	проходить через
wire	провод, проволока
solid	твердое вещество
both	оба, обе; и тот и другой

I. Read and translate the text below.

Ever since Volta first produced a source of steady continuous current, men of science have been forming theories on this subject. For some time they could see no real difference between the newly-discovered phenomenon and the former understanding of static charges. Then the famous French scientist Ampere (after whom the unit of current was named) determined the difference between the current and the static charges. In addition to it, Ampere gave the current direction: he supposed it to flow from the positive pole of the source round the circuit and back again to the negative pole.

We consider Ampere to be right in his first statement but he was certainly wrong in the second, as to the direction of the current. The student is certain to remember that the flow of current is in a direction opposite to what he thought.

Let us turn our attention now to the electric current itself. The current which flows along wires consists of moving electrons. What can we say about the electron? We know the electron to be a minute particle having an electric charge. We also know that that charge is negative. As these minute charges travel along a wire, that wire is said to carry an electric current. In addition to traveling through solids, however, the electric current can flow through liquids as well and even through gases. In both cases it produces some most important effects to meet1ndustrial requirements.

Some liquids, such as melted metals for example, conduct current without any change to themselves. Others, called electrolytes, are found to change greatly when the current passes through them.

When the electrons flow in one direction only, the current is known to be d.c., that is, direct current. The simplest source of power for the direct current is a battery, for a battery pushes the electrons in the same direction all the time (i.e., from the negatively charged terminal to the positively charged terminal).

The letters a.c. stand for alternating current. The current under consideration flows first in one direction and then in the opposite one. The a.c. used for power and lighting purposes is assumed to go through 50 cycles in one second.

One of the great advantages of a.c. is the ease with which power at low voltage can be changed into an almost similar amount of power at high voltage and vice versa. Hence, on the one hand alternating voltage is increased when it is necessary for long-distance transmission and, on the other hand, one can decrease it to meet industrial requirements as well as to operate various devices at home.

Although there are numerous cases when d.c. is required, at least 90 per cent of electrical energy to be generated at present is a.c. A.c. finds wide application for lighting, heating, industrial, and some other purposes.

One cannot help mentioning here that Yablochkov, Russian scientist and inventor, was the first to apply a.c. in practice.

II. Ask questions.

1. if electricity is a form of energy.
2. if there are two types of electricity.
3. if alternating voltage can be increased and decreased.
4. if Franklin made an important contribution to the science of electricity.
5. if Ampere determined the difference between the current and the static charges.
6. if the electric current can flow through liquids and through gases.
7. if the electrolytes change greatly when the current passes through them.
8. if a negatively charged electron will move to the positive end of the wire.

III. Explain why.

1. static electricity cannot be used to light lamps, to boil water, to run electric trains and so on.
2. voltage is increased and decreased.
3. the unit of electric pressure is called the volt.
4. students must learn English.
5. Ampere was wrong as to the current direction.
6. the current is said to flow from the positive end of the wire to its negative end.

IV. The following statements are not true to the fact. Correct them.

1. Electrons flow from the positively charged terminal of the battery to the negatively charged terminal.
2. Ampere supposed the current to flow from the negative pole to the positive.
3. Static electricity is used for practical purposes.
4. Static electricity is not very high in voltage and it is easy to control it.
5. To show that the charges are unlike and opposite Franklin decided to call the charge on the rubber positive and that on the glass negative.
6. Galvani thought that electricity was generated because of the contact of the two dissimilar metals used.
7. Volta took great interest in atmospheric electricity and began to carryon experiments.
8. The direct current is known to flow first in one direction and then in the opposite one.

ELECTRIC CIRCUIT

Vocabulary:

simplest	простейший
circuit	цепь
power source	источник эл. энергии
receiver of energy	приемник эл. энергии
conductor	проводник
uninterrupted stream	непрерывный поток
closed circuit	замкнутая цепь
short circuit	короткое замыкание
series circuit	последовательная цепь
parallel circuit	параллельная цепь
direction of the current	направление тока

I. Read and translate the text below.

The power source together with the conductors and the receiver form a closed path. A closed path along which an uninterrupted stream of electric charges flows is called an electric circuit. The simplest electric circuit consists of a power source, a receiver of energy and two conductors, connected to the receiver and power source terminals. A primary cell, an accumulator are referred to the power source. Electric lamp, electric heating device, electric motor are referred to the energy receiver. The power source transforms mechanical, chemical, thermal, or other energy into electric energy. The energy receiver transforms electric energy into other forms of energy: radiant, thermal, mechanical and so on.

There are various kinds of electric circuits such as: open circuit, closed circuit, series circuit, parallel circuit and short circuit. The electrical bell circuit is a typical example of a series circuit. The circuit of an electric lamp in your room or your house is an example of a parallel circuit. The short circuit is a result of a cable fault or a wire one.

With respect to the source, the conductors and receiver form an external circuit. The direction of the current is from positive to negative in the external circuit and from negative to positive inside the source.

Both the external circuit and the source possess resistance. The value of resistance in a circuit depends on the material, shape and dimensions of the conductors.

II. Answer the questions on the text.

1. What elements does the simplest electric circuit consist of?
2. What is referred to the power source?
3. What is referred to the energy receiver?
4. What is the function of the power source?
5. What is the function of the energy receiver?
6. What elements form a closed path?
7. What is called an electric circuit?
8. What forms an external circuit with respect to the source?

III. Complete the following sentences.

1. A closed path along which an uninterrupted stream….
2. Electric lamp, electric heating device, electric motor are referred….
3. There are various kinds of electric circuits such as…
4. The short circuit is a result of…
5. The value of resistance in a circuit depends on….

CONDUCTORS, SEMICONDUCTORS AND INSULATORS

Vocabulary:

conductor	проводник
semiconductor	полупроводник
insulator	изолятор, диэлектрик
circuit	цепь, схема
current	ток
alternating current	переменный ток
direct current	постоянный ток
source	источник
to supply	снабжать, снабжение
property	свойство
velocity	скорость
potential difference	разность потенциалов
electromotive force	электродвижущая сила
to measure	измерять
charge	заряд

I. Read and translate the text below.

A conductor is an electrical material (usually a metal) which offers very little resistance to electrical current. The reason that certain materials are good conductors is that the outer orbits (the valence shells) in adjacent atoms overlap one another, allowing electrons to move freely between the atoms.

An insulator (such as glass or plastic) offers a very high resistance to current flow. The reason that some materials are good insulators is that the outer orbits of the atoms do not overlap one another, making it very difficult for electrons to move through the material.

A semiconductor is a material whose resistance is midway between that of a good conductor and that of a good insulator. Commonly used semiconductor materials include silicon and germanium (in diodes, transistors and integrated circuits), cadmium sulphide (in photoconductive cells), gallium arsenide (in lasers, and light-emitting diodes), etc. Silicon is the most widely used material, and it is found in many rocks and stones (sand is silicon dioxide).

II. Agree or disagree with the following statements using introductory phrases: You are quite right; It is really so; I quite agree with you; That's wrong; On the contrary; I'm afraid you are wrong.

1. A conductor offers very little resistance.
2. Commonly used semiconductor materials are different metals.
3. Conductor materials are usually metals.
4. An insulator offers very little resistance.
5. Semiconductor materials such as silicon and germanium are used in diodes, transistors, integrated circuits.
6. It is very difficult for electrons to move through the material in insulators.
7. A semiconductor resistance is midway between that of a good conductor and that of a good insulator.
8. Electrons move freely between the atoms in semiconductors.
9. Insulator materials are glass and plastic.

ELECTRIC MOTORS

Vocabulary:

rotary motion – вращательное движение
an appliance – прибор, приспособление
commutator – коллектор, переключатель
a brush – щётка
starting torque – пусковой момент
a field coil – катушка обмотки возбуждения
a shunt field winding – шунтовая обмотка возбуждения

I. Read and translate the text below.

We know the generator to produce electrical energy. To use this generated energy we need another machine to convert electrical energy into mechanical one. The electric motor is a machine which produces the rotary motion which turns our machinery and various appliances.

The motor consists of an armature with two windings, a commutator and brushes. A very strong magnetic field is necessary to provide a powerful starting torque. It is achieved by adding a series winding to the magnetic field. The series winding is connected in series with the armature. The heavy starting torque passing through the armature winding now passes through the series field coil. This starting torque provides a strong field necessary for starting. The shunt field winding provides the running conditions.

There is a wide variety of d.c. and a.c. motors. Direct-current motors are of three principal kinds and are named according to the manner in which their coils are connected to the armature. They are named series, shunt and compound motors.

Alternating current motors may be single-phase or polyphase ones. They may be divided into two kinds: synchronous and induction motors.

Numerous electric motors are used in industry, transport, mines, farms and even houses. They are the moving elements in various household appliances, such as vacuum cleaners, washing machines, refrigerators and the like. Motors are readily switched on, at will, and they continue running until we switch them off again. Generally speaking, the motor revolutionized industry by making use of energy that can be transmitted from great distances.

II. Answer the questions.

1. What is the motor used for?
2. What parts does the motor consist of?
3. What is necessary to provide a powerful starting torque?
4. How is the series winding connected to the armature?
5. What winding provides the running conditions?
6. What kinds of d.c. motors are there?
7. What kinds of a.c. motors are there?
8. Where are numerous electric motors used?
9. What device revolutionized industry?

III. Agree or disagree using That's not right, That's not true.

1. The generator is used to convert the electrical energy into mechanical one.
2. The motor produces the elliptical motion.
3. The motor consists of an armature with a pair of electromagnets.
4. A very weak magnetic field is needed to provide a powerful starting torque.
5. The series winding is connected in parallel with the armature.
6. Motors are used only in industry.

ELECTRICAL ENGINEERING

Vocabulary:
deal with – иметь дело с
distinction – различие
alternatively – кроме того

I. Read and translate the text below.

Electrical engineering is a field of engineering that generally deals with the study and application of electricity, electronics and electromagnetism.

The field first became an identifiable occupation in the late nineteenth century after commercialization of the electric telegraph and electrical power supply. It now covers a range of subtopics including power, electronics, control systems, signal processing and telecommunications.

Electrical engineering may include electronic engineering. Where a distinction is made, electrical engineering is considered to deal with the problems associated with large-scale electrical systems such as power transmission and motor control, whereas electronic engineering deals with the study of small-scale electronic systems including computers and integrated circuits.

Alternatively, electrical engineers are usually concerned with using electricity to transmit energy, while electronic engineers are concerned with using electricity to process information. Electrical engineers design new and better electronics. They also test equipment and solve problems. A project starts by deciding what the new electronics will do. Then, the engineer designs the circuits and other parts of the electronics. Later, the engineers test their designs and make them better. Many projects don't work at first. The engineers have to figure out why and then fix them. Electrical engineers work on many kinds of products. They might work on cars, robots, cell phone systems, the lighting and wiring in buildings, and radar and navigation systems. Some examples of high-tech projects that electrical and electronics engineers work on are global positioning systems that can pinpoint a car's location, giant generators that can power entire cities, or a new design for an airplane's electrical system. Engineers should be creative, curious, logical, and detail-oriented. They should also be able to work as part of a team.

II. Answer the questions on the text.

1. What is electrical engineering?
2. What subtopics does electrical engineering include?
3. What is the distinction between electrical engineering and electronic engineering?
4. What do electrical engineers deal with?
5. What high-tech projects do electrical engineers work on?

III. Complete the following sentences.

1. Electrical engineering deals with ….
2. In the late nineteenth century electrical engineering was associated with ….

3. Electrical engineering is considered to deal with ….
4. Electronic engineering deals with the study of ….
5. Electrical and electronics engineers work on ….
6. Electronics engineering systems can ….

SUPPLEMENTARY READING

THE EARLY DAYS OF ELECTRICITY

The discovery of electricity is one of the greatest accomplishments in human history. Electricity has changed our lives and enabled us to do things we never thought possible before. But, it wasn't always so easy to harness electricity. In fact, many scientists worked for hundreds of years trying to understand and control electricity before it became a usable power source.

To understand the early days of electricity, we must look back to ancient times when people first started to experiment with electric shocks and currents. Ancient civilizations, such as the Greeks and Romans, were fascinated by the effects of electricity. They noted that electric eels could generate shock and that electric sparks could be created by rubbing animal fur against certain objects. These observations provided the basis for much of the experimentation that followed over the next centuries.

In the 1700s, Benjamin Franklin famously experimented with electricity by flying a kite during a thunderstorm. This experiment showed that lightning was an electrical discharge, and it further spurred people's curiosity about electricity. Other prominent figures of this era, including Galvani, Volta, and Faraday, continued to conduct experiments and make discoveries about electricity.

These experiments laid the groundwork for the development of electricity as a usable power source. By the late 1800s, electricity had become widespread in homes and businesses, and it has been integral to our lives ever since. The early days of electricity were full of discovery and exploration as people sought to understand this new phenomenon.

HOW ELECTRICITY WAS DISCOVERED?

The history of electricity is a long and winding one, with numerous important discoveries leading up to the modern understanding of electricity. The first known observation of electricity dates back to 600 BC when Thales of Miletus noticed that when an amber rod was rubbed against fur, it could attract objects such as feathers. This phenomenon became known as "static electricity" and was studied further by other ancient Greeks.

In 1600, English scientist William Gilbert published De Magnete, which described the results of experiments he conducted using static electricity and magnetism. This was the first time that electricity was studied scientifically, and Gilbert's findings laid the foundation for future discoveries.

In the late 1700s, Alessandro Volta discovered that electricity could be created through chemical reactions between two different metals. This type of electricity is known as "electrochemical electricity" and it was the first time that electricity had been artificially created.

In 1831, Michael Faraday discovered the principles of electromagnetic induction, which led to the invention of electric generators and motors. This discovery was the basis for many subsequent advances in electrical engineering.

In 1873, James Clerk Maxwell developed a mathematical theory to describe electricity and magnetism, which he called Maxwell's equations. This led to the development of radio waves and the transmission of information over long distances.

Finally, in the early 20th century, quantum mechanics was developed and this led to a deeper understanding of how electricity works on a subatomic level. This revolutionized electrical engineering and made possible the invention of modern electronics such as televisions and computers.

THE APPLICATIONS OF ELECTRICITY

Electricity has become one of the most important elements of our lives, powering almost every modern convenience and device. The applications of electricity are virtually endless and have changed the way we live, work, and play.

Electricity is used in many areas including lighting, heating and cooling, communications, transportation, medical equipment, computers, entertainment, and household appliances. Lighting has become much more energy efficient thanks to LED lighting which uses very little electricity to produce light.

Electric heating systems are becoming increasingly popular as they offer a cost-effective way to keep your home warm. Communications rely heavily on electricity with devices such as smartphones and tablets relying on it for operation

Electricity has also changed the way we travel with cars, trains, planes, and other forms of transportation all requiring electricity in some form or another. Medical equipment also relies heavily on electricity with MRI machines and other diagnostic tools being powered by it. Computers are another application of electricity, with almost every computer on the planet using it in some form or another.

Entertainment relies on electricity to power televisions, speakers, and other audio equipment. Finally, household appliances such as vacuum cleaners, microwaves, and washing machines all require electricity for operation.

The applications of electricity are seemingly endless and have changed the way we live for the better. As technology advances, new applications for electricity will continue to be developed, making our lives easier and more efficient.

HOW ELECTRICITY HAS CHANGED OVER TIME?

Since its discovery, electricity has changed significantly over time. In the early days of electricity, it was used mostly for lighting, communications, and

industrial applications. However, as technology advanced and our knowledge of electricity grew, so did its use.

Today, electricity is used to power nearly every aspect of life. We use it to power our homes, offices, and businesses, providing us with energy to light and heat our spaces, run appliances, and even charge our mobile devices. Electricity also allows us to connect with each other in unprecedented ways, using the Internet to communicate with one another across the world in real-time.

Electricity has also become much more efficient over time. Through advances in technology, we are now able to produce more electricity with less energy input, resulting in more energy-efficient buildings and vehicles that run on electric power. Additionally, renewable energy sources such as solar and wind power have become increasingly popular as people strive to reduce their reliance on fossil fuels.

In the future, experts predict that electricity will continue to evolve, with newer technologies allowing us to produce and use electricity even more efficiently. This could lead to a much greener future, where electricity plays an even greater role in our lives than it does today.

MICHAEL FARADAY

Michael Faraday (1791–1867), one of the greatest men of science, had little chance to get an education. His father was a blacksmith who made his living in the heat of his forge, and Faraday was born to work with his hands, too.

Being thirteen years of age, he went as apprentice to learn book-binding. He read many of the books he had to bind and made clear and careful notes from those books that interested him most. Once when binding an encyclopedia, he ran across an article on electricity. When Faraday turned to that page and began to read he knew nothing of the subject, but it struck his imagination and aroused his interest. With the little money he could save, he bought a cheap and simple apparatus and set to make experiments. The farther he went along the road, the more interested lie became.

He attended the lectures of Humphry Davy, an outstanding scientist and the most popular lecturer in London at that time. It was Davy who helped Faraday to become an assistant at the laboratory of the Royal Institute and to get a profounder knowledge of the subject.

While still an assistant he helped Davy to create a safety lamp for miners. He learned chemistry, lectured to young people interested in science and wrote for a quarterly scientific journal.

In his spare moments Faraday was working on the problem of turning gases, into liquids. We know him to have heated hydrate of chlorine in a sealed tube and thus to have succeeded in liquefying chlorine. An important discovery of Faraday was that of benzol which he separated from condensed oil gas, and which since then found world-wide application.

For several years he is known to have been working at the problem of a perfect optical glass and to Lave made a glass that greatly improved the telescope.

Yet the problem of electricity and magnetism interested him above all. All scientific worlds had known by that time that if a current is run through a copper wire wound around a piece of iron, the iron becomes a magnet. If electricity magnetizes, why won't magnetism electrify? That was the question Faraday asked himself over and over. For a long time he tried different experiments to solve the problem. At last in 1831 he made his major discovery in the field of electricity – the electromagnetic induction.

But Faraday's work on electricity could not end at this point. He set about testing electricity from every known source and after a series of tests came to the conclusion that electricity, whatever the source may be, is identical in its nature.

Among a number of other discoveries he is also known to have measured for the first time the electric current, and to have made several important observations on the conductivity of different materials. Although Faraday enjoyed world-wide popularity he remained a modest man never wanting either to accept high titles or to get any money out of his numerous discoveries.

He was one of those great men who made possible the age of electricity in which we live, all the marvels it brings us and all those it may bring to the future generations.

EDISON' LIGHTING SYSTEM

It was only in the last quarter of the nineteenth century that electricity began to play its part in modern civilization, and the man who achieved more in this field of practical engineering than any of his contemporaries was the American inventor, Thomas Alva Edison. His dramatic career is too well known, and has been described too often, to be told again; it may suffice to recall that he became interested in the problem of electric lighting in 1877, and began to tackle it with the systematic energy which distinguished him from so many other inventors of his time. Edison was no scientist and never bothered much about theories and fundamental laws of Nature; he was a technician pure and simple, and a very good business man as well.

He knew what had been done in the field of electric lighting before his time, and he had seen some appliances of his contemporaries, such as the arclamp illuminations which had been installed here and there. Two sticks of carbon, nearly touching, can be made to produce an electric arc which closes the circuit. Many scientists and inventors who tried to tackle the problem were therefore convinced that only incandescent electric light – produced by some substance glowing in a vacuum so that it cannot burn up – could ever replace gas lighting, then the universal system of illumination in Europe and America.

Edison put his entire laboratories at Menlo Park to the task of developing such a lamp. The most important question was that of a suitable material for the filament. He experimented with wires of various metals, bamboo fiber, human hair, paper; everything was carbonized and tried out in glass bulbs from which the air had been exhausted. In the end – it is said that a button hanging thread on his jacket gave him the idea – he found that ordinary sewing thread, carefully

carbonized and inserted in the airless bulb, was the most suitable material. His first experimental lamp of 1879 shed, its soft, yellowish light for forty hours: the incandescent electric lamp was born.

It was, no doubt, one of the greatest achievements in the history of modern invention. Yet Edison was a practical man who knew well that the introduction of this revolutionary system of illumination must be properly prepared. He worked out methods for mass-producing electric bulbs at low cost, and devised circuits for feeding any number of bulbs with current. He found that 110/220 volts was the most suitable potential difference and would reduce transmission losses of current to a minimum – he could not have foreseen that the introduction of that voltage was to set the standard for n century of electric lighting. But most important of all "accessories" of the lamp was the generator that could produce the necessary high-tension current.

Since Faraday's ingenious discovery of the way in which movement could be transformed into electricity, only a small number of engineers had tried to build generators based on this principle. But none of these generators answered the particular requirements of Edison's electric light: so he had to design his own generator, which he did so well that his system – apart from minor improvements and of course the size of the machines – is still in general use today.

It is little known that the first application of Edison's lighting system was on board an arctic-expedition steamer, the "Jeanette", which the inventor himself equipped with lamps and a generator only a few weeks after his first lamp had lit up at Menlo Park. The installation worked quite satisfactorily until the ship was crushed in, the polar ice two years later.

Edison, a superb showman as well as a brilliant inventor, introduced his electric lamp to the world by illuminating his own laboratories at Menlo Park with 500 bulbs in 1880. It caused a sensation. From dusk to midnight, visitors trooped around the laboratories, which Edison had thrown open for the purpose, regarding the softly glowing lamps with boundless admiration. Extra trains were run from New York, and engineers crossed the Atlantic from Europe to see the new marvel.

There was much talk about the end of gas-lighting, and gas shares slumped on the stock exchanges of the world. But a famous Berlin engineer – none other than Werner von Siemens, who later became Edison's great rival in central Europe – pronounced that electric light would never take the place of gas. When Edison showed his lamps for the first time in Europe, at the Paris Exhibition of 1881, a well-known French industrialist said that this would also be the last time.

Meanwhile, however, Edison staked his money and reputation on a largescale installation in the middle of New York. He bought a site on Pearl Street, moved into it with a small army of technicians, and built six large direct-current generators, altogether of 900 h.p., powered by steam-engines. Several miles of streets were dug up for the electric cables – also designed and manufactured by Edison – to be laid, and eighty-five buildings were wired for illumination. On 4 September 1881 New Yorkers had their first glimpse of the electric age when 2,300 incandescent lamps began to glow at the throwing of a switch in the Pearl Street power station. Electric lighting had come to stay. And what was most

important: Edison had finally established a practical method of supplying electricity to the homes of the people. Pearl Street was not the first generator station to be built. A 1 h.p.generator for the supply of current for Edison lamps was built in 1881. In Germany, Werner von Siemens did more than any other engineer for theintroduction of electric lighting, in which he had first refused to believe, by perfecting his "dynamo", as he called the generator for continuous current.

Spectacular as the advent of electric lighting was, it represented only one aspect of the use of electricity, which was rapidly gaining in popularity among industrial engineers. For a century, the reciprocating steam-engine had been the only important man-made source of mechanical energy. Bui its power was limited to the place where it operated; there was no way of transmitting that power to some other place where it might have been required. For the first time, there was now an efficient means of distributing energy for lighting up homes and factories, and for supplying engines with power.

The engine which could convert electric energy into mechanical power was already in existence. As early as 1822, nearly a decade before he found the principle of the electric generator, Faraday outlined the way in which an electric motor could work: by placing a coil, or armature, between the poles of an electromagnet; when a current is made to flow through the coil the electromagnetic force causes it to rotate – the reverse principle, in fact, of the generator.

The Russian physicist, Jacobi built several electric motors during the middle decades of the 19th century.

Jacobi even succeeded in running a small, battery-powered electric boat on the Neva River in St. Petersburg. All of them, however, came to the conclusion that the electric motor was a rather uneconomical machine so long as galvanic batteries were the only source of electricity. It didn't occur to him that motors and generators could be made interchangeable.

In 1888, Professor Galileo Ferraris in Turin and Nikola Tesla – the pioneer of high-frequency engineering – in America invented independently and without knowing of each other's work, the induction motor. This machine, a most important but little recognized technical achievement, provides no less than two-thirds of all the motive power for the factories of the world, and much of modern industry could not do without it. Known under the name of "squirrel cage motor" – because it resembles the wire cage in which tame squirrels used to be kept – it has two robust circular rings made of copper or aluminum joined by a few dozen parallel bars of the same material, thus forming a cylindrical cage. It is built into an iron cylinder which is mounted on the shaft, and forms the rotor, the rotating part of the is exposed to a rotating magnetic field set up by the stator, the fixed part of the machine, consisting of many interconnected electrical conductors called the winding. The relative motion between the magnetic field and the rotor induces voltages and currents which exert the driving force, turning the "cage" round.

Although the induction motor has been improved a great deal and its power increased many times over since its invention, there has never been any change of the underlying principle. One of its drawbacks was that its speed was constant and unchangeable. Only in 1959 did a research team at the University of Bristol

succeed in developing a squirrel-cage motor with two speeds – the most far reaching innovation since the invention of the inductor motor. The speed-change is achieved by modulating the pole-amplitude of the machine.

From the day when Edison's lamps began to glow in New York, the entire world asked for electricity. Already a year earlier, Werner von Siemens had succeeded in coupling a steam-engine directly to a dynamo. But the engineers had their eves on another, cheaper source of mechanical power than the reciprocating steam-engine: that of falling water. We do not know which of them suggested the idea of a hydroelectric power station for the first time; it was probably very much "in the air". Back in 1827, a young Frenchman had won the first prize ill a competition for the most effective water turbine in which the water would act on the wheel inside a casing instead of from outside. It was one of the prototypes of the modern water turbine. In the 1880's, an American engineer designed a turbine wheel with enormous bucket-shaped blades along the rim, and a few American towns with waterfalls installed these turbines coupled to Edison generators. This type proved especially efficient where the fall of water was sleep but its quantity limited; for a low fall of water the turbine – with only four large blades proved better suited. However, the type which appeals most to the engineers is now the turbine for falls of water from 100 to 1000 feet, with a great number of curved blades.

The power-station which convincingly showed the enormous possibilities of hydro-generated electricity was the one at Niagara Falls, begun in 1891, and put into operation a few years later with an output of 5000 h.p. – it is 8 million h.p. today. The early power stations generated direct current at low voltage but they could distribute it only within a radius of a few hundred yards. The Niagara station was one of the first to use alternating current (although the skeptics prophesied that this would never work), generated a high voltage; this was transmitted by overhead cables to the communities where it was to be used, and here "stepped down" into lower voltages (110 or 220) for domestic and industrial use by means of transformers. High voltage transmission is much more economical than low-voltage; all other circumstances being equal, if the transmission voltage is increased tenfold the losses in electric energy during transmission arc reduced to one-hundredth. This means that alternating current at tens or even hundreds of thousands of volts, as it is transmitted today, can be sent over long distances without much loss.

These ideas must have had something frightening to the people at the end of the last century, when electricity was still a mysterious and alarming novelty.

The engineers who built London's first power station, with a 10000-volt generator, in 1889, and their German colleagues who set up a 16000-volt dynamo driven by a waterfall in the River Neckar, to supply Frankfurt, 100 miles away, with electricity in 1891 – these men must have felt like true pioneers, derided, despised, and abused by the diehards. There were, of course, also some powerful commercial interests involved, for the gas industry feared for its monopoly in the realm of lighting – and with a good deal of justification as it turned out.

THE STEAM TURBINE

It is most important to remember that electricity is only a means of distributing energy, of carrying it from the place where it is produced to the places where it is used. It is not a “prime mover” like the steam-engine or even the water mill. A generator is no use at all unless it is rotated by a prime mover.

During the first few years of electric power there was no other way of moving the generators than either by the force of falling water or by ordinary steamengines.

Soon, however, there came a new and very efficient prime mover, the steam-turbine. The steam-turbine must be a much more efficient and powerful prime mover than the reciprocating engine because it must short-cut the complicated process of converting steam energy into rotary motion via reciprocating motion. But the problems involved in building such a machine seemed formidable, especially hint of high-precision engineering. It was only towards the end of the nineteenth century that engineering methods were developed highly enough for a successful attempt.

Two men undertook it almost simultaneously. The Swedish engineer, Gustaf Patrik de Laval, built his first model in 1883. He made the steam from the boiler emerge from four stationary nozzles arranged around the rim of a wheel with a great number of small inches, de Laval’s turbine wheel rotated at up to 10000 revolutions per minute. He supported the wheel on a flexible shaft so that it would adjust itself to the fluctuation of procure – which at Midi speeds, would have broken a rigid shaft in no time.

De Laval geared an electric generator to his turbine alter he had succeeded in reducing the speed of rotation to 300 r.p.m. His turbo generator worked, but its capacity was limited, and it was found unsuitable for large-scale power stations. Although the simplest form of a machine has often proved the most efficient one in the history of technology, this was not the ease with the teamturbine. Another inventor, and another system, proved much more successful.

In 1876 Charles Parsons began to work on the idea of a steam-turbine, for which he foresaw a wide range of applications. The reciprocating steam-engine, which was unable to convert more than 12 per cent of the latent energy of coal into mechanical power, was not nearly efficient enough for the economical generation of electricity – energy leaked out right and left from the cylinder, and the condenser. Besides, there were limits to the size in which it could be built, and therefore to the output: and Parsons saw that the time had come to build giant electric power stations.

As he studied the problem he understood that the point where most would-be turbine inventors had been stumped was the excessive velocity of steam. Even steam at a comparatively low pressure escaping into the atmosphere may easily travel at speeds of more than twice the velocity of sound – and highpressure steam may travel twice as fast again, at about 5000 feet per second.

Unless the wheel of a turbine could be made to rotate at least at half the speed of the steam acting upon its blades, there could be no efficient use of its energy.

But the centrifugal force alone, to say nothing of the other forces which de Laval tried to counter with his flexible shaft, would have destroyed such an engine.

Parsons had the idea of reducing the steam pressure and speed, without reducing efficiency and economy, by causing the whole expansion of the steam to take place in stages so that only moderate velocities would have to be reached by the turbine wheels. This principle still forms the basis of ail efficient steamturbines today. Parsons put it into practice for the first time in his model of 1884, a little turbine combined with an electric generator, both coupled without reducing gear and revolving at 18000 r.p.m. The turbine consisted of a cylindrical rotor enclosed in a casing, with many rings of small blades fixed alternately lo the casing and to the rotor. The steam entered the casing at one end and flowed parallel with the rotor (“axial flow”); in doing so it had to pass between the rings of blade – each acting virtually as a nozzle in which partial steam expansion could take place, and the jets thus formed gave up their energy in driving the rotor blades.

It was a more complicated solution of the problem than de Laval’s, but it proved to be the right one. The speed of 18000 r.p.m. used the energy of the steam very well, and the generator developed 75 amperes output at 100 volts.

The little machine, built in 1884, is now at the Science Museum.

Parsons expected, and experienced, a good deal of opposition after all, there, were enormous vested interests in the manufacture of reciprocating steam engines. He began to build some portable turbo generators, but there were no buyers. Strangely enough, a charity event created the necessary publicity for the turbine. In the winter of 1885–1886, a pond froze over, and a local hospital decided to raise funds by getting young people to skate on the ice and charging for admission. The Chief Constable had the idea of asking Mr. Parsons to illuminate the pond with electric lamps, powered by one of the portable 4-kW turbo-generators.

The event was a great success, and the newspapers wrote about it. The next step was that the organizers of the Newcastle Exhibition of 1887 asked Parsons to supply the current for its display of electric lighting. Parsons, who died in 1931 at the age of 76, lived long enough to see one of his turbines producing more than 200000 kW. He also succeeded in introducing his steamturbine as a new prime mover in ship propulsion.

Until this day, the steam-turbine has held its place as the great prime mover for the generation of electricity where no water power is available. The steam which drives them hi the power stations may be raised by coal, oil, natural gas, or atomic energy – but it is invariably the steam-turbine which drives the generators. Diesel-engines are the exceptions, and are only used where smaller or mobile stations are required and no fuel but heavy oil is available. Today’s steam-turbines, large or small, run at much lower speeds than Parson’s first model, usually at 1000–3000 r.p.m.

When, a quarter of a century after Charles Algernon Parsons’s death, the first nuclear power station in the world started up, his steam-turbines were there to convert the heat from the reactor into mechanical energy for the generators. The atomic age cannot do without them – not yet.

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