TOMSK POLYTECHNIC UNIVERSITY

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PROFESSIONAL ENGLISH FOR STUDENTS OF E-LEARNING INSTITUTE IN SPECIALTY OF «ELECTRICAL ENGINEERING AND ELECTRICAL POWER ENGINEERING»

2017

МИНИСТЕРСТВО ОБРАЗОВАНИЯ И НАУКИ РОССИЙСКОЙ ФЕДЕРАЦИИ
Федеральное государственное автономное
образовательное учреждение высшего образования
**«НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ
ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ»**

ПРОФЕССИОНАЛЬНЫЙ ИНОСТРАННЫЙ ЯЗЫК (АНГЛИЙСКИЙ)
Часть 1

для студентов направления
13.03.02 «Электроэнергетика и электротехника»

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2017

УДК 811.111’243:621.(075.8)
ББК Ш143.21-923
П 78

В авторской редакции

Пособие предназначено для студентов 3 курса ИнЭО, изучающих профессиональный курс английского языка и обучающихся по заочной классической, дистанционной и гибридной формам обучения по направлению 13.03.02 «Электроэнергетика и электротехника».

УДК 811.111’243:621.3(075.8)
ББК Ш143.21-923

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UNIT 1

WHAT IS ELECTRICAL ENGINEERING?

Text 1 Electrical Engineering **Text 2** Electricity **Grammar Revision**: Tenses in Active and Passive Forms Types of questions

LEAD-IN

1. What do you imagine when you think of electricity?

2. What are the ways of producing electricity?

READING

3. Read the text below and answer the questions (1–5).

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?

ELECTRICAL ENGINEERING

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.

4. Match the beginnings of the sentences (1–6) with their endings (a–f).

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 ….

a. pinpoint a car's location..
b. the problems associated with large-scale electrical systems.
c. the electric telegraph and electrical power supply
d. global positioning systems
e. small-scale electronic systems including computers and integrated circuits.
f. the study and application of electricity, electronics and electromagnetism.

5. Read the text below and choose the appropriate answer for each statement.

1. Electricity is a phenomenon associated with stationary or moving electric ……
   A. charges
   B. atoms
   C. conductors

2. The Greeks discovered that …... rubbed with fur attracted light objects.
   A. gold
   B. rubber
   C. amber

3. The invention of the …... and the construction of the first central power station led to the rapid introduction of electric power into factories and homes.
   A. semiconductors
   B. incandescent light bulb
   C. the number of electrons

4. Most elementary particles of matter possess charge, either …… or negative.
   A. chemical
   B. positive
   C. moving

5. If the numbers of …... and protons are equal, the atom is electrically neutral.
   A. electrons
   B. atoms
   C. charges

6. According to the ability of the materials to allow charge to flow through them, there are …... types of them.
   A. two
   B. ten
   C. three

ELECTRICITY

Electricity is a phenomenon associated with stationary or moving electric charges. The word comes from the Greek elektron (amber); the Greeks discovered that amber rubbed with fur attracted light objects such as feathers. Such effects due to stationary charges, or static electricity, were the first electrical phenomena to be studied. Not until the early 19th century were static electricity and electric current shown to be aspects of the same phenomenon. The discovery of the electron, which carries a charge designated as negative, showed that the various manifestations of electricity are the result of the accumulation or motion of numbers of electrons. The invention of the incandescent lightbulb (1879) and the construction of the first central power station (1881) by Thomas Alva Edison led to the rapid introduction of electric power into factories and homes.

According to modern theory, most elementary particles of matter possess charge, either positive or negative. Two particles with like charges, both positive or both negative, repel each other, while two particles with unlike charges are attracted (see Coulomb's law). The electric force between two charged particles is much greater than the gravitational force between the particles. The negatively charged electrons in an atom are held near the nucleus because of their attraction for the positively charged protons in the nucleus.

If the numbers of electrons and protons are equal, the atom is electrically neutral; if there is an excess of electrons, it is a negative ion; and if there is a deficiency of electrons, it is a positive ion. Under various circumstances, the number of electrons associated with a given atom may change; chemical bonding results from such changes, with electrons being shared by more than one atom in covalent bonds or being transferred from one atom to another in ionic bonds (see chemical bond). Thus many of the bulk properties of matter ultimately are due to the electric forces among the particles of which the substance is composed.

Materials differ in their ability to allow charge to flow through them. Materials that allow charge to pass easily are called conductors, while those that do not are called insulators, or dielectrics. A third class of materials, called semiconductors, conduct charge under some conditions but not under others.

6. Answer the questions.

1. What is electricity?
2. What charges do most elementary particles of matter possess?
3. What does the charge depend on?
4. How do the negatively charged electrons in an atom behave?
5. When the atom is electrically neutral?
6. How do materials differ?
7. What is a conductor?

USE OF ENGLISH

7. Complete the text with the missing words from the box.

1. current
2. charge
3. electrolyte
4. carriers
5. second
6. conductor
7. ammeter
8. electrons
9. direction
10. ampere

Electric current is a flow of electric charge through a medium. This charge is typically carried by moving electrons in a…… such as wire. It can also be carried by ions in an ……., or by both ions and ……in a plasma.

The SI unit for measuring the rate of flow of electric charge is the ……, which is charge flowing through some surface at the rate of one coulomb per …... Electric …… is measured using an ……..

To provide a definition of current that is independent of the type of charge ……. flowing, conventional current is defined to flow in the same …….. as positive charges.

8. Choose the right option (A–C) to complete the sentences (1–8). The example is given.

1. Electrical engineering is a field of engineering that generally deals ***with*** the study and application of electricity, electronics and electromagnetism.
   A. with
   B. at
   C. in

2. The discovery of the electron, which carries ..…. designated as negative, showed that the various manifestations of electricity are the result of the accumulation or motion of numbers of electrons.
   A. atom
   B. charge
   C. amber

3. The first central …... station (1881) was built by Thomas Alva Edison.
   A. power
   B. railway
   C. factory

4. Materials that allow charge to pass easily are called ……
   A. semiconductors
   B. insulator
   C. conductors

5. Electric current is a flow of electric …… through a medium.
   A. substance
   B. charge
   C. current

6. States have many statutes and regulations in place to protect the public from …... shock.
   A. current

B. electric
C. amber

7. Other dangers from electricity include stray voltage and electromagnetic …… radiation.
A. field
B. insulator
C. conductor

8. Studies have shown a …... between electromagnetic fields and cancer.
A. correlate
B. correlating
C. correlation

9. Match the words 1–10 with their definitions A–J.

1. electricity	**A.**	a substance that readily conducts e.g. electricity and heat
2. conductor	**B.**	a form of energy usually carried by wires or produced by batteries used to power machines and computing, communications, lighting, and heating devices.
3. insulator	**C.**	an article which is bought or sold
4. circuit	**D.**	a material or an object that does not easily allow heat, electricity, light, or sound to pass through it.
5. commodity	**E.**	an extremely small piece of matter; speck
6. gravitation	**F.**	the force of attraction that bodies exert on one another as a result of their mass
7. particle	**G.**	the extent to which a body or medium transmits light, sound, or some other form of energy
8. power	**H.**	a reciprocal relation between two or more things
9. transmission	**I.**	a complete path through which an electric current can flow
10. correlation	**J.**	the rate at which work is done, expressed as the amount of work per unit time and commonly measured in units such as the watt and horsepower

10. Translate the sentences from English into Russian.

1. Resistivity is electrical resistance of a conductor of unit cross-sectional area and unit length.
2. In the hydraulic analogy, current flowing through a wire (or resistor) is like water flowing through a pipe.

3. Resistance is proportional to how much pressure is required to achieve a given flow.
4. The resistance and conductance of a wire, resistor, or other element is generally determined by two factors: geometry (shape) and materials.
5. A long, thin copper wire has higher resistance (lower conductance) than a short, thick copper wire.
6. The pressure difference between two sides of a pipe, not the pressure itself, determines the flow through it.
7. Resistivity of metallic conductors generally increases with a rise in temperature.
8. A photoresistor or light dependent resistor (LDR) is a resistor whose resistance decreases with increasing incident light intensity.
9. A photoelectric device can be either intrinsic or extrinsic.
10. An electric current flowing in a loop of superconducting wire can persist indefinitely with no power source.

GRAMMAR REVISION

The Active Voice	The Passive Voice
• подлежащее предложения выполняет действие; • форма образования: V develop *Engineers **develop** these technologies.* *Инженеры разрабатывают эти технологии.*	• подлежащее предложения подвергается действию; • форма образования: be + Ved be + developed *These technologies are developed by engineers.* *Эти технологии разрабатываются инженерами.*

11. Search the texts above for the sentences in the passive voice and translate them into Russian.

12. Put the words into the correct form. The example is given.

1	Electricity is ***considered*** an alternative fuel under the Energy Policy Act of 1992.	consider
2	Electricity can be …... from a variety of primary energy sources,	produce
3	…… oil, coal, nuclear energy, moving water, natural gas, wind energy,	include
4	and solar energy. Plug-in vehicles are …... of drawing electricity	capability

5	from off-board …... power sources (generally the electricity grid)	electricity
6	and ….. it in batteries. Fuel cells are being explored as a way to use	store
7	hydrogen to …. generate electricity onboard the vehicle.	clean
8	Vehicles that run only on electricity produce no tailpipe …... But there	emit
9	are emissions associated with the …... of most of the country's electricity.	produce
10	In plug-in electric vehicles, onboard …... batteries power electric motors.	recharge

Types of questions
1. General: **Do you** study mechanical engineering at your university? 2. Special: What **do you** study at your university? 3. Alternative: **Do you** study mechanical engineering or management? 4. Tag: You study mechanical engineering, **don't you**? ***Remember*** the following auxiliary verbs: **am, is, are, do, does, did, have, has, will, can, must, may, should, would** which are used before the subject in the questions. ***Remember*** the following interrogative words: **who, whose, whom, what, which, when, where, why, how, how many, how much, how long** which start special questions.

13. Make up different types of questions to the following sentences.

1. Our engineers work hard at this problem. (general)
2. They designed this instrument. (special)
3. People are going to use bicycles instead of cars. (alternative)
4. This plant will produce only tires. (tag)
5. The car has crashed into the tree. (general)
6. The laboratory is provided with new equipment. (special)
7. Irrigation systems were devised by skilled technicians. (alternative)
8. The education and training of engineers must be a partnership between industry and higher education. (tag)

SPEAKING

14. Use the words and phrases below to make sentences.

electrical engineering, large-scale electrical systems, electromagnetic fields, resistivity, bio-electricity, light dependent resistor, nuclear energy, current flow, plug-in electric vehicles, rechargeable

15. Work in pairs. Think of some questions to review the contents of the text about the electrical engineering and electricity and ask each other.

WRITING

16. Read the text and write an abstract to the following text. The length of the abstract is 100–120 words (see Appendix).

WHO INVENTED ELECTRICITY?

The earliest mention of electric phenomena is found in ancient Egyptian texts from about 2750 BC. These texts talk about electric fish that were known as «Thunderers» of the Nile» and defenders of other fish. So the earliest discovery of electricity in recorded history was in the form of bio-electricity. Many ancient civilizations have reported the attractive effect that amber has on light objects like feathers when rubbed against cat fur.

The magnetic effect of minerals like magnetite was known to the ancient Greeks. Around 600 BC, a Greek philosopher, Thales of Miletus, investigated the static electric effect of amber and wrongly classified it as a magnetic effect arising out of friction. In 1600 AD, an Englishman named William Gilbert studied both the phenomena of electricity and magnetism and distinguished between the electric effect of amber and magnetic effect of lodestone. He gave the name «electricus» (Latin) to the phenomenon of attraction showed by amber. It was derived from the ancient Greek word for amber, which was «electron». This gave rise to the modern word of electricity which first appeared in print, in the book written by Sir Thomas Brown in 1646.

In the 18th century, Benjamin Franklin is supposed to have first proved conclusively that lightning was indeed electricity, through some kite experiments.

In the year 1791, Luigi Galvani proved that nerves conduct signals to the muscles in the form of electric currents, thus giving rise to the science of bio-electricity.

Later in 1800, one of the first electric batteries were created by Allesandro Volta. Later, Hans Christian Oersted and Ampere proved the uni-

ty between electricity and magnetism and Michael Faraday invented the first electric motor. James Clark Maxwell, through his theory of electromagnetism, proved the unity between electricity and magnetism and proved that light was an electromagnetic wave. Since then, electrical engineering developed as an applied science and eventually gave rise to telecommunication.

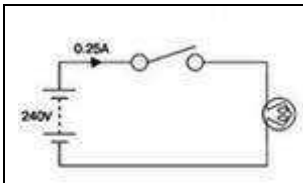
UNIT 2

ELECTRICITY

Text 1 Conductance and resistance **Text 2** Superconductivity **Grammar Revision**: Tenses in Active and Passive Forms

LEAD-IN

1. Look at the pictures. Think: What unites all these pictures? What is opposite to resistance?





$$R = \frac{V}{I}, \quad G = \frac{I}{V}$$

2. Complete the chain:

…. – conductor – semiconductor – …….

READING

3. Read the text about «Conductance and Resistance» and choose the right option for every question.

1. Current flowing through a wire (or resistor) is like …... flowing through a pipe.
   A. water
   B. gas
   C. solids
2. The voltage drop across the wire is like the …… drop which pushes water through the pipe.
   A. flow
   B. pressure
   C. rain

3. The voltage drop is the ..…. in voltage between one side and the other.
   A. reciprocals
   B. difference
   C. resistance

4. The resistance and conductance of a wire, resistor, or other element is generally determined by …... factors.
   A. three
   B. one
   C. two

5. Electrons can flow freely and easily through ….. a wire.
   A. steel
   B. rubber
   C. copper

CONDUCTANCE AND RESISTANCE

In the hydraulic analogy, current flowing through a wire (or resistor) is like water flowing through a pipe, and the voltage drop across the wire is like the pressure drop which pushes water through the pipe. Conductance is proportional to how much flow occurs for a given pressure, and resistance is proportional to how much pressure is required to achieve a given flow.

The voltage drop (i.e., difference in voltage between one side and the other), not the voltage itself, is the driving force pushing current through a resistor. In hydraulics, it is similar: The pressure difference between two sides of a pipe, not the pressure itself, determines the flow through it. For example, there may be a large water pressure above the pipe, which tries to push water down through the pipe. But there may be an equally large water pressure below the pipe, which tries to push water back up through the pipe. If these pressures are equal, no water will flow.

The resistance and conductance of a wire, resistor, or other element is generally determined by two factors: geometry (shape) and materials.

Geometry is important because it is more difficult to push water through a long, narrow pipe than a wide, short pipe. In the same way, a long, thin copper wire has higher resistance (lower conductance) than a short, thick copper wire.

Materials are important as well. A pipe filled with hair restricts the flow of water more than a clean pipe of the same shape and size. In a similar way, electrons can flow freely and easily through a copper wire, but cannot as easily flow through a steel wire of the same shape and size, and they essentially cannot flow at all through an insulator like rubber, regardless of its shape. The difference between, copper, steel, and rubber is related to their microscopic structure and electron configuration, and is quantified by a property called resistivity.

4. Answer the questions.

1. What is conductance proportional to?
2. What is the driving force pushing current through a resistor?
3. What kind of wire has higher resistance?
4. What materials are more conductive?
5. What is the difference between copper, steel and rubber?

5. Read the text below and decide if the sentences are TRUE or FALSE.

1. Superconductivity was discovered by Heike Kamerlingh Onnes on April 8, 1911 in Leiden.
2. It is characterized by the complete ejection of magnetic field lines from the interior of the superconductor as it transitions into the superconducting state.
3. In a superconductor, the conductivity drops abruptly to zero when the material is cooled below its critical temperature.
4. In conventional superconductors, electrons are not held together in pairs by an attraction mediated by lattice phonons.
5. An electric current flowing in a loop of superconducting wire can persist indefinitely with no power source.

SUPERCONDUCTIVITY

Superconductivity is a phenomenon of exactly zero electrical resistance and expulsion of magnetic fields occurring in certain materials when cooled below a characteristic critical temperature. It was discovered by Heike Kamerlingh Onnes on April 8, 1911 in Leiden. Like ferromagnetism and atomic spectral lines, superconductivity is a quantum mechanical phenomenon. It is characterized by the Meissner effect, the complete ejection of magnetic field lines from the interior of the superconductor as it transitions into the superconducting state.

The occurrence of the Meissner effect indicates that superconductivity cannot be understood simply as the idealization of perfect conductivity in classical physics. The electrical resistivity of a metallic conductor decreases gradually as temperature is lowered. In ordinary conductors, such as copper or silver, this decrease is limited by impurities and other defects. Even near absolute zero, a real sample of a normal conductor shows some resistance. In a superconductor, the resistance drops abruptly to zero when the material is cooled below its critical temperature. An electric current flowing in a loop of superconducting wire can persist indefinitely with no power source.

In 1986, it was discovered that some cuprate-perovskite ceramic materials have a critical temperature above 90 K (−183 °C). Such a high transition temperature is theoretically impossible for a conventional superconductor, leading the materials to be termed high-temperature superconductors. Liquid nitrogen boils at 77 K, facilitating many experiments and applications that are less practical at lower temperatures. In conventional superconductors, electrons are held together in pairs by an attraction mediated by lattice phonons.

The best available model of high-temperature superconductivity is still somewhat crude. There is a hypothesis that electron pairing in high-temperature superconductors is mediated by short-range spin waves known as paramagnons.

6. Choose the right option (A–C) for every question (1–5). The example is given.

1. Superconductivity is a phenomenon of exactly zero electrical ***resistance*** and expulsion of magnetic fields.
   A. conductivity
   B. resistance
   C. semi conductivity
2. Superconductivity occurs in certain materials when ….. below a characteristic critical temperature.
   A. cooled
   B. heated
   C. frozen
3. Even near absolute zero, a real sample of a …..conductor shows some resistance.
   A. super
   B. semi-
   C. normal
4. An electric … flowing in a loop of superconducting wire can persist indefinitely with no power source.
   A. current
   B. circuit
   C. device
5. In conventional superconductors, ……. are held together in pairs by an attraction mediated by lattice phonons.
   A. electrons
   B. atoms
   C. phonons

USE OF ENGLISH

7. Form meaningful expressions using the words from two columns. Translate your expressions into Russian. Use them in your own sentences. The example is given.

1. voltage	***A. drop***
2. copper	B. structure
3. microscopic	C. wire
4. electrical	D. property
5. characteristic	E. conductors
6. poor	F. resistance
7. free	G. electron
8. extrinsic	H. superconductor
9. incandescent	I. lamp
10. conventional	J. devices

8. Put the words into the correct form. The example is given.

1	Electrical engineers have contributed to the *<u>develop</u>ment* of a wide range	develop
2	of technologies. They design, develop, test and …… the deployment	supervision
3	of electrical systems and …. devices. For example, they may work	electron
4	on the design of …… systems, the operation of electric power stations	telecommunicate
5	the lighting and wiring of buildings, the design of household…..,	apply
6	or the electrical control of …… machinery. Satellite communications	industry
7	is one of many projects an ….. engineer might work on. Fundamental	electricity
8	to the discipline are the …… of physics and mathematics as these	science
9	help to obtain both a qualitative and quantitative …..of how such	describe
10	systems will work. Today most …… work involves the use of computers.	engineering

9. Complete the sentences (1–10) with the suitable collocations (A–J). Use each collocation only once. The example is given.

A. a compass needle
B. charged and non-charged objects
C. to charged bodies
D. devices known as electroscopes
E. is influenced by electrostatic
F. magnetic and electrical forces
G. magnetism and static electricity
H. another device called a Terrella
I. electricity
J. a needle constructed out of metal

The versorium is 1…A… which is allowed to pivot freely on a pedestal. It is similar to 2……, but unmagnetized. The needle is attracted 3…….. brought near it, turning towards the charged object.

Since it is able to distinguish between 4……, it is an example of a class of 5……. The versorium is of a similar construction to the magnetic compass, but 6……. rather than magnetic forces. At the time it was invented, the differences between 7 …….were poorly understood and Gilbert did a series of experiments to prove they were two separate types of forces with the versorium and 8….. (or «little Earth»). In fact, Gilbert was the first to draw a clear distinction between 9….. and is credited with establishing the term 10……...

10. Translate the sentences from English into Russian.

1. Electricity is a phenomenon associated with stationary or moving electric charges.
2. The discovery of the electron, which carries a charge designated as negative, showed that the various manifestations of electricity are the result of the accumulation or motion of numbers of electrons.
3. If the numbers of electrons and protons are equal, the atom is electrically neutral.
4. The charge can be built up by rubbing certain objects together, such as silk and glass or rubber and fur.
5. Electricity, especially at high voltages or high currents, is a dangerous commodity.

6. Studies have shown a correlation between electromagnetic fields and cancer, but many of the studies have been challenged as methodologically flawed.
7. Other dangers from electricity include stray voltage and electromagnetic field radiation.
8. The generation, transmission, and distribution of electric power are heavily regulated.
9. The electric generator was invented by Michael Faraday in 1831.
10. A flow of electric charge constitutes an electric current.

GRAMMAR REVISION

11. Change the sentences from the Active into the Passive Voice.

1. The senior students laughed at the freshman.
2. The group spoke to the dean yesterday.
3. Young mothers looked after their babies with great care.
4. Nobody lived in that old house.
5. We thought about our friend all the time.
6. The doctor will operate on him in a week.
7. The teacher sent for the pupils parents.
8. They looked for the newspaper everywhere.
9. Nobody slept in the bed.
10. The neighbor asked for the telegram.

12. Use the correct form of the verb in the Passive Voice.

1. The roads (cover) with the snow. – Дороги покрыты снегом.
2. Chocolate (make) from cocoa. – Шоколад изготавливается из какао.
3. The Pyramids (build) in Egypt. – Пирамиды были построены в Египте.
4. This coat (buy) four years ago. – Это пальто было куплено 4 года назад.
5. The stadium (open) next month. – Стадион будет открыт в следующем месяце.
6. Your parents (invite) to a meeting. – Твои родители будут приглашены на собрание.
7. Where is your car? – It (mend) at the moment. – Где твоя машина? – В данный момент она ремонтируется.
8. The books already (pack). – Книги уже упакованы.
9. The castle can (see) from a long distance. – Замок можно увидеть издалека.
10. The guests must (meet) at noon. – Гости должны быть встречены в полдень.

13. Make sentences in the Passive voice like in the example:

10 schools/ build/last year. – 10 schools were built last year. (10 школ было построено в прошлом году).

1. The museum/open/in 2005. (Музей был открыт в 2005 г.).
2. 3000 books/sell/every week. (3000 книг продается каждую неделю).
3. The parcel/deliver/tomorrow morning. (Посылку доставят завтра утром).
4. The flight/not cancel/because of the rain. (Рейс не отменили из-за дождя).
5. This wine/not produce/next year. (Это вино не будет производиться в следующем году).
6. Paper/make/from wood. (Бумагу изготовляют из дерева).
7. Coffee/not grow/in Russia. (Кофе не выращивают в России).
8. The New Year tree/decorate/last night. (Елку украсили вчера вечером).
9. The airport/surround/by soldiers. (Аэропорт окружен солдатами).
10. I/tell/to keep silent. (Мне сказали молчать).

SPEAKING

14. Use the words and phrases below to make sentences.

given pressure, voltage drop, superconductor, electrical resistance, critical temperature, absolute zero, classical physics, development, electric control, electric current.

15. Work in pairs. Think of some questions to review the contents of the text about the conductance, resistance and superconductivity and ask each other.

WRITING

16. Read the text and write an abstract to the following text. The length of the abstract is 100–120 words (see Appendix).

VOLTAGE DROP

Voltage drop is the reduction in voltage in the passive elements (not containing sources) of an electrical circuit. Voltage drops across conductors, contacts, connectors and source internal resistances are undesired as they reduce the supplied voltage (think: drain the battery) while voltage drops across loads and other electrical and electronic elements are useful and desired.

In electrical wiring, national and local electrical codes may set guidelines for maximum voltage drop allowed in a circuit conductors, to ensure

reasonable efficiency of distribution and proper operation of electrical equipment (the maximum permitted voltage drop varies from one country to another). Voltage drop may be neglected when the impedance of the interconnecting conductors is small relative to the other components of the circuit. For example, an electric space heater may very well have a resistance of ten ohms, and the wires which supply it may have a resistance of 0.2 ohms, about 2 % of the total circuit resistance. This means that 2 % of the supplied voltage is lost in the wire itself. Excessive voltage drop will result in unsatisfactory operation of electrical equipment, and represents energy wasted in the wiring system. Voltage drop can also cause damage to electrical motors.

In electronic design and power transmission, various techniques are used to compensate for the effect of voltage drop on long circuits or where voltage levels must be accurately maintained. The simplest way to reduce voltage drop is to increase the diameter of the conductor between the source and the load which lowers the overall resistance. The more sophisticated techniques use active elements to compensate the undesired voltage drop.

SELF-STUDY

READING

TEXT 1

1. Read the text and say whether the sentences are true or false.

THE MODERN DISTRIBUTION SYSTEM

The modern distribution system begins as the primary circuit leaves the sub-station and ends as the secondary service enters the customer's meter socket. Distribution circuits serve many customers. The voltage used is appropriate for the shorter distance and varies from 2,300 to about 35,000 volts depending on utility standard practice, distance, and load to be served. Distribution circuits are fed from a transformer located in an electrical substation, where the voltage is reduced from the high values used for power transmission.

Conductors for distribution may be carried on overhead pole lines, or in densely-populated areas where they are buried underground. Urban and sub-urban distribution is done with three-phase systems to serve both residential, commercial, and industrial loads. Distribution in rural areas may be only single-phase if it is not economical to install three-phase power for relatively few and small customers.

Only large consumers are fed directly from distribution voltages; most utility customers are connected to a transformer, which reduces the distribution voltage to the relatively low voltage used by lighting and interior wiring systems. The transformer may be pole-mounted or set on the ground in a protective enclosure. In rural areas a pole-mount transformer may serve only one customer, but in more built-up areas multiple customers may be connected. In very dense city areas, a secondary network may be formed with many transformers feeding into a common bus at the utilization voltage. Each customer has an «electrical service» or «service drop» connection and a meter for billing. (Some very small loads, such as yard lights, may be too small to meter and so are charged only a monthly rate).

A ground connection to local earth is normally provided for the customer's system as well as for the equipment owned by the utility. The purpose of connecting the customer's system to ground is to limit the voltage that may develop if high voltage conductors fall on the lower-voltage conductors, or if a failure occurs within a distribution transformer. If all conductive objects are bonded to the same earth grounding system, the risk of electric shock is minimized. However, multiple connections between the utility ground and customer ground can lead to stray voltage problems; customer piping, swimming pools or other equipment may develop objectionable voltages. These

problems may be difficult to resolve since they often originate from places other than the customer's premises.

1. The voltage used is appropriate for the longer distance and varies from 2,300 to about 35,000 volts.
2. Distribution circuits are fed from a transformer located in an electrical substation, where the voltage is reduced from the high values used for power transmission.
3. Conductors for distribution may be carried on overhead pole lines, or be buried underground.
4. Most utility customers are connected to a transformer, which reduces the distribution voltage to the relatively low voltage used by lighting and interior wiring systems.
5. In rural areas a pole-mount transformer may not serve only one customer,
6. In very dense city areas, a secondary network may be formed with many transformers feeding into a common bus at the utilization voltage.
7. The purpose of connecting the customer's system to ground is to limit the voltage that may develop if high voltage conductors fall on the lower-voltage conductors.
8. If all conductive objects are bonded to the same earth grounding system, the risk of electric shock is maximized.
9. Multiple connections between the utility ground and customer ground can lead to stray voltage problems.
10. The problems never originate from places other than the customer's premises.

TEXT 2

2. Read the text and choose the right option (A–C) for every question (1–5).

PHOTORESISTOR

A photoresistor or light dependent resistor (LDR) is a resistor whose resistance decreases with increasing incident light intensity. It can also be referred to as a photoconductor.

A photoresistor is made of a high resistance semiconductor. If light falling on the device is of high enough frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electron (and its hole partner) conduct electricity, thereby lowering resistance.

A photoelectric device can be either intrinsic or extrinsic. An intrinsic semiconductor has its own charge carriers and is not an efficient semiconductor, e.g. silicon. In intrinsic devices the only available electrons are in the valence band, and hence the photon must have enough energy to excite the elec-

tron across the entire bandgap. Extrinsic devices have impurities, also called dopants, whose ground state energy is closer to the conduction band; since the electrons do not have as far to jump, lower energy photons (i.e., longer wavelengths and lower frequencies) are sufficient to trigger the device. If a sample of silicon has some of its atoms replaced by phosphorus atoms (impurities), there will be extra electrons available for conduction. This is an example of an extrinsic semiconductor.

Photoresistors come in many different types. Inexpensive cadmium sulfide cells can be found in many consumer items such as camera light meters, street lights, clock radios, alarms, and outdoor clocks.

They are also used in some dynamic compressors together with a small incandescent lamp or light emitting diode to control gain reduction.

Lead sulfide (PbS) and indium antimonide (InSb) LDRs (light dependent resistor) are used for the mid infrared spectral region. Ge:Cu photoconductors are among the best far-infrared detectors available, and are used for infrared astronomy and infrared spectroscopy.

1. A photoresistor is a resistor whose resistance …... with increasing incident light intensity.
   A. increases
   B. decreases
   C. excite
2. A photoresistor is made of a high resistance.
   A. semiconductor
   B. insulator
   C. conductor
3. Extrinsic devices have …... also called dopants.
   A. impurities
   B. detectors
   C. spectral region
4. If a sample of silicon has some of its atoms replaced by phosphorus atoms, there will be extra electrons available for.
   A. resistance
   B. conduction
   C. lowering resistance
5. Photoresistors are also used in some dynamic compressors to control gain …….
   A. production
   B. reduction
   C. conduction

VOCABULARY AND GRAMMAR TEST

3. Choose the right option (A–C) for every question (1–10). The example is given.

1. Voltage drop is the ***reduction*** in voltage in the passive elements (not containing sources) of an electrical circuit.
   A. reduction
   B. conduction
   C. resistance
2. Resistance is a material's opposition to the flow of electric …...
   A. occurrence
   B. current
   C. reduction
3. Resistance is …... in ohms.
   A. facilitated
   B. measured
   C. decreased
4. The resistance and conductance of a wire, resistor, or other element is generally determined by shape and ……
   A. energy
   B. mechanics
   C. materials.
5. Electron is a stable elementary …... present in all atoms, orbiting the nucleus in numbers equal to the atomic number of the element in the neutral atom.
   A. particle
   B. energy
   C. property
6. Electric current is a flow of electric …… through a medium.
   A. particle
   B. charge
   C. material
7. A photoresistor is made of a high …… semiconductor.
   A. resistance
   B. energy
   C. material

8. Superconductivity ……by Heike Kamerlingh Onnes on April 8, 1911 in Leiden.
   A. is discovered
   B. was discover
   C. was discovered
9. There …... a hypothesis that electron pairing in high-temperature superconductors is mediated by short-range spin waves known as paramagnons.
   A. is
   B. are
   C. be
10. If these pressures …… equal, no water will flow.
   A. will be
   B. are
   C. were

TRANSLATION

4. Translate the sentences from English into Russian.

1. It is also recommended to avoid a parallel running of power and signal control coaxial cables.
2. Also, for each signal a separate two-core control cable must be used, since common return of different analogue signals is not recommended.
3. In a fixed construction, all the feeders in the switchboard, feeding the various load points, are securely mounted in the assembly and rigidly connected to the main bus.
4. In the event of a fault in one feeder on the bus side, a shutdown of the entire switchboard may be required.
5. A process industry or critical loads can ill afford such an arrangement.
6. However, since this is the most cost-effective switchboard, it is also the most common type and is used extensively.
7. Transformer is an electrical machine consisting of a set of inductively associated windings on any magnetic wire.
8. In such cases a draw-out type switchboard will prove to be a better choice.
9. A fixed-type construction may further be classified as follows.
10. In this construction there is a common bus that runs horizontally and is mounted on vertical floor structures.

WRITING

5. Read the text and write an abstract to the following text. The length of the abstract is 100–120 words (see Appendix).

DISTRIBUTION NETWORK CONFIGURATION

Distribution networks are typically of two types, radial or interconnected (see spot network). A radial network leaves the station and passes through the network area with no normal connection to any other supply. This is typical of long rural lines with isolated load areas. An interconnected network is generally found in more urban areas and will have multiple connections to other points of supply. These points of connection are normally open but allow various configurations by the operating utility by closing and opening switches. Operation of these switches may be by remote control from a control centre or by a lineman. The benefit of the interconnected model is that in the event of a fault or required maintenance a small area of network can be isolated and the remainder kept on supply.

Within these networks there may be a mix of overhead line construction utilizing traditional utility poles and wires and, increasingly, underground construction with cables and indoor or cabinet substations. However, underground distribution is significantly more expensive than overhead construction. In part to reduce this cost, underground power lines are sometimes co-located with other utility lines in what are called common utility ducts. Distribution feeders emanating from a substation are generally controlled by a circuit breaker which will open when a fault is detected. Automatic circuit reclosers may be installed to further segregate the feeder thus minimizing the impact of faults.

Long feeders experience voltage drop requiring capacitors or voltage regulators to be installed.

Characteristics of the supply given to customers are generally mandated by contract between the supplier and customer. Variables of the supply include:

- AC or DC – Virtually all public electricity supplies are AC today. Users of large amounts of DC power such as some electric railways, telephone exchanges and industrial processes such as aluminum smelting usually either operate their own or have adjacent dedicated generating equipment, or use rectifiers to derive DC from the public AC supply.
- Voltage, including tolerance (usually +10 or −15 percent).
- Frequency, commonly 50 or 60 Hz, 16.6 Hz and 25 Hz for some railways and, in a few older industrial and mining locations, 25 Hz. [2]

- Phase configuration (single-phase, polyphase including two-phase and three-phase).
- Maximum demand (usually measured as the largest amount of power delivered within a 15 or 30 minute period during a billing period).
- Load factor, expressed as a ratio of average load to peak load over a period of time. Load factor indicates the degree of effective utilization of equipment (and capital investment) of distribution line or system.
- Power factor of connected load.
- Earthing systems – TT, TN-S, TN-C-S or TN-C.
- Prospective short circuit current.
- Maximum level and frequency of occurrence of transients.

SELF-STUDY / KEYS

Reading

Text 1

1. T
2. T
3. T
4. T
5. F
6. T
7. T
8. F
9. T
10. F

Text 2

1. B
2. A
3. A
4. B
5. B

Vocabulary and Grammar

2. B
3. B
4. C
5. A
6. B
7. A
8. C
9. A

TRANSLATION

1. Кроме того, рекомендуется избегать параллельного функционирования силовых и управляющих сигналов коаксиальных кабелей.
2. Кроме того, для каждого сигнала необходимо использовать отдельный двужильный кабель управления, так как общий возврат различных аналоговых сигналов не рекомендуется.
3. В стационарной конструкции, все подводки в распределительном щите, питающие различные точки нагрузки, надежно закреплены в сборке и прочно соединены с основной шиной.
4. В случае неисправности одой подводки шины, может потребоваться отключение всего распределительного щита.
5. Непрерывное производство или критические нагрузки не могут позволить себе такое устройство.
6. Тем не менее, так как он является наиболее экономически эффективным распределительным щитом, он также является наиболее распространенным типом и широко используется.
7. Трансформатор представляет собой электрическую машину, состоящую из множества индуктивно связанных обмоток на любом магнитном проводе.
8. В таких случаях распределительный щит с выдвижными блоками окажется лучшим выбором.
9. Конструкция фиксированного типа может быть дополнительно классифицирована следующим образом.
10. В этой конструкции есть общая шина, которая проходит горизонтально и крепится на вертикальное перекрытие конструкций.

CONTROL WORK № 1

Variant 1

READING

Text 1

1. Read the text, and match the questions (A–F) to the numbered spaces (1–5), as in the example (0).

A. How did the invention of the incandescent light bulb change people's life?
B. Was Edison the only one who dealt with electricity?
C. What did Thomas Edison and George Westinghouse do to control the industry?
D. What was invented by Thomas Alva Edison?
E. Why did many inventors try to perfect incandescent lamps?
F. How do incandescent lamps make light?

THE MODERN WORLD IS AN ELECTRIFIED WORLD

0. The *incandescent light bulb* changed human existence by illuminating the night and making it hospitable to a wide range of human activity.

1. The electric light, one of the everyday conveniences that most affects our lives, was invented in 1879 by Thomas Alva Edison.

2. Incandescent lamps make light by using electricity *to heat a thin strip of material* (called a filament) until it gets hot enough to glow.

3. Many inventors had tried to perfect incandescent lamps to «subdivide» electric light or make it smaller and weaker than it was in the existing electric arc lamps, which were too bright to be used for small spaces such as the rooms of a house.

4. Edison was neither the first nor the only person trying to invent an incandescent electric lamp. Many inventors had tried and failed, some were discouraged and went on to invent other devices. Among those inventors who made a step forward in understanding the *eclectic light* were Sir Humphrey Davy, Warren De la Rue, James Bowman Lindsay, James Prescott Joule, Frederick de Moleyns and Heinrich Göbel.

5. Between the years 1878 and 1892 the electric light industry was growing. Thomas Edison and George Westinghouse determined to control the industry. They formed the Board of Patent Control, a joint arrangement between General Electric and the Westinghouse Company.

Text 2

2. Read the article. Choose the best word (A, B or C) for each space (1–8).

RESISTIVITY OF VARIOUS MATERIALS

A conductor such as a metal has high 1…... and a low resistivity. An insulator like glass has low conductivity and a 2..…. resistivity.

The conductivity of a semiconductor is generally intermediate, but varies widely under different conditions, such as exposure of the material to 3…. fields or specific frequencies of light, and, most important, with temperature and composition of the semiconductor material.

The degree of doping in semiconductors makes a large difference in conductivity. To a point, more doping leads to higher 4….. The conductivity of a solution of water is highly 5…… on its concentration of dissolved salts, and other chemical species that ionize in the solution. Electrical conductivity of water samples is used as an 6…... of how salt-free, ion-free, or impurity-free the sample is; the purer the water, 7…... the conductivity (the higher the resistivity). Conductivity measurements in water are often reported as specific conductance, relative to the conductivity of pure water at 25 °C. An EC meter is normally used to 8…... conductivity in a solution.

1. a. conductivity	b. resistivity	c. impurity
2. a. conventional	b. low	c. high
3. a. electric	b. dielectric	c. specific
4. a. conductivity	b. transition	c. temperature
5. a. dependent	b. depend	c. dependency
6. a. conductor	b. insulator	c. indicator
7. a. the lower	b. the higher	c. the colder
8. a .decrease	b. increase	c. measure

VOCABULARY AND GRAMMAR TEST

3. Choose the right option.

1. In electronic design and …... transmission, various techniques are used to compensate for the effect of voltage drop.
   A. power
   B. current
   C. wire
2. Resistivity is electrical …... of a conductor of unit cross-sectional area and unit length.
   A. resistance

B. conductivity
C. transition

3. An electric current flowing in a loop of superconducting …… can persist indefinitely with no power source.
A. current
B. circuit
C. wire

4. Voltage drop is the reduction in ……. in the passive elements (not containing sources) of an electrical circuit.
A. voltage
B. power
C. resistance

5. The idea behind an electron gun is to create electrons and then …… them to a very high speed.
A. facilitate
B. accelerate
C. persist

6. Electric …… is a flow of electric charge through a medium.
A. current
B. circuit
C. wire

7. Electrical engineering is a field of engineering that generally deals …… the study and application of electricity, electronics and electromagnetism.
A. at
B. in
C. with

8. Electrical engineers …… new and better electronics.
A. design
B. designs
C. designers

9. Many projects …... at first.
A. does not work
B. do not works
C. do not work

10. Electrical engineers are usually concerned with using electricity to …… energy
A. transmit
B. transmission
C. transmitted

TRANSLATION

4. Translate the sentences from English into Russian.

1. The simplest way to reduce voltage drop is to increase the diameter of the conductor between the source and the load which lowers the overall resistance.
2. Excessive voltage drop will result in unsatisfactory operation of electrical equipment.
3. The earliest mention of electric phenomena is found in ancient Egyptian texts from about 2750 BC.
4. The magnetic effect of minerals like magnetite was known to the ancient Greeks.
5. In the 18th century, Benjamin Franklin first proved that lightning was electricity.
6. Electrical engineering gave rise to telecommunication.
7. Electrons can flow freely and easily through a copper wire, but cannot as easily flow through a steel wire of the same shape and size.
8. The difference between, copper, steel, and rubber is related to their microscopic structure and electron configuration, and is quantified by a property called resistivity.
9. The voltage drop is the driving force pushing current through a resistor.
10. Conductance and resistance are reciprocals.

WRITING

5. Read the text and write an abstract.

WELCOME TO CALTECH ELECTRICAL ENGINEERING

EE at Caltech has a century-long record of excellence, innovation and training many distinguished leaders in the field. As a discipline, EE has had a huge impact on the technologies that define modern-day life and society.

EE at Caltech emphasizes both the fundamentals of electronics and systems, as well as acknowledging the multi-disciplinary nature of the field. Closely allied with Computation and Neural Systems, Applied Physics, Bioengineering, Computer Science, and Control and Dynamical System, it offers students the opportunity for study and research, both theoretical and experimental, in a wide variety of subjects, including wireless systems, quantum electronics, modern optics, lasers and guided waves, solid-state materials and devices, bio-optics and bio-electronics, power and energy systems, control theory, learning systems, computational finance, signal processing, data

compression, communications, parallel and distributed computing, fault-tolerant computing, and computational vision.

Substantial experimental laboratory facilities, housed mainly in the Moore Laboratory of Engineering, are associated with each of these research fields. The Charles Wilts Prize is awarded every year to one EE graduate student for outstanding independent research in Electrical Engineering leading to a PhD.

Caltech has a reputation as a world-class research university, and it is no exaggeration to say that much of this reputation is based on the quality of its graduate students. Its bright and motivated graduate students collaborate with its professors in their research efforts and make it one of the top Electrical Engineering departments in the country.

Variant 2

READING

Text 1

1. Read the text, and match the questions (A–F) to the numbered spaces (1–5), as in the example (0).

A. How is current often described in engineering or household applications?
B. What current reverses direction repeatedly?
C. What concept was introduced by Michael Faraday?
D. What is alternating current affected by?
E. What is direct current?
F. What is the time-averaged value of an alternating current?

0. In engineering or household applications, *current* is often described as being either direct current (DC) or alternating current (AC). These terms refer to how the current varies in time.

1. Direct current, as produced by example from a battery and required by most electronic devices, is a unidirectional flow from the positive part of a circuit to the negative. If, as is most common, this flow is carried by electrons, they will be travelling in the opposite direction.

2. Alternating current is any current that reverses direction repeatedly; almost always this takes the form of a sinusoidal wave. Alternating current thus pulses back and forth within a conductor without the charge moving any net distance over time.

3. The time-averaged value of an alternating current is zero, but it delivers energy in first one direction, and then the reverse.

4. Alternating current is affected by electrical properties that are not observed under steady state direct current, such as inductance and capacitance. These properties, however, can become important when circuitry is subjected to transients, such as when first energised.

5. The concept of the electric field was introduced by Michael Faraday. An electric field is created by a charged body in the space that surrounds it, and results in a force exerted on any other charges placed within the field.

Text 2

2. Read the text. Choose the best word (A, B or C) for each space (1–8).

WHAT DO ELECTRICAL ENGINEERS DO?

Electrical engineers design computers and incorporate them into 1….. and systems. They design two-way communications systems such as telephones and fiber-optic systems, and one-way communications systems such as radio and television. They design control systems, such as aircraft collision-avoidance systems, and a variety of systems used in medical electronics. Electrical engineers are involved with 2….., control, and delivery of electric 3….. to homes, offices, and industry. 4….. power lights, heats, and cools working and living space and operates the many devices used in homes and offices. Electrical engineers analyze and interpret computer-aided tomography data, seismic data from earthquakes and well drilling, and data from space probes. They 5….. with systems that educate and entertain, such as computers and computer networks, compact-disk players, and multimedia systems.

The 6…… of communications equipment, control systems, computers, and other devices and processes into reliable, easily understood, and practical systems is a major challenge, which has given rise to the discipline of systems engineering. Electrical 7….. must respond to numerous demands, including signal 8….., better communications; faster and more reliable transfer of funds, orders, and information in the business world; and the need of medical professionals for access to medical data and advice from all parts of the world.

1. a. devices	b. circuits	c. currents
2. a. correlation.	b. gravitation	c. generation
3. a. power	b. charge	c. voltage
4. a. electricity	b. electric	c. electronic
5. a. deal	b. design	c. depend
6. a. correlation	b. integration	c. transmission
7. a. power	b. equipment	c. engineering
8. a. processing	b. induction	c. accumulation

GRAMMAR AND VOCABULARY TEST

3. Choose the right option.

1. …... guns are actually the devices that are the heart of most TVs and computer monitors.
   A. electrical
   B. electricity
   C. electron

2. Electrical engineering …… with the problems associated with large-scale electrical systems such as power transmission and motor control
   A. resist
   B. has
   C. deals

3 Resistivity of semiconductors, such as carbon and silicon, generally …... with temperature rise.
   A. decreases
   B. measures
   C. occurs

4. Electrical engineers …… on many kinds of products.
   A. work
   B. working
   C. works

5. The value of resistivity…... also on the temperature of the material.
   A. depends
   B. resists
   C. powers

6. The …... can be built up by rubbing certain objects together, such as silk and glass or rubber and fur.
   A. electron
   B. atom
   C. charge

7. Electric fields …... by a charged body in the space that surrounds it.
   A. is created
   B. are created
   C. is creating

8. An electric …… is an interconnection of electric components, usually to perform some useful task, with a return path to enable the charge to return to its source.
   A. circuit
   B. field
   C. charge
9. Electrical …... is usually generated by electro-mechanical generators driven by steam produced from fossil fuel combustion.
   A. energy
   B. circuit
   C. charge
10. Electric current in a wire, where the charge carriers are electrons, is a …… of the quantity of charge passing any point of the wire per unit of time
    A. energy
    B. measure
    C. power

TRANSLATION

4. Translate the sentences from English into Russian.

1. The discovery of the electron, which carries a charge designated as negative, showed that the various manifestations of electricity are the result of the accumulation or motion of numbers of electrons.
2. Electricity is a phenomenon associated with stationary or moving electric charges.
3. A long, thin copper wire has higher resistance (lower conductance) than a short, thick copper wire.
4. A photoresistor or light dependent resistor (LDR) is a resistor whose resistance decreases with increasing incident light intensity.
5. Photoresistors can be found in many consumer items such as camera light meters, street lights, clock radios, alarms, and outdoor clocks.
6. The electric light, one of the everyday conveniences that most affects our lives, was invented in 1879 by Thomas Alva Edison.
7. The need for electrical engineers was not felt until the invention of the telephone (1876) and the incandescent lamp.
8. Electrical engineering is concerned with the practical applications of electricity in all its forms, including those of electronics.

9. The Charles Wilts Prize is awarded every year to one graduate student for outstanding independent research in Electrical Engineering.
10. The university offers students the opportunity for study and research, both theoretical and experimental, in a wide variety of subjects, including wireless systems and quantum electronics.

WRITING

5. Read the text and write an abstract. The length of the abstract is 100–120 words (see Appendix).

The modern world is an electrified world. The incandescent light bulb changed human existence by illuminating the night and making it hospitable to a wide range of human activity. The electric light, one of the everyday conveniences that most affects our lives, was invented in 1879 by Thomas Alva Edison. Incandescent lamps make light by using electricity to heat a thin strip of material (called a filament) until it gets hot enough to glow. Many inventors had tried to perfect incandescent lamps to «sub-divide» electric light or make it smaller and weaker than it was in the existing electric arc lamps, which were too bright to be used for small spaces such as the rooms of a house.

Edison was neither the first nor the only person trying to invent an incandescent electric lamp. Many inventors had tried and failed, some were discouraged and went on to invent other devices. Among those inventors who made a step forward in understanding the eclectic light were Sir Humphrey Davy, Warren De la Rue, James Bowman Lindsay, James Prescott Joule, Frederick de Moleyns and Heinrich Göbel.

Between the years 1878 and 1892 the electric light industry was growing. Thomas Edison and George Westinghouse determined to control the industry and its advancement. They formed the Board of Patent Control, a joint arrangement between General Electric and the Westinghouse Company.

Variant 3

READING

Text 1

1. Read the text. Choose the best word (A, B or C) for each space (1–8).

WHAT DO ELECTRICAL ENGINEERS DO?

Electrical engineers design computers and incorporate them into 1…… and systems. They design two-way communications systems such as telephones and fiber-optic systems, and one-way communications systems such as radio and television. They design control systems, such as aircraft collision-avoidance systems, and a variety of systems used in medical electronics. Electrical engineers are involved with 2….., control, and delivery of electric 3….. to homes, offices, and industry. 4…... power lights, heats, and cools working and living space and operates the many devices used in homes and offices. Electrical engineers analyze and interpret computer-aided tomography data, seismic data from earthquakes and well drilling, and data from space probes. They 5…... with systems that educate and entertain, such as computers and computer networks, compact-disk players, and multimedia systems.

The 6…… of communications equipment, control systems, computers, and other devices and processes into reliable, easily understood, and practical systems is a major challenge, which has given rise to the discipline of systems engineering. Electrical 7…... must respond to numerous demands, including signal 8…..., better communications; faster and more reliable transfer of funds, orders, and information in the business world; and the need of medical professionals for access to medical data and advice from all parts of the world.

1. a. devices	b. circuits	c. currents
2. a. correlation	b. gravitation	c. generation
3. a. power	b. charge	c. voltage
4. a. electricity	b. electric	c. electronic
5. a. deal	b. design	c. depend
6. a. correlation	b. integration	c. transmission
7. a. power	b. equipment	c. engineering
8. a. processing	b. induction	c. accumulation

Text 2

2. Read the text, and match the questions (A–F) to the numbered spaces (1–5), as in the example (0).

A. How did the invention of the incandescent light bulb change people's life?
B. Was Edison the only one who dealt with electricity?
C. What did Thomas Edison and George Westinghouse do to control the industry?
D. What was invented by Thomas Alva Edison?
E. Why did many inventors try to perfect incandescent lamps?
F. How do incandescent lamps make light?

The modern world is an electrified world

0. The **incandescent** light bulb changed human existence by illuminating the night and making it hospitable to a wide range of human activity.

1. The electric light, one of the everyday conveniences that most affects our lives, was invented in 1879 by Thomas Alva Edison.

2. Incandescent lamps make light by using electricity *to* heat a thin strip of material (called a filament) until it gets hot enough to glow.

3. Many inventors had tried to perfect incandescent lamps to «subdivide» electric light or make it smaller and weaker than it was in the existing electric arc lamps, which were too bright to be used for small spaces such as the rooms of a house.

4. Edison was neither the first nor the only person trying to invent an incandescent electric lamp. Many inventors had tried and failed ,some were discouraged and went on to invent other devices. Among those inventors who made a step forward in understanding the eclectic light were Sir Humphrey Davy, Warren De la Rue, James Bowman Lindsay, James Prescott Joule, Frederick de Moleyns and Heinrich Göbel.

5. Between the years 1878 and 1892 the electric light industry was growing. Thomas Edison and George Westinghouse determined to control the industry. They formed the Board of Patent Control, a joint arrangement between General Electric and the Westinghouse Company.

GRAMMAR AND VOCABULARY TEST

3. Choose the right option.

1. Resistivity is electrical …... of a conductor of unit cross-sectional area and unit length.
   A. resistance
   B. conductivity
   C. transition
2. Electrical engineering …… with the problems associated with large-scale electrical systems such as power transmission and motor control.
   A. resist
   B. has
   C. deals
3 Resistivity of semiconductors, such as carbon and silicon, generally …... with temperature rise.
   A. decreases
   B. measures
   C. occurs
4. Electrical engineers …on many kinds of products.
   A. work
   B. working
   C. works
5. Electric …... is a flow of electric charge through a medium.
   A. current
   B. circuit
   C. wire
6. Electrical engineering is a field of engineering that generally deals …... the study and application of electricity, electronics and electromagnetism.
   A. at
   B. in
   C. with
7. Electrical engineers ..…. new and better electronics.
   A. design
   B. designs
   C. designers

8. Many projects …... at first.
   A. does not work
   B. do not works
   C. do not work

9. Electrical engineers are usually concerned with using electricity to …… energy.
   A. transmit
   B. transmission
   C. transmitted

10. In electronic design and …… transmission, various techniques are used to compensate for the effect of voltage drop.
   A. power
   B. current
   C. wire

TRANSLATION

4. Translate the sentences from English into Russian.

1. The discovery of the electron, which carries a charge designated as negative, showed that the various manifestations of electricity are the result of the accumulation or motion of numbers of electrons.
2. Electricity is a phenomenon associated with stationary or moving electric charges.
3. A long, thin copper wire has higher resistance (lower conductance) than a short, thick copper wire.
4. A photoresistor or light dependent resistor (LDR) is a resistor whose resistance decreases with increasing incident light intensity.
5. The simplest way to reduce voltage drop is to increase the diameter of the conductor between the source and the load which lowers the overall resistance.
6. Excessive voltage drop will result in unsatisfactory operation of electrical equipment.
7. Electrons can flow freely and easily through a copper wire, but cannot as easily flow through a steel wire of the same shape and size.
8. The difference between, copper, steel, and rubber is related to their microscopic structure and electron configuration, and is quantified by a property called resistivity.
9. The voltage drop is the driving force pushing current through a resistor.
10. Conductance and resistance are reciprocals.

WRITING

5. Read the text and write an abstract. The length of the abstract is 100–120 words (see Appendix).

WELCOME TO CALTECH ELECTRICAL ENGINEERING

EE at Caltech has a century-long record of excellence, innovation and training many distinguished leaders in the field. As a discipline, EE has had a huge impact on the technologies that define modern-day life and society.

EE at Caltech emphasizes both the fundamentals of electronics and systems, as well as acknowledging the multi-disciplinary nature of the field. Closely allied with Computation and Neural Systems, Applied Physics, Bioengineering, Computer Science, and Control and Dynamical System, it offers students the opportunity for study and research, both theoretical and experimental, in a wide variety of subjects, including wireless systems, quantum electronics, modern optics, lasers and guided waves, solid-state materials and devices, bio-optics and bio-electronics, power and energy systems, control theory, learning systems, computational finance, signal processing, data compression, communications, parallel and distributed computing, fault-tolerant computing, and computational vision.

Substantial experimental laboratory facilities, housed mainly in the Moore Laboratory of Engineering, are associated with each of these research fields. The Charles Wilts Prize is awarded every year to one EE graduate student for outstanding independent research in Electrical Engineering leading to a PhD.

Caltech has a reputation as a world-class research university, and it is no exaggeration to say that much of this reputation is based on the quality of its graduate students. Its bright and motivated graduate students collaborate with its professors in their research efforts and make it one of the top Electrical Engineering departments in the country.

Variant 4

READING

Text 1

1. Read the article. Choose the best word (A, B or C) for each space (1–8).

RESISTIVITY OF VARIOUS MATERIALS

A conductor such as a metal has high 1…... and a low resistivity. An insulator like glass has low conductivity and a 2…... resistivity.

The conductivity of a semiconductor is generally intermediate, but varies widely under different conditions, such as exposure of the material to 3…... fields or specific frequencies of light, and, most important, with temperature and composition of the semiconductor material.

The degree of doping in semiconductors makes a large difference in conductivity. To a point, more doping leads to higher 4…... The conductivity of a solution of water is highly 5…… on its concentration of dissolved salts, and other chemical species that ionize in the solution. Electrical conductivity of water samples is used as an 6…... of how salt-free, ion-free, or impurity-free the sample is; the purer the water, 7…... the conductivity (the higher the resistivity). Conductivity measurements in water are often reported as specific conductance, relative to the conductivity of pure water at 25 °C. An EC meter is normally used to 8…... conductivity in a solution.

1. a. conductivity	b. resistivity	c. impurity
2. a. conventional	b. low	c. high
3. a. electric	b. dielectric	c. specific
4. a. conductivity	b. transition	c. temperature
5. a. dependent	b. depend	c. dependency
6. a. conductor	b. insulator	c. indicator
7. a. the lower	b. the higher	c. the colder
8. a. decrease	b. increase	c. measure

Text 2

2. Read the text, and match the questions (A–F) to the numbered spaces (1–5), as in the example (0).

A. How is current often described in engineering or household applications?
B. What current reverses direction repeatedly?
C. What concept was introduced by Michael Faraday?

D. What is alternating current affected by?
E. What is direct current?
F. What is the time-averaged value of an alternating current?

0. In engineering or household applications, current is often described as being either direct current (DC) or alternating current (AC). These terms refer to how the current varies in time.

1. Direct current, as produced by example from a battery and required by most electronic devices, is a unidirectional flow from the positive part of a circuit to the negative. If, as is most common, this flow is carried by electrons, they will be travelling in the opposite direction.

2. Alternating current is any current that reverses direction repeatedly; almost always this takes the form of a sinusoidal wave. Alternating current thus pulses back and forth within a conductor without the charge moving any net distance over time.

3. The time-averaged value of an alternating current is zero, but it delivers energy in first one direction, and then the reverse.

4. Alternating current is affected by electrical properties that are not observed under steady state direct current, such as inductance and capacitance. These properties however can become important when circuitry is subjected to transients, such as when first energised.

5. The concept of the electric field was introduced by Michael Faraday. An electric field is created by a charged body in the space that surrounds it, and results in a force exerted on any other charges placed within the field.

GRAMMAR AND VOCABULARY TEST

3. Choose the right option.

1. Electric current in a wire, where the charge carriers are electrons, is a …… of the quantity of charge passing any point of the wire per unit of time
   A. energy
   B. measure
   C. power

2. …... guns are actually the devices that are the heart of most TVs and computer monitors.
   A. electrical
   B. electricity
   C. electron

3. An electric current flowing in a loop of superconducting …… can persist indefinitely with no power source.
   A. current
   B. circuit
   C. wire

4. Voltage drop is the reduction in …... in the passive elements (not containing sources) of an electrical circuit.
   A. voltage
   B. power
   C. resisitance

5. Electric …... is a flow of electric charge through a medium.
   A. current
   B. circuit
   C. wire

6. The value of resistivity ..…. also on the temperature of the material.
   A. depends
   B. resisits
   C. powers

7. The …… can be built up by rubbing certain objects together, such as silk and glass or rubber and fur.
   A. electron
   B. atom
   C. charge

8. Electric fields …... by a charged body in the space that surrounds it.
   A. is created
   B. are created
   C. is creating

9. An electric ..…. is an interconnection of electric components, usually to perform some useful task, with a return path to enable the charge to return to its source.
   A. circuit
   B. field
   C. charge

10. Electrical ..…. is usually generated by electro-mechanical generators driven by steam produced from fossil fuel combustion.
    A. energy
    B. circuit
    C. charge

TRANSLATION

4. Translate the sentences from English into Russian.

1. The earliest mention of electric phenomena is found in ancient Egyptian texts from about 2750 BC.
2. The magnetic effect of minerals like magnetite was known to the ancient Greeks.
3. In the 18th century, Benjamin Franklin first proved that lightning was electricity.
4. Electrical engineering gave rise to telecommunication.
5. Photoresistors can be found in many consumer items such as camera light meters, street lights, clock radios, alarms, and outdoor clocks.
6. The electric light, one of the everyday conveniences that most affects our lives, was invented in 1879 by Thomas Alva Edison.
7. The need for electrical engineers was not felt until the invention of the telephone (1876) and the incandescent lamp.
8. Electrical engineering is concerned with the practical applications of electricity in all its forms, including those of electronics.
9. The Charles Wilts Prize is awarded every year to one graduate student for outstanding independent research in Electrical Engineering.
10. The university offers students the opportunity for study and research, both theoretical and experimental, in a wide variety of subjects, including wireless systems and quantum electronics.

WRITING

5. Read the text and write an abstract. The length of the abstract is 100–120 words (see Appendix).

The modern world is an electrified world. The incandescent light bulb changed human existence by illuminating the night and making it hospitable to a wide range of human activity. The electric light, one of the everyday conveniences that most affects our lives, was invented in 1879 by Thomas Alva Edison. Incandescent lamps make light by using electricity to heat a thin strip of material (called a filament) until it gets hot enough to glow. Many inventors had tried to perfect incandescent lamps to "sub-divide" electric light or make it smaller and weaker than it was in the existing electric arc lamps, which were too bright to be used for small spaces such as the rooms of a house.

Edison was neither the first nor the only person trying to invent an incandescent electric lamp. Many inventors had tried and failed, some were

discouraged and went on to invent other devices. Among those inventors who made a step forward in understanding the eclectic light were Sir Humphrey Davy, Warren De la Rue, James Bowman Lindsay, James Prescott Joule, Frederick de Moleyns and Heinrich Göbel.

Between the years 1878 and 1892 the electric light industry was growing. Thomas Edison and George Westinghouse determined to control the industry and its advancement. They formed the Board of Patent Control, a joint arrangement between General Electric and the Westinghouse Company.

UNIT 3

THE AGE OF ELECTRICITY

Text 1 The Age of Electricity **Text 2** Power Engineering **Grammar Revision**: Conditional sentences

LEAD-IN

1. Do you know when electricity was discovered? Who was the author of the discovery?

2. How did the discovery of electricity influence the scientific progress?

READING

3. Read the text below and decide if the sentences are True or False.

1. The age of electricity began in 1919.
2. The power grid is an electrical network that connects a variety of electric generators to the suppliers of electric power.
3. Users purchase electricity from the grid can not avoid the costly exercise of having to generate their own.
4. Transforming is important because higher voltages suffer less power loss during transmission.
5. To drive highly efficient electric motors such as induction motors you need three-phase power.
6. The losses, appearing in the form of heat, are equal to the current squared times the electrical resistance through which the current flows.

THE AGE OF ELECTRICITY

The age of electricity began with the work of Hans Christian Oersted (1777–1851), who demonstrated in 1819 that a current-caving conductor could produce a magnetic field. This was the first time that a relationship between electricity and magnetism had been established. Oersted's work started a chain of experiments across Europe that culminated in the discovery of electromagnetic induction by Michael Faraday (1791–1867) in 1831. Faraday demonstrated that it was possible to produce an electric current by means of a magnetic field and this subsequently led to the development of electric motors, generators and transformers.

In 1888 Nikola Tesla (1 856–1943) at Columbus, Ohio, USA, invented the first induction motor which has become the basic prime mover to run the wheels of industry today. Below, for simplicity, we first discuss a polyphase and then a single-phase motor.

Power Engineering deals with the generation, transmission and distribution of electricity as well as the design of a range of related devices. These include transformers, electric generators, electric motors and power electronics.

The power grid is an electrical network that connects a variety of electric generators to the users of electric power. Users purchase electricity from the grid avoiding the costly exercise of having to generate their own. Power engineers may work on the design and maintenance of the power grid as well as the power systems that connect to it. Such systems are called on-grid power systems and may supply the grid with additional power, draw power from the grid or do both.

Power engineers may also work on systems that do not connect to the grid. These systems are called off-grid power systems and may be used in preference to on-grid systems for a variety of reasons. For example, in remote locations it may be cheaper for a mine to generate its own power rather than pay for connection to the grid and in most mobile applications connection to the grid is simply not practical.

Today, most grids adopt three-phase electric power with alternating current. This choice can be partly attributed to the ease with which this type of power can be generated, transformed and used. Often the power is split before it reaches residential customers whose low-power appliances rely upon single-phase electric power. However, many larger industries and organizations still prefer to receive the three-phase power directly because it can be used to drive highly efficient electric motors such as three-phase induction motors.

Transformers play an important role in power transmission because they allow power to be converted to and from higher voltages. This is important because higher voltages suffer less power loss during transmission. This is because higher voltages allow for lower current to deliver the same amount of power, as power is the product of the two. Thus, as the voltage steps up, the current steps down. It is the current flowing through the components that result in both the losses and the subsequent heating. These losses, appearing in the form of heat, are equal to the current squared times the electrical resistance through which the current flows, so as the voltage goes up the losses are dramatically reduced.

For these reasons, electrical substations exist throughout power grids to convert power to higher voltages before transmission and to lower voltages suitable for appliances after transmission.

4. Answer the questions.

1. When did the age of electricity begin?
2. What was the invention of N. Tesla?
3. What does power engineering deal with?
4. How can you call the systems which are not connected to the grid?
5. Where are single-phase and three-phase electric powers used?
6. What is the aim of increasing voltage?

5. Read the text below and decide if the sentences are TRUE or FALSE.

1. Modern power engineering consists of two main subsystems.
2. There are several different transformation processes, among which are chemical, photo-voltaic, and electromechanical.
3. The turbine-generator conversion process is the most economical and most common in the industry today.
4. Transmission circuits may be built only underground.
5. There are four possible causes for power flow limitations to a transmission line.
6. Without adequate contact protection, the occurrence of undesired electric arcing causes significant degradation of the contacts, which suffer serious damage.

POWER ENGINEERING

Power engineering is a network of interconnected components which convert different forms of energy to electrical energy. Modern power engineering consists of three main subsystems: the generation subsystem, the transmission subsystem, and the distribution subsystem. In the generation subsystem, the power plant produces the electricity. The transmission subsystem transmits the electricity to the load centers. The distribution subsystem continues to transmit the power to the customers.

Generation of electrical power is a process whereby energy is transformed into an electrical form. There are several different transformation processes, among which are chemical, photo-voltaic, and electromechanical. Electromechanical energy conversion is used in converting energy from coal, petroleum, natural gas, uranium into electrical energy. Of these, all except the wind energy conversion process take advantage of the synchronous AC generator coupled to a steam, gas or hydro turbine such that the turbine converts steam, gas, or water flow into rotational energy, and the synchronous generator then converts the rotational energy of the turbine into electrical energy. It is the turbine-generator conversion process that is by far most economical and consequently most common in the industry today.

The AC synchronous machine is the most common technology for generating electrical energy. It is called synchronous because the composite magnetic field produced by the three stator windings rotate at the same speed as the magnetic field produced by the field winding on the rotor. A simplified circuit model is used to analyze steady-state operating conditions for a synchronous machine. The phasor diagram is an effective tool for visualizing the relationships between internal voltage, armature current, and terminal voltage. The excitation control system is used on synchronous machines to regulate terminal voltage, and the turbine-governor system is used to regulate the speed of the machine.

The operating costs of generating electrical energy is determined by the fuel cost and the efficiency of the power station. The efficiency depends on generation level and can be obtained from the heat rate curve. We may also obtain the incremental cost curve from the heat rate curve.

6. Answer the questions.

1. What does modern power engineering consist of?
2. How do all three components function?
3. What is the generation of electrical power?
4. What are the forms of transformation process?
5. How does the AC synchronous machine work?

USE OF ENGLISH

7. Match the words to their definitions.

1	generation	A	change *o*r be able to change from one form to another
2	deal with	B	an electromotive force or potential difference expressed in volts
3	resistance	C	a device that converts mechanical energy to electrical energy for use in an external circuit.
4	subsequent	D	the production of something
5	convert	E	coming after something in time
6	voltage	F	capacity or performance of an engine or other device
7	transmission	G	be concerned with
8	power	H	the action of sharing something out among a number of recipients
9	distribution	I	ability of a substance or an electrical circuit to stop the flow of an electrical current through it
10	electric generator	J	the mechanism by which power is transmitted from an engine to the wheels of a motor vehicle

8. Fill in the blanks with the words from the table.

electric current	neutral wire	alternating currents
transfer	three-phase system	single-phase appliances

In a_____ 1 three circuit conductors carry three _____ 2 (of the same frequency) which reach their instantaneous peak values at different times. Taking one conductor as the reference, the other two currents are delayed in time by one-third and two-thirds of one cycle of the _____3. This delay between phases has the effect of giving constant power _____ 4 over each cycle of the current and also makes it possible to produce a rotating magnetic field in an electric motor.

Three-phase systems may have a _____ 5. A neutral wire allows the three-phase system to use a higher voltage while still supporting lower-voltage _____ 6. In high-voltage distribution situations, it is common not to have a neutral wire as the loads can simply be connected between phases (phase-phase connection).

9. Fill in the blanks with the necessary forms of the words from the right.

Single-phase loads may _____ 1 to a three-phase system in two ways. A load may be connected across two of the three phase _____ 2 or a load can be connected from a live phase conductor to the system neutral. Single-phase loads should be distributed _____ 3 between the phases of the three-phase system for efficient use of the supply transformer and supply conductors. Where the line-to-neutral voltage is a standard _____ 4 voltage (for example in a 230 V/400 V system), individual single-phase utility customers or loads may each be connected to a _____ 5 phase of the supply. Where the line-to-neutral voltage is not a common utilization voltage, for example in a 347/600 V system, single-phase loads must be supplied by individual step-down _____ 6.	1. CONNECT 2. CONDUCT 3. EVEN 4. UTILIZE 5. DIFFER 6. TRANSFORM

10. Translate the sentences from English into Russian.

1. Central processing unit (CPU) is the hardware within a computer system which carries out the instructions of a computer program by performing the basic arithmetical, logical, and input/output operations of the system.
2. This is in the form of a micro controller and can be called the brain of the PLC.
3. It computes and analyses the various data fed into it.
4. The protection equipment includes lightning protectors, circuit breakers, disconnectors and fuses.
5. Memory unit is the unit that stores the data and the messages and the diagnostic information.
6. It stores all the data that define the process to help the CPU act logically and also stores diagnostic information.
7. It is a part of a computer that contains arithmetical and logical controls and internal memory and programming devices.
8. The unit receives inputs (temperature, pressure, speed or any information which may form a part of the process) from the system.
9. The electricity is transported to load locations from a power station to a transmission subsystem.
10. A separate unit is used for programming and editing (e.g. a hand-held programmer or a computer).

GRAMMAR REVISION

TYPES OF CONDITIONALS

0	***If/When*** *the sun* ***shines***, *snow* ***melts***.
1	***Unless*** *he* ***pays*** *the fine*, *he* ***will go*** *to prison.* ***If*** *you* ***need help***, ***come*** *and* ***see*** *me.* ***If*** *you* ***have finished*** *your work*, *we* ***can have*** *a break.*
2	***If*** *I* ***had*** *time*, *I* ***would take up*** *a sport.* (*but I don't have time-untrue in the present*) ***If*** *I* ***were*** *you*, *I* ***would talk*** *to your parents about it.* (*giving advice*)
3	***If*** *she* ***had studied*** *harder*, *she* ***would have passed*** *the test.* ***If*** *he* ***hadn't been acting*** *so foolishly, he* ***wouldn't have been punished***.

11. Fill in the gaps with *if* or *unless*.

1. _____ you don't study materials science, you won't get to know how the materials can be fabricated to meet the needs of modern technology.
2. _____ scientists use the laboratory techniques, they will find new ways of using materials.
3. Engineers won't find new ways of technology, _____ they will have enough knowledge of physics and chemistry.
4. _____ the external force disappears, the materials return their original size.
5. The materials don't return their original size _____ there isn't an external force.
6. _____ there is an external force, the materials will have permanent deformation.
7. _____ the material is compressed, it will decrease in volume.
8. One side of the material will be subjected to a tensional force _____ a metal bar is bent.
9. _____ the material is under tension, it doesn't usually stretch.
10. The material ruptures _____ it is under greater forces.

12. Put the verbs in brackets into the proper tense. (Type 1, 2, 3 Conditionals).

1. The materials _____ (have) fracture if they are subjected to external forces.
2. The material would have permanent deformation if it _____ (be) under external forces.
3. If the engineers had thoroughly studied the material, they _____(fail) the experiment.
4. Both sides of the metal bar will be deformed if it _____ (be) bent.
5. If the material is compressed, it _____ (cause) a decrease in volume.
6. If the force _____ (not to exceed) the material's elastic limit, the material will return to its original length.
7. Fatigue _____ (not to occur) if the material had not been subjected to a repeated stress.
8. If a mechanical part was subjected to vibration, small cracks _____ (develop).
9. If there _____ (be) a steady force acting on a material, it will result in creep.
10. Creep would have led to the rupture of the material if it _____ (extend) over a long time.

13. Complete the sentences.

1. If I could change everything, I _____.
2. If I were the chief engineer of the plant, I _____.
3. If there were no machine-tools, there _____.
4. If there were no electricity, there _____.
5. If I worked at the scientific research institute, I _____.
6. If there were no universities, people _____.
7. If there were no prominent scientists, the world _____.
8. If I were very rich, I _____.

SPEAKING

14. Use the words and phrases below to make sentences.

electricity, invention, transmission, electrical network, technological development, three-phase equipment, alternating current, voltage, electromechanical energy.

15. Work in pairs. Think of some questions to review the contents of the text about the electrical engineering and electricity and ask each other.

WRITING

16. Read the text and write an abstract. The length of the abstract is 100–120 words (see Appendix).

ELECTRIC CIRCUITS

The concepts of electric charge and potential are very important in the study of electric currents. When an extended conductor has different potentials at its ends, the free electrons of the conductor itself are caused to drift from one end to the other. The potential difference must be maintained by some electric source such as electrostatic generator or a battery or a direct current generator. The wire and the electric source together form an electric circuit, the electrons are drifting around it as long as the conducting path is maintained.

There are various kinds of electric circuits such as: open circuits, closed circuits, series circuits, parallel circuits and short circuits.

To understand the difference between the following circuit connections is not difficult at all. If the circuit is broken or «opened» anywhere, the current is known to stop everywhere. The circuit is broken when an electric device is switched off. The path along which the electrons travel must be com-

plete otherwise no electric power can be supplied from the source to the load. Thus the circuit is “closed” when an electric device is switched on.

When electrical devices are connected so that the current flows from one device to another, they are said «to be connected in series». Under such conditions the current flow is the same in all parts of the circuit as there is only a single path along which it may flow. The electrical bell circuit is considered to be a typical example of a series circuit. The “parallel” circuit provides two or more paths for the passage of current. The circuit is divided in such a way that part of the current flows through one path and part through another. The lamps in the houses are generally connected in parallel.

The “short” circuit is produced when the current can return to the source of supply without control. The short circuits often result from cable fault or wire fault. Under certain conditions the short circuit may cause fire because the current flows where it was not supposed to flow. If the current flow is too great a fuse is used as a safety device to stop the current flow.

UNIT 4

AC/DC POWER

Text 1 AC/DC power
Text 2 Dangers and Liabilities
Grammar Revision: Conditional sentences

LEAD-IN

1. What is the difference between DC and AC?

2. Where can AC and DC be applied?

READING

3. Read the text below and decide if the sentences are TRUE or FALSE.

1. There are no practical advantages of Ac power over dc power.
2. One major drawback of the single-phase circuit is the oscillatory nature of the instantaneous power flow.
3. A three-phase circuit, under balanced conditions has no constant, nonpulsating (time invariant), instantaneous power.
4. Almost all bulk electric power generation and consumption take place in three-phase systems.
5. The majority of three-phase systems are four-wire, wye-connected systems.
6. The cost of a neutral conductor is substantially more than that of a phase conductor.

AC/DC POWER

AC power has significant practical advantages over DC power in generation, transmission, and distribution. One major drawback of the single-phase circuit is the oscillatory nature of the instantaneous power flow $p(t)$. The consequent shaft vibration and noise in single-phase machinery are rather undesirable. A three-phase circuit, on the other hand, under balanced conditions has constant, nonpulsating (time invariant), instantaneous power, the pulsating strain on generating and load equipment is eliminated. Also for power transmission, a balanced three-phase system delivers more watts per kilogram of conductor than an equivalent single-phase system. For these rea-

sons, almost all bulk electric power generation and consumption take place in three-phase systems.

The majority of three-phase systems are four-wire, wye-connected systems, in which a grounded neutral conductor is used. Some three-phase systems such as delta-connected and three wire wye-connected systems do not have a neutral conductor. Because the neutral current is nearly zero under normal operating conditions, neutral conductors for transmission lines are typically smaller in size and current-carrying capacity than the phase conductors. Thus, the cost of a neutral conductor is substantially less than that of a phase conductor. The capital and operating costs of three-phase transmission and distribution systems, with or without neutral conductors, are comparatively much less than those of separate single-phase systems.

Ratings of three-phase equipment, such as generators, motors, transformers, and transmission lines, are usually given as total three-phase real power in MW, or as total three-phase apparent power in MVA, and as line-to-line voltage in kV.

4. Answer the questions.

1. What are the major drawbacks of the single-phase circuit?
2. Why do almost all bulk electric power generation and consumption take place in three-phase systems?
3. How are three-phased systems constructed?
4. What is the cost of a neutral conductor in comparison with phase conductor?
5. Why do any systems have no neutral conductor?
6. Compare the capital and operating costs of three-phase transmission and distribution systems.

5. Read the text below and choose the right option (A–C) for every question (1–5).

1. Faulty wiring can subject an individual to ……
   A. electric shock
   B. cancer
   C. thousands of dollars

2. Stray …… affects farm animals, especially dairy cattle.
   A. atoms
   B. voltage
   C. regulations

3. When cattle drink from electric feeding troughs or are attached to electric milking machines, small …... pass through the cattle.
   A. electric shocks
   B. electromagnetic fields
   C. high voltages

4. Some juries have awarded …. to farmers whose cattle have been damaged.
   A. electric milking machines
   B. farmer's equipment
   C. thousands of dollars

5. Electromagnetic …... are created whenever current moves through power lines.
   A. power lines
   B. voltage
   C. fields

DANGERS AND LIABILITIES

Electricity, especially at high voltages or high currents, is a dangerous commodity. Faulty wiring, power lines that are close to trees and buildings, and inadequate warning signs and fences around transformer stations and over buried electrical cables can subject an individual to electric shock or even electrocution. Because of the ultrahazardous nature of providing electric power, states have many statutes and regulations in place to protect the public from electric shock.

Other dangers from electricity include stray voltage and electromagnetic field radiation. Stray voltage affects farm animals, especially dairy cattle. On dairy farms, it occurs when cattle drink from electric feeding troughs or are attached to electric milking machines, and small electric shocks pass through the cattle, through their hooves, and into the ground. Repeated shocks can inhibit or destroy the milk-producing capability of dairy cattle. Liability for stray voltage on farms can be attributed to public utilities when wiring is faulty or negligently connected to a farmer's equipment. Some juries have awarded thousands of dollars to farmers whose cattle have been damaged by this phenomenon.

Electromagnetic fields are created whenever current moves through power lines. The strength of these fields drops off exponentially as the distance from the power lines increases. Individuals whose homes or businesses are close to power wires must live and work in these fields. Some individuals who live or work near high-voltage power lines have developed brain cancer and leukemia, and blame their condition on the constant exposure to electromagnetic field radiation. Studies have shown a correlation between electro-

magnetic fields and cancer, but many of the studies have been challenged as methodologically flawed. By the mid-1990s, no conclusive scientific evidence proved an epidemiological relationship between cancer and the electromagnetic fields produced by high-voltage power lines.

6. Answer the questions.

1. What can subject an individual to electric shock?
2. How do states protect the public from electric shock?
3. What can inhibit or destroy the milk-producing capability of dairy cattle?
4. What is created whenever current moves through power lines?
5. Why is it dangerous to live or work near high-voltage power lines?

USE OF ENGLISH

7. Match the words to their definitions.

1	apparent	A	the parts of a machine or a collection of machines
2	generate	B	a part of a project or process
3	instantaneous	C	size; quantity; volume
4	machinery	D	done immediately without any time going by
5	neutral	E	electrical energy
6	eliminate	F	exchanges or sacrifices made in order to obtain something else
7	bulk	G	not having a strong position, opinion or favourite
8	phase	H	obvious; easy to understand
9	voltage	I	get rid of
10	cost	J	to create, make or produce

8. Fill in the gaps with the words from the exercise 7.

1. The radio _____ ended when the battery died.
2. The old house doesn't have enough _____ for a big air conditioner.
3. The box wasn't heavy but it was expensive to mail because of its _____.
4. Catching prey by running it down _____ energy.
5. In the first _____ of life, babies are totally dependent on their mothers.
6. The article _____ a lot of letters to the editor.
7. It will take time to get in shape; the results will be slow, not _____.

8. The company _____ revenue by leasing cars.
9. The empty bottles and dirty dishes make it _____ that there was a party here.
10. After cars became common, horses were _____ from many cities.

9. Fill in the blanks with the necessary forms of the words from the right.

_____1 the solar heat concentrators, photovoltaic panels convert sunlight directly to electricity. Although sunlight is free and abundant, solar electricity is still usually more expensive to produce than large-scale mechanically generated power due to the cost of the panels. Low-efficiency silicon solar cells _____2 in cost and multifunction cells with close to 30 % conversion efficiency are now _____ 3 available. Over 40 % efficiency has been demonstrated in experimental systems. Until recently, photovoltaics were most commonly used in remote sites where there is no access to a commercial power grid, or as a supplemental electricity source for individual homes and businesses. Recent advances in _____4 efficiency and photovoltaic technology, combined with subsidies driven by _____5 concerns, have dramatically accelerated the deployment of solar panels. _____6 capacity is growing by 40 % per year led by increases in Germany, Japan, California and New Jersey.	1. LIKE 2. DECREASE 3. COMMERCE 4. MANUFACTURE 5. ENVIRONMENT 6. INSTALL

10. Translate the sentences from English into Russian.

1. The feeders are mounted above and below this busbar chamber.
2. Since there are only two feeders in a vertical plane, these switchboards occupy a sizeable floor space, but they are rugged and easy to handle.
3. They are good for very hard use such as construction power – i.e. the temporary power required during the construction period of a project – and have to weather severe climatic and dusty conditions.
4. It is possible to construct them in a cast iron enclosure making them suitable for extremely humid and chemically aggressive areas and also for areas that are fire-prone.
5. The use of such assemblies is now on the decline, due to the availability of better cubicle designs.

6. This is in the form of a sheet metal housing, compact in design and elegant in appearance.
7. The feeders are now mounted one above the other up to a permissible height at which the operator can easily operate.
8. It thus makes an optimum utilization of the vertical space and saves on floor area.
9. In this construction each feeder is mounted on a separate withdrawable chassis.
10. In the event of regular maintenance or repairs, they can be swiftly racked-out or racked-in to their modules without disconnecting the incoming or outgoing power connections or the control terminals.

GRAMMAR REVISION

11. Fill in the gaps with *if* or *unless*.

1. _____ a metal has small grains, it will be harder than one with coarse grains.
2. Metals cannot be bent without fracture _____ they are not malleable.
3. _____ small amounts of other metals are added to a pure metal, this is called alloying.
4. _____ we add small amounts of other metals to a pure metal, it won't change its properties.
5. Metals can be formed _____ we draw, roll and hammer them.
6. _____ metals are subject to metal fatigue, it causes deformation.
7. The engineers won't be a success when designing _____ they take into account these important effects.
8. _____ the engineers don't know the properties of metals, they won't be able to work with a metal.
9. _____ there are special conditions, the metals won't react with air.
10. It will cause failure _____ metals are subject to slow increase in length under stress.

12. Put the verbs in brackets into the proper tense. (Type 1, 2, 3 Conditionals)

1. If it were not for their properties, metals _____ widely (not to use) in industry.
2. Most metals wouldn't be dense if the separation between the atoms in them _____ (not to be) small.
3. Unless this basic relationship is understood, difficulties _____ (experience) in the machine shop.

4. If we _____ (increase) strength, it will imply reduced machinability.
5. If metals are subject to metal fatigue, it _____ (cause) deformation.
6. Engineers would employ ceramics if materials withstanding high temperatures _____ (need).
7. If rate of loading _____ (increase) greatly, mechanical properties of the material will vary significantly.
8. If casting processes had been based on more mechanized machines, it _____ (give) reduced waste.
9. These new methods _____(allow) savings to be made if they were used for assembly.
10. If a new materials technology were not rapidly emerging, there _____ (not to be) any opportunities for more efficient manufacture.

13. Complete the sentences.

1. If you work with new materials, _____.
2. If a metal is with small grains, _____.
3. An engineer would be a good specialist if he _____.
4. If high-tech field of nanotechnology hadn't emerged, _____.
5. If a mechanical engineer does not know about new materials, _____.
6. If there were a close partnership between industry and higher education,_____.
7. The production would be impossible if _____.
8. If I had been involved in the design earlier, _____.
9. If I ran my own business, _____.
10. They would have achieved high productivity if _____.

SPEAKING

14. Use the words and phrases below to make sentences.

AC power, DC power, power transistors, single-phase circuit, neutral conductor, operating costs, transmission, practical advantages, electric power generation.

15. Work in pairs. Think of some questions to review the contents of the text about the conductance, resistance and superconductivity and ask each other.

WRITING

16. Read the text and write an abstract. The length of the abstract is 100–120 words (see Appendix).

Power transistors are used in applications ranging from a few to several hundred kilowatts and switching frequencies up to about 10 kHz. Power transistors used in power conversion applications are generally *npn* type. The power transistor is turned on by supplying sufficient base current, and this base drive has to be maintained throughout its conduction period. It is turned off by removing the base drive and making the base voltage slightly negative (within AVBE (max)). The saturation voltage of the device is normally 0.5 to 2.5 V and increases as the current increases. Hence, the on-state losses increase more than proportionately with current. The transistor off-state losses are much lower than the on-state losses because the leakage current of the device is of the order of a few milliamperes. Because of relatively larger switching times, the switching loss significantly increases with switching frequency. Power transistors can block only forward voltages. The reverse peak voltage rating of these devices is as low as 5 to 10 V.

Power transistors do not have to withstand capability. In other words, they can absorb only very little energy before breakdown. Therefore, they cannot be protected by semiconductor fuses, and thus an electronic protection method has to be used. To eliminate high base current requirements, Darlington configurations are commonly used. They are available in monolithic or in isolated packages. The Darlington configuration presents a specific advantage in that: it can considerably increase the current switched by the transistor for a given base drive. The VCE (sat) for the Darlington is generally more than that of a single transistor of similar rating with corresponding increase in on-state power loss. During switching, the reverse-biased collector junction may show hot-spot breakdown effects that are specified by reverse-bias safe operating area (RBSOA) and forward-bias safe operating area (FBSOA). Modern devices with highly interdigited emitter base geometry force more uniform current distribution and therefore considerably improve secondary breakdown effects. Normally, a well-designed switching aid network constrains the device operation well within the SOA.

SELF-STUDY

READING

TEXT 1

1. Read the text and say whether the sentences are true (T) or false (F).

1. Moscow Power Engineering Institute is older than Tomsk Polytechnic university.
2. MPEI now is the largest Russian Power Engineering University and scientific center.
3. In accordance with official rating of the Ministry of Education of Russian Federation the MPEI holds one of the leading places in the list of all technical universities of Russia.
4. MPEI consists of 9 Technical Institutes, 3 special Faculties.
5. There are 70 Departments in MPEI, 550 educational laboratories for students and more than 100 research laboratories.
6. MPEI has two branches in Russia and abroad.

Moscow Power Engineering Institute (Technical University) – MPEI – was founded in 1930 in Moscow at the very beginning of world power engineering development and was widened and enlarged with the discovering of new energy sources, solving new scientific and technological problems, implementing of new methods of energy generating, distributing and consuming. MPEI is of the same age as Russian Power Engineering.

MPEI now is the largest Russian Power Engineering University and scientific center, one of the main universities in Russia in the field of Power Engineering, Electrical Engineering, Electronics and Computers Science. MPEI today is a unity of modern educational and scientific laboratories, cabinets and lecture halls supplied with modern equipment, installations, control and measuring systems and technical means of education. The MPEI has the official status of Technical University and is a Member of International Association of Universities being really international higher educational institution. In accordance with official rating of the Ministry of Education of Russian Federation the MPEI holds one of the leading places in the list of all technical universities of Russia.

MPEI has a unique educational Heat and Power Plant which was the first plant of such type from those, which were built for Universities; Main Computer Center and many computer laboratories; the Center of Video-Computer Methods of Teaching; Center of Distant Education; one of the

largest university's Scientific and Technological Library; own Publishing House, which produces text-books, manuals, scientific literature; Russian Language Center; large sport stadium, swimming pool, sport halls for students and professors.

Now MPEI consists of 7 Technical Institutes, 3 special Faculties, including Preliminary Faculty and Retraining Faculty for the specialists from industry and educational institutions, Institute of Humanities, Institute of Technology, Ecology and Business and also several affiliated educational centers, such as Institute of Business Security, Linguistics Institute, Institute MPEI-FESTO, etc. There are 70 Departments in MPEI, 550 educational laboratories for students and more than 100 research laboratories. Now more than 14 000 students are trained at MPEI, including about 700 foreign students from 60 countries, and more than 500 Ph.D. students (100 foreigners included) are preparing the Ph.D. thesis.

More than 1500 professors, associated professors and lecturers are in the MPEI's educational staff, and the most among them have the Degree of Doctor of Science and Doctor of Philosophy.

MPEI has two branches in Russia (it the cities of Smolensk and Voljskiy).

TEXT 2

2. Read the text about «*Superconductivity*» and choose the right option (A–C) for every question (1–5).

SUPERCONDUCTIVITY

Superconductivity is a phenomenon of exactly zero electrical resistance and expulsion of magnetic fields occurring in certain materials when cooled below a characteristic critical temperature. It was discovered by Heike Kamerlingh Onnes on April 8, 1911 in Leiden. Like ferromagnetism and atomic spectral lines, superconductivity is a quantum mechanical phenomenon. It is characterized by the Meissner effect, the complete ejection of magnetic field lines from the interior of the superconductor as it transitions into the superconducting state.

The occurrence of the Meissner effect indicates that superconductivity cannot be understood simply as the idealization of perfect conductivity in classical physics. The electrical resistivity of a metallic conductor decreases gradually as temperature is lowered. In ordinary conductors, such as copper or silver, this decrease is limited by impurities and other defects. Even near absolute zero, a real sample of a normal conductor shows some resistance. In a superconductor, the resistance drops abruptly to zero when the material is

cooled below its critical temperature. An electric current flowing in a loop of superconducting wire can persist indefinitely with no power source.

In 1986, it was discovered that some cuprate-perovskite ceramic materials have a critical temperature above 90 K (−183 °C). Such a high transition temperature is theoretically impossible for a conventional superconductor, leading the materials to be termed high-temperature superconductors. Liquid nitrogen boils at 77 K, facilitating many experiments and applications that are less practical at lower temperatures. In conventional superconductors, electrons are held together in pairs by an attraction mediated by lattice phonons.

The best available model of high-temperature superconductivity is still somewhat crude. There is a hypothesis that electron pairing in high-temperature superconductors is mediated by short-range spin waves known as paramagnons.

1. Superconductivity is a phenomenon of exactly zero electrical …… and expulsion of magnetic fields.
   A. conductivity
   B. resistance
   C. semi-conductivity
2. Superconductivity occurs in certain materials when ….. below a characteristic critical temperature.
   A. cooled
   B. heated
   C. frozen
3. Even near absolute zero, a real sample of a …..conductor shows some resistance.
   A. super
   B. semi-
   C. normal
4. An electric … flowing in a loop of superconducting wire can persist indefinitely with no power source.
   A. current
   B. circuit
   C. device
5. In conventional superconductors, ……. are held together in pairs by an attraction mediated by lattice phonons.
   A. electrons
   B. atoms
   C. phonons

VOCABULARY AND GRAMMAR TEST

3. Choose the right option (A–C) for every question (1–10).

1. The unit for measuring current was named in honor of A.M. Ampere, the French ….. .
   A. politician
   B. physicist
   C. psychologist
2. …… current is the current that changes direction periodically.
   A. alternating
   B. moving
   C. rotating
3. Materials that occupy a place between the conductors of the electric current and the non-conductors are called …… .
   A. ultraconductors
   B. introconductors
   C. semiconductors
4. The electromotive force is the very force that moves the electrons from one point in an electric …… towards another.
   A. circuit
   B. place
   C. space
5. Electrical engineering is a field of engineering that generally deals with the study and …… of electricity.
   A. apply
   B. application
   C. applied
6. Electrical engineers typically possess an academic degree with a major in ….. engineering.
   A. electrical
   B. mathematical
   C. computer
7. From the Global Positioning System to electric power generation, electrical ….. have contributed to the development of a wide range of technologies.
   A. plumbers
   B. students
   C. engineers

8. If you touch a socket with wet hands, you ….. an electric shock.
   A. will get
   B. would get
   C. would have got
9. They ….. let you on the plane unless you have a valid passport.
   A. had
   B. will
   C. won't
10. If I ….. noticed Nick, I would have stopped him.
   A. –
   B. would have
   C. had

TRANSLATION

4. Translate the sentences from English into Russian.

1. When there are many switchgear assemblies, the room itself can be pressurized, which is safer and easier.
2. The classification of gases, vapour and volatile liquids according to their ignition temperatures has been given.
3. It is also possible that when the enclosure door is opened to check, test or replace a component, contaminants may have entered the enclosure.
4. The content of asymmetry will depend upon the instant at which the short-circuit condition occurs.
5. The content of asymmetry is ignored after three or four cycles for all calculations and practical purposes.
6. In fact, a d.c. component less than 50 % that of the peak symmetrical component of the fault, current at any instant during the course of short-circuit condition may be ignored.
7. When the short-circuit occurs at a voltage zero the current will also commence at zero.
8. Supposing the current and the voltage waves both have some value on their respective wave forms at the instant of short-circuit.
9. Such a construction is cumbersome and requires utmost caution to ensure that the terminals are properly disengaged before the trolley is racked-out.
10. These contacts engage or disengage automatically when the trolley is racked-in or racked-out of the module respectively.

WRITING

5. Read the text and write an abstract. The length of the abstract is 100–120 words (see Appendix).

DYNAMOS

The term «dynamo» is applied to machines which convert either mechanical energy into electrical energy or electrical energy into mechanical energy by utilizing the principle of electromagnetic induction. A dynamo is called a generator when mechanical energy supplied in the form of rotation is converted into electrical energy. When the energy conversion takes place in the reverse order the dynamo is called a motor. Thus a dynamo is a reversible machine capable of operation as a generator or motor as desired.

A generator does not create electricity, but generates or produces an induced electromotive force, which causes a current to flow through a properly insulated system of electrical conductors external to it. The amount of electricity obtainable from such a generator is dependent upon the mechanical energy supplied. In the circuit external to a generator the e. m. f. causes the electricity to flow from a higher or positive potential to a lower or negative potential. In the internal circuit of a generator the e. m. f. causes the current to flow from a lower potential to a higher potential. The action of a generator is based upon the principles of electromagnetic induction.

The dynamo consists essentially of two parts: a magnetic field, produced by electromagnets, and a number of loops or coils of wire wound upon an iron core, forming the armature. These parts are arranged so that the number of the magnetic lines of force of the field threading through the armature, coils will be constantly varied, thereby producing a steady e. m. f. in the generator or a constant torque in the motor.

SELF-STUDY / KEYS

Reading

Text 1

11.F
12.T
13.T
14.F
15.T
16.F

Text 2

10.B
11.A
12.C
13.A
14.A

Vocabulary and Grammar

1. B
2. A
3. C
4. A
5. B
6. A
7. C
8. A
9. C
10. C

TRANSLATION

1. Когда есть много распределительных устройств, можно герметизировать саму комнату, что будет безопаснее и легче.
2. Была дана классификация газов, пара и легковоспламеняющихся жидкостей согласно температурам их воспламенения.
3. Также возможно, что, когда дверь открывается для проверки, теста или замены компоненты, загрязнители могут проникнуть во вложение.
4. Допустимая асимметрия будет зависеть от момента, в который происходит короткое замыкание.
5. Допустимая асимметрия игнорируется после трех или четырех циклов для всех вычислений и практических целей.
6. Фактически, d.c. компонент меньше пикового на 50 % , ток, в любой момент короткого замыкания может быть проигнорирован.
7. Когда короткое замыкание произойдет в ноле напряжения, ток также начнется в ноле.
8. Предположим, у тока и амплитуды напряжения есть некоторый потенциал в соответствующих формах волны в момент короткого замыкания.
9. Такое строительство тяжело и требует предельной осторожности, гарантирующей, что терминалы должным образом расцеплены прежде, чем тележка выключена.
10. Эти контакты замыкают или размыкают автоматически, когда тележка включена или выключена соответственно.

CONTROL WORK № 2

Variant 1

READING

Text 1

1. Read the text, and match the questions (A–F) to the numbered spaces (1–6).

A. What is the conductor material?
B. Why isn't copper used for overhead transmission?
C. What allows increasing capacity and modernizing transmission circuits?
D. Why are thicker wires not effective?
E. What is transmission level voltage today?
F. What rules are necessary to be kept to maintain safety in overhead transmission wires?

1. Thicker wires would lead to a relatively small increase in capacity due to the skin effect that causes most of the current to flow close to the surface of the wire. Because of this current limitation, multiple parallel cables (called bundle conductors) are used when higher capacity is needed.

2. High-voltage overhead conductors are not covered by insulation. The conductor material is nearly always an aluminium alloy, made into several strands and possibly reinforced with steel strands.

3. Improved conductor material and shapes are regularly used to allow increased capacity and modernize transmission circuits. Conductor sizes range from 12 mm^2 (#6 American wire gauge) to 750 mm^2 (1,590,000 circular mils area), with varying resistance and current-carrying capacity.

4. Copper was sometimes used for overhead transmission but aluminium is lighter, yields only marginally reduced performance, and costs much less. Overhead conductors are a commodity supplied by several companies worldwide.

5. Since overhead transmission wires depend on air for insulation, design of these lines requires minimum clearances to be observed to maintain safety. Adverse weather conditions of high wind and low temperatures can lead to power outages.

6. Today, transmission-level voltages are usually considered to be 110 kV and above. Lower voltages such as 66 kV and 33 kV are usually considered subtransmission voltages but are occasionally used on long lines with

light loads. Voltages less than 33 kV are usually used for distribution. Voltages above 230 kV are considered extra high voltage and require different designs compared to equipment used at lower voltages.

Text 2

2. Read the text below and decide if the sentences are TRUE or FALSE.

1. The symbol for current is I.
2. The electric current can flow only through liquids.
3. The current can be of two types: direct current and alternating current.
4. Electrolytes don't change greatly when current passes through them.
5. The alternating current flows in one direction.
6. A battery is the simplest source of power for the direct current.
7. One of the great advantages of alternating current is the ease with which voltage can be changed.
8. Direct current finds wider application than alternating current.

ELECTRIC CURRENT

The electric current is a quantity of electrons flowing in a circuit per second of time. The unit of measure for current is ampere. If one coulomb passes a point in a circuit per second then the current strength is 1 ampere. The symbol for current is I.

The current which flows along wires consists of moving electrons. The electrons move along the circuit because the e .m. f. drives them. The current is directly proportional to the e. m. f. 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 meet industrial 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 percent of electrical energy to be generated at present is a. c. In fact, it finds wide application for lighting, heating, industrial, and some other purposes.

VOCABULARY AND GRAMMAR TEST

3. Choose the right option (A–C) for every question (1–10).

When the load power factor is unity, corresponding to a purely _____ 1 load, both wattmeters _____ 2 the same wattage. In fact, both of them should read positive; if one of the wattmeters has a below-zero _____ 3 in the laboratory, an upscale deflection _____ 4 obtained by simply _____ 5 the loads of either the current or the potential coil of the wattmeter. The sum of the wattmeter readings _____ 6 the total power absorbed by the load. At zero power factor, corresponding to a purely reaction load, both wattmeters _____ 7 again have the same wattage indication but with the opposite signs, so that their _____ 8 sum will yield zero power absorbed, as it should. The _____ 9 from a negative to a positive value occurs when the load power factor is 0.5 (i.e., φ is equal to 60°). At this power factor, one wattmeter reads zero while the other one reads the total real power _____ 10 to the load.

1. a. resist	b. resistant	c. resistivity
2. a. will indicate	b. is indicated	c. did indicate
3. a. indicate	b. indication	c. indicative
4. a. would	b. could	c. can be
5. a. reverse	b. reversing	c. be reversed
6. a. gives	b. give	c. given
7. a. will	b. be	c. is
8. a. algebraically	b. algebra	c. algebraic
9. a. transitory	b. transition	c. transitive
10. a. delivered	b. deliver	c. delivery

TRANSLATION

4. Translate the sentences from English into Russian.

1. Similarly, the control terminals are to be disengaged manually first, when the trolley is to be drawn out.
2. Such a construction is cumbersome and requires utmost caution to ensure that the terminals are properly disengaged before the trolley is racked-out.
3. Otherwise it may pull the wires and snap the connections and result in a major repair.
4. It is also possible that, due to human error, the operator may slip to engage the terminals at the first attempt and may have to do it at a second attempt, adding to the downtime, while energizing or replacing a faulty trolley, eventually defeating the purpose of a draw-out system.
5. In this construction the control terminals are of the sliding type
6. The moving contacts are mounted on the trolley while the fixed matching contacts are mounted on the panel frame.
7. These contacts engage or disengage automatically when the trolley is racked-in or racked-out of the module respectively.
8. This type of construction eliminates human error and reduces racking time.
9. The trolley can now be replaced swiftly with the least downtime.
10. To analyse the shape of a current wave on a short-circuit, consider the following conditions that may occur at the instant of the fault:

WRITING

5. Read the text and write an abstract. The length of the abstract is 100–120 words (see Appendix).

LIMITATIONS

The amount of power that can be sent over a transmission line is limited. The origins of the limits vary depending on the length of the line. For a short line, the heating of conductors due to line losses sets a thermal limit. If too much current is drawn, conductors may sag too close to the ground, or conductors and equipment may be damaged by overheating. For intermediate-length lines on the order of 100 km (62 mi), the limit is set by the voltage drop in the line. For longer AC lines, system stability sets the limit to the power that can be transferred. Approximately, the power flowing over an AC line is proportional to the cosine of the phase angle of the voltage and current at the receiving and transmitting ends. Since this angle varies depending on

system loading and generation, it is undesirable for the angle to approach 90 degrees.

Very approximately, the allowable product of line length and maximum load is proportional to the square of the system voltage. Series capacitors or phase-shifting transformers are used on long lines to improve stability. High-voltage direct current lines are restricted only by thermal and voltage drop limits, since the phase angle is not material to their operation.

Up to now, it has been almost impossible to foresee the temperature distribution along the cable route, so that the maximum applicable current load was usually set as a compromise between understanding of operation conditions and risk minimization. The availability of industrial Distributed Temperature Sensing (DTS) systems that measure in real time temperatures all along the cable is a first step in monitoring the transmission system capacity. This monitoring solution is based on using passive optical fibers as temperature sensors, either integrated directly inside a high voltage cable or mounted externally on the cable insulation.

A solution for overhead lines is also available. In this case the optical fiber is integrated into the core of a phase wire of overhead transmission lines (OPPC). The integrated Dynamic Cable Rating (DCR) or also called Real Time Thermal Rating (RTTR) solution enables not only to continuously monitor the temperature of a high voltage cable circuit in real time, but to safely utilize the existing network capacity to its maximum. Furthermore it provides the ability to the operator to predict the behavior of the transmission system upon major changes made to its initial operating conditions.

Variant 2

READING

Text 1

1. Read the text, and match the questions (A–F) to the numbered spaces (1–6).

A. What are the transmission networks designed for?
B. Who administrates the transmission networks?
C. What does the transmission efficiency depend on?
D. How is the change in voltage usually achieved?
E. What is a transmission grid?
F. What is the most cost-effective number of wires?

1. These networks use components such as power lines, cables, circuit breakers, switches and transformers. The transmission network is usually administered on a regional basis by an entity such as a regional transmission organization or transmission system operator.

2. A transmission grid is a network of power stations, transmission circuits, and substations. Energy is usually transmitted within a grid with three-phase AC. Single phase AC is used only for distribution to end users since it is not usable for large polyphase induction motors.

3. Engineers design transmission networks to transport the energy as efficiently as feasible, while at the same time taking into account economic factors, network safety and redundancy.

4. In the 19th century, two-phase transmission was used but required either three wires with unequal currents or four wires. Higher order phase systems require more than three wires, but deliver marginal benefits.

5. Transmission efficiency is hugely improved by devices that increase the voltage, and proportionately reduce the current in the conductors, thus keeping the power transmitted nearly equal to the power input. The reduced current flowing through the line reduces the losses in the conductors. According to Joule's Law, energy losses are directly proportional to the square of the current. Thus, reducing the current by a factor of 2 will lower the energy lost to conductor resistance by a factor of 4.

6. This change in voltage is usually achieved in AC circuits using a *step-up transformer*. HVDC systems require relatively costly conversion equipment which may be economically justified for particular projects, but are less common currently.

Text 2

2. Read the text and decide whether the sentences are TRUE or FALSE.

1. The capital cost of electric power stations is not very high.
2. Electricity is usually produced locally.
3. The power can flow even if some links are inoperative.
4. Base load is the unvarying (or slowly varying over many hours) portion of the electric demand.
5. Base load is generally served best by large facilities.
6. Renewable energy sources such as solar photovoltaics, wind, wave, and tidal are also considered «base load».
7. The remaining power demand, if any, is supplied by peaking power plants.
8. Power plants are typically bigger, faster-responding, and higher cost sources, such as combined cycle or combustion turbine plants fuelled by natural gas.

The capital cost of electric power stations is so high, and electric demand is so variable, that it is often cheaper to import some portion of the needed power than to generate it locally. Because nearby loads are often correlated (hot weather in the Southwest portion of the US might cause many people to use air conditioners), electricity often comes from distant sources. Because of the economics of load balancing, wide area transmission grids now span across countries and even large portions of continents. The web of interconnections between power producers and consumers ensures that power can flow, even if a few links are inoperative.

The unvarying (or slowly varying over many hours) portion of the electric demand is known as the *base load* and is generally served best by large facilities (which are therefore efficient due to economies of scale) with low variable costs for fuel and operations. Such facilities might be nuclear or coal-fired power stations, or hydroelectric, while other renewable energy sources such as concentrated solar thermal and geothermal powers have the potential to provide base load power. Renewable energy sources such as solar photovoltaics, wind, wave, and tidal are, due to their intermittency, not considered «base load» but can still add power to the grid. The remaining power demand, if any, is supplied by peaking power plants, which are typically smaller, faster-responding, and higher cost sources, such as combined cycle or combustion turbine plants fuelled by natural gas.

GRAMMAR AND VOCABULARY TEST

3. Choose the right option (A–C) for every question (1–10).

FARADAY'S LAW

MICHEL FARADAY was a great British physicist, the founder of the _____ 1 of electron field, a member of the London Royal Society. He _____ 2 born in London in the family of a smith. Spending a few years in the primary school, he continued his studies all by himself, reading books and listening public _____ 3. Greatly impressed by lectures of a well-known English _____ 4 H. Davy, he sent him a letter asking for a job at the Royal Institute. In 1813 Davy _____ 5 him a job of a laboratory assistant. Thanks to the brilliant talent of an _____ 6, Faraday soon made himself known. All his future _____ 7 work was carried out in the Royal Institute laboratories.

Faraday's law _____ 8 formulated as follows:

(a) the induced E.M.F. in a _____ 9 is proportional to the rate at which the conductor cuts the magnetic lines of force;

(b) The induced E.M.F. in a circuit is _____ 10 to the rate of change of the rate of change of the number of lines of force threading the circuit.

1. a. theory	b. theoretical	c. theoretic
2. a. be	b. was	c. been
3. a. course books	b. lectures	c. libraries
4. a. chemistry	b. chemical	c. chemist
5. a. gave	b. given	c. giving
6. a. experience	b. experiment	c. experimenter
7. a. scientific	b. science	c. scientifically
8. a. have	b. is	c. are
9. a. conductor	b. conduct	c. conducting
10. a. proportion	b. portion	c. proportional

TRANSLATION

4. Translate the sentences from English into Russian.

1. When the short-circuit occurs at a current zero, i.e., when the applied voltage is almost at its peak, the voltage and current waves will follow the current lagging the voltage by almost 84".
2. The current will now be almost symmetrical.
3. When the short-circuit occurs at a voltage zero the current will also commence at zero.

4. This is an unusual situation when both the voltage and the current waves commence at zero and yet cannot propagate in phase with each other, in view of the current lagging the voltage by almost 84".
5. This situation is resolved by a shift in the zero axis of the current wave by almost 84".
6. Now it is able to fulfil its above condition again.
7. The current will now be fully asymmetrical.
8. Let us consider a more realistic situation, when the short-circuit may occur somewhere between the above two conditions.
9. Supposing the current and the voltage waves both have some value on their respective wave forms at the instant of short-circuit.
10. The current will again tend to become somewhat asymmetrical but not fully.

WRITING

5. Read the text and write an abstract. The length of the abstract is 100–120 words (see Appendix).

LOAD BALANCING

The transmission system provides for base load and peak load capability, with safety and fault tolerance margins. The peak load times vary by region largely due to the industry mix. In very hot and very cold climates home air conditioning and heating loads have an effect on the overall load. They are typically highest in the late afternoon in the hottest part of the year and in mid-mornings and mid-evenings in the coldest part of the year. This makes the power requirements vary by the season and the time of day. Distribution system designs always take the base load and the peak load into consideration.

The transmission system usually does not have a large buffering capability to match the loads with the generation. Thus generation has to be kept matched to the load, to prevent overloading failures of the generation equipment.

Multiple sources and loads can be connected to the transmission system and they must be controlled to provide orderly transfer of power. In centralized power generation, only local control of generation is necessary, and it involves synchronization of the generation units, to prevent large transients and overload conditions.

In distributed power generation the generators are geographically distributed and the process to bring them online and offline must be carefully controlled. The load control signals can either be sent on separate lines or on the power lines themselves. To load balance the voltage and frequency can be used as a signaling mechanism.

Variant 3

READING

Text 1

1. Read the text, and match the questions (A–F) to the numbered spaces (1–6).

A. What is the average loss of transmitting electricity?
B. What happens to the losses if the conductor size is reduced?
C. What is the voltage of overhead lines?
D. What measures are taken to reduce corona losses?
E. How are losses estimated?
F. What is the longest cost-effective distance between DC?

LOSSES

1. For example, raising the voltage by a factor of 10 reduces the current by a corresponding factor of 10 and therefore the I^2R losses by a factor of 100, provided the same sized conductors are used in both cases. Even if the conductor size (cross-sectional area) is reduced 10-fold to match the lower current the I^2R losses are still reduced 10-fold.

2. In general, losses are estimated from the discrepancy between energy produced (as reported by power plants) and energy sold to end customers; the difference between what is produced and what is consumed constitutes transmission and distribution losses.

3. Transmitting electricity at high voltage reduces the fraction of energy lost to resistance, which averages around 7 %. For a given amount of power, a higher voltage reduces the current and thus the resistive losses in the conductor.

4. The longest cost-effective distance for DC electricity was determined to be 7 km (4,300 mi). For AC it was 4,000 km (2,500 mi), though all transmission lines in use today are substantially shorter.

5. Long distance transmission is typically done with overhead lines at voltages of 115 to 1,200 kV. At extremely high voltages, more than 2,000 kV between conductor and ground, corona discharge losses are so large that they can offset the lower resistance loss in the line conductors.

6. Measures to reduce corona losses include conductors having large diameter; often hollow to save weight, or bundles of two or more conductors.

Text 2

2. Read the text and decide whether the sentences are TRUE or FALSE.

1. In an alternating current circuit, the inductance and capacitance of the phase conductors is insignificant.
2. Reactive current causes extra losses in the transmission circuit.
3. The ratio of real power (transmitted to the load) to apparent power is the power factor.
4. As reactive current increases, the reactive power decreases and the power factor decreases.
5. For systems with low power factors, losses are higher than for systems with high power factors.
6. For systems with low power factors, losses are equal to the systems with high power factors.
7. To control reactive power flow for reduction of losses and stabilization of system voltage, utilities add capacitor banks and other components.
8. Utilities don't add capacitor banks and other components throughout the system to control reactive power flow for reduction of losses and stabilization of system voltage.

In an alternating current circuit, the inductance and capacitance of the phase conductors can be significant. The currents that flow in these components of the circuit impedance constitute reactive power, which transmits no energy to the load. Reactive current causes extra losses in the transmission circuit. The ratio of real power (transmitted to the load) to apparent power is the power factor. As reactive current increases, the reactive power increases and the power factor decreases.

For systems with low power factors, losses are higher than for systems with high power factors. Utilities add capacitor banks and other components (such as phase-shifting transformers; static VAR compensators; physical transposition of the phase conductors; and flexible AC transmission systems, FACTS) throughout the system to control reactive power flow for reduction of losses and stabilization of system voltage.

GRAMMAR AND VOCABULARY TEST

3. Choose the right option (A–C) for every question (1–10).

A HIGH-POWER ELECTRICAL TRANSMISSION TOWER

Long-distance _____1 of electricity (thousands of kilometers) is cheap and _____2, with costs of US$0.005–0.02/kWh (compared to annual averaged large _____3 costs of US$0.01–0.025/kWh, retail rates upwards of US$0.10/kWh, and multiples of retail for instantaneous _____4 at the highest demand moments). Thus distant _____5 can be _____6 than local sources (e.g., New York City buys a lot of _____ 7 from Canada). Multiple local sources (even if more expensive and _____8 used) can _____ 9 the transmission grid more fault tolerant to weather and other disasters that can _____ 10 distant suppliers.

1. a. transmit	b. transmitted	c. transmission
2. a. efficient	b. efficiency	c. efficiently
3. a. production	b. product	c. produce
4. a. supplied	b. suppliers	c. suppliant
5. a. suppliers	b. supply	c. supplied
6. a. cheap	b. cheaper	c. cheapest
7. a. electrically	b. electrical	c. electricity
8. a. frequently	b. frequent	c. frequency
9. a. made	b. making	c. make
10. a. connection	b. connect	c. connected

TRANSLATION

4. Translate the sentences from English into Russian.

1. The content of asymmetry will depend upon the instant at which the short-circuit condition occurs.
2. The higher the recovery voltage at the instant of fault, the lower will be the asymmetry.
3. It is observed that there may be asymmetry in the system as long as the short-circuit condition lasts.
4. But the content of the asymmetry may be quite feeble after three or four cycles.
5. However, if the short-circuit condition still prevails. Such as when conducting a short-circuit test up to the desired duration of 1 or 3 seconds, the short-circuit current, although theoretically asymmetrical until the test

period, may be regarded as symmetrical (having reached its steady state) after three or four cycles.
6. The content of asymmetry is ignored after three or four cycles for all calculations and practical purposes.
7. In fact, a d.c. component less than 50 % that of the peak symmetrical component of the fault, current at any instant during the course of short-circuit condition may be ignored.
8. In other words, the relevance of the asymmetry may be considered only up to the first peak, as the immediate subsequent peaks may also be less than 50 %.
9. The generation of an asymmetrical current on an a.c. system, leads to the inference that a short-circuit condition will give rise to a d.c. component due to a shift in its zero axis.
10. During the sub-transient state the value of the asymmetrical current will be the phasor sum of the symmetrical and the asymmetrical current components.

WRITING

5. Read the text and write an abstract. The length of the abstract is 100–120 words (see Appendix).

Operators of long transmission lines require reliable communications for control of the power grid and, often, associated generation and distribution facilities. Fault-sensing protective relays at each end of the line must communicate to monitor the flow of power into and out of the protected line section so that faulted conductors or equipment can be quickly de-energized and the balance of the system restored. Protection of the transmission line from short circuits and other faults is usually so critical that common carrier telecommunications are insufficiently reliable, and in remote areas a common carrier may not be available. Communication systems associated with a transmission project may use:

- Microwaves;
- Power line communication;
- Optical fibers.

Rarely, and for short distances, a utility will use pilot-wires strung along the transmission line path. Leased circuits from common carriers are not preferred since availability is not under control of the electric power transmission organization.

Transmission lines can also be used to carry data: this is called power-line carrier, or PLC. PLC signals can be easily received with a radio for the long wave range.

Optical fibers can be included in the stranded conductors of a transmission line, in the overhead shield wires. These cables are known as optical ground wire (*OPGW*). Sometimes a standalone cable is used, all-dielectric self-supporting (*ADSS*) cable, attached to the transmission line cross arms.

Some jurisdictions, such as Minnesota, prohibit energy transmission companies from selling surplus communication bandwidth or acting as a telecommunications common carrier. Where the regulatory structure permits, the utility can sell capacity in extra dark fibers to a common carrier, providing another revenue stream.

Variant 4

READING

Text 1

1. Read the text, and match the questions (A–F) to the numbered spaces (1–6).

A. What is HDVC used for?
B. What current is used for long distance transmissions?
C. Why DC is more cost-effective than AC?
D. What is the maximum length when AC can be applied?
E. What is the length of submarine connect?
F. What is the relation of the power transmitted by an AC line to the phase angle between source end voltage?

1. When electrical energy is required to be transmitted over very long distances, it is more economical to transmit using direct current instead of alternating current.

2. Many submarine cable connections – up to 600 km length – are in use nowadays.

3. High-voltage direct current (HVDC) is used to transmit large amounts of power over long distances or for interconnections between asynchronous grids.

4. The power transmitted by an AC line increases as the phase angle between source end voltage and destination ends increases, but too great a phase angle will allow the generators at either end of the line to fall out of step. A DC link stabilizes the AC grids at either end, since power flow and phase angle can be controlled independently.

5. For a long transmission line, the lower losses and reduced construction cost of a DC line can offset the additional cost of converter stations at each end. Also, at high AC voltages, significant (although economically acceptable) amounts of energy are lost due to corona discharge.

6. HVDC is also used for long submarine cables because over about 30 km length AC can no longer be applied. In that case special high voltage cables for DC are built.

Text 2

2. Read the text and decide if the sentences are TRUE or FALSE.

1. Adjustment of the flow of AC power with the relative phase of three electrical grids is everyday occurrence in AC systems.
2. To adjust the flow of AC power on a hypothetical line between Seattle and Boston would require adjustment of the relative phase of the two electrical grids.
3. Adjusting the flow of AC power is an everyday occurrence in AC systems.
4. If one of AC system components fails it places sudden loads on a remaining working grid system.
5. With an HVDC line instead, such an interconnection would convert AC in Seattle into HVDC.
6. With an HVDC line, such an interconnection would not convert the HVDC to locally synchronized AC in Boston
7. Such a system would be less prone to cascade failures if part of it were suddenly shut down.
8. There is no prominent example of such a transmission line in the Western United States.

AC POWER

To adjust the flow of AC power on a hypothetical line between Seattle and Boston would require adjustment of the relative phase of the two electrical grids. This is an everyday occurrence in AC systems, but one that can occasionally fail when AC system components fail and place sudden loads on a remaining working grid system.

With an HVDC line instead, such an interconnection would convert AC in Seattle into HVDC, use HVDC for the three thousand miles of cross country transmission then convert the HVDC to locally synchronized AC in Boston, and optionally in other cooperating cities along the transmission route. Such a system would be less prone to cascade failures if part of it were suddenly shut down. One prominent example of such a transmission line is the Pacific DC Intertie located in the Western United States.

GRAMMAR AND VOCABULARY TEST

3. Choose the right option (A–C) for every question (1–10).

MAIN STRUCTURAL ELEMENTS OF A D. C. MACHINE

A direct-current machine consists of two main parts, a stationary part, usually called the stator, designed mainly for producing a magnetic flux, and a rotating part, called the armature or the rotor. The stationary and rotating parts should _____ 1 separated from each other by an air-gap. The stationary part of a d.c. machine _____ 2 of main poles, designed to create the main magnetic flux; commutating poles interposed between the main poles; and a frame. It should be noted here that sparkless _____ 3 of the machine would be impossible without the commutating poles. Thus, they should ensure sparkless operation of the brushes at the _____ 4.

The main pole consists of a laminated core the end of which facing the armature carries a pole shoe and a field coil through which direct current _____ 5. The armature is a cylindrical body rotating in the _____ 6 between the poles and comprising a slotted armature core, a winding inserted in the armature slots, a commutator, and a brush gear.

The _____ 7 is the stationary part of the machine to which are fixed the main and commutating poles and by means of which the machine is bolted to its bedplate. The ring shaped portion which _____ 8 as the path for the main and commutating pole fluxes is called the yoke. End-shields or frame-heads which carry the bearings are also _____ 9 to the frame.

Of these main structural elements of the machine the yoke, the pole cores, the armature core and the air-gap between the armature core and the pole core are known to form the magnetic circuit while the pole coils, the armature windings, the commutator and brushes should _____ 10 the electric circuit of the machine.

1. a. be	b. can	c. been
2. a. consists	b. contain	c. includes
3. a. operating	b. operate	c. operation
4. a. commute	b. commuter	c. commutator
5. a. pass	b. passes	c. passed
6. a. space	b. spacious	c. spacing
7. a. frameless	b. frame	c. framed
8. a. serves	b. serve	c. server
9. a. attach	b. attachment	c. attached
10. a. formed	b. form	c. formation

TRANSLATION

4. Translate the sentences from English into Russian.

1. For hazardous areas flameproof enclosures alone are recommended, except in areas with moderate intensity of contamination and where such assemblies are located away from the affected area and in a separate well-ventilated room, when pressurized enclosures may also be safe.
2. The reason for this precaution is that frequent arcing takes place within the enclosure on each switching of a contactor, switch, breaker or an OCR etc. and also during operation of power and auxiliary contactors.
3. The classification of gases, vapour and volatile liquids according to their ignition temperatures has been given.
4. As a switch, a contactor or a breaker produces an arc during a switching operation, an explosion may occur within the enclosure on a re-switching.
5. It is also possible that when the enclosure door is opened to check, test or replace a component, contaminants may have entered the enclosure.
6. It is also likely that on a re-closing of the feeder door, the closure is not perfect due to human error and contaminants have leaked into the enclosure.
7. All this may lead to an explosion on a re-switching.
8. Since it is not practical to manufacture a flameproof enclosure due to its size and bulk and the number of knockouts and openings on the doors for switches, metering, indicators, and pushbuttons (PBs) etc., it is common practice to locate these assemblies some distance from the affected area in a separate well-ventilated room.
9. Depending upon the location and intensity of contamination, it may be permissible to meet the requirement by using a pressurized enclosure by maintaining a positive pressure inside the enclosure similar to that for motors.
10. When there are many switchgear assemblies, the room itself can be pressurized, which is safer and easier.

WRITING

5. Read the text and write an abstract. The length of the abstract is 100–120 words (see Appendix).

GENERATORS

The powerful, highly efficient generators and alternators that are in use today operate on the same principle as the dynamo invented by the great English scientist Faraday in 1831.

Dynamo-electric machines are used to supply light, heat and power on a large scale. These are the machines that produce more than 99.99 per cent of the entire world's electric power.

There are two types of dynamos – the generator and the alternator. The former supplies d. c. which is similar to the current from a battery and the latter provides a. c. To generate electricity both of them must be continuously provided with energy from some outside source of mechanical energy such as steam engines, steam turbines or water turbines.

A generator is an electric machine, which converts mechanical energy into electric energy. There are direct-current (d. c.) generators and alternating-current (a. c.) generators. Their construction is much alike. A d. c. generator consists of stationary and rotating elements. The stationary elements are: the yoke or the frame and the field structure. The yoke forms the closed circuit for the magnetic flux. The function of the magnetic structure is to produce the magnetic field.

The rotating elements are: true armature and the commutator. They are on the same shaft. The armature consists of the core and the winding. The winding is connected to the commutator. With the help of the brushes on the commutator that conduct the electric current to the line the winding is connected to the external circuit. The stationary element of an a. c. generator is called a stator. The rotating element is called a rotor.

The essential difference between a d. c. generator and a. c. generator is that the former has a commutator by means of which the generated e. m. f. is made continuous, i. e. the commutator mechanically rectifies the alternating e.m. f. so that it is always of the same polarity.

D. c. generators are used for electrolytic processes such as electroplating. Large d. c. generators are employed in such manufacturing processes as steel making. The d. c. generator of small capacities is used for various special purposes such as arc welding, automobile generators, train lighting systems, etc. It also finds rather extensive use in connection with communication systems.

GRAMMAR REFERENCE
THE PASSIVE VOICE

Tense/Verb Form	Active	Passive
Present Simple	They **develop** films here.	Films **are developed** here.
Present Continuous	They **are developing** a film now.	A film **is being developed** now.
Past Simple	They **developed** this film yesterday.	This film **was developed** yesterday.
Past Continuous	They **were developing** a film when I arrived.	A film **was being developed** when arrived.
Present Perfect	They **have already developed** ten films.	Ten films **have already been developed.**
Past Perfect	They **had developed** fifty films by that year.	Fifty films **had been developed** by that year.
Future Simple	They **will develop** the film tomorrow.	The film **will be developed** tomorrow.
Conditionals	They **would develop** the film if they had time.	The film **would be developed** if they had time.
Modals	They **must develop** the film by noon.	The film **must be developed** by noon.

1.1. The Formation of the Passive Voice

to be + V_3

1.2. The Use of the Passive Voice

* when the person who carries out the action (the agent) is unknown, unimportant or obvious from the context.

My car was stolen last night, (*unknown agent*)
The plants are watered every evening, (*unimportant agent*)
The house was burgled, (*by a burglar-obvious agent*)

* when the action itself is more important than the agent, especially in news headlines, newspaper articles, formal notices, instructions, advertisements, etc.

The new wing of the hospital was opened by the President yesterday morning.

* when we want to emphasize the agent.

The town library was built by my great-great-grandfather in 1874.

* when we want to make statements more polite or formal.

My new CD player is broken, (more polite than *You've broken my new CD player*).

EXERCISES

1. Form the Passive from the verbs.

***Example*:** to take – to be taken

to ask, to read, to write, to invite, to drink, to eat, to smoke, to drive, to see, to send, to inform, to build, to publish, to help, to advise, to give, to bring, to speak

2. Translate the sentences paying attention to the Present Simple Passive.

1. Many books are published in Russia. 2. The machines are tested by the police. 3. I am always driven to work by my neighbor. 4. The machines are tested before use. 5. The car is polished once every three months. 6. Concrete is made of cement, sand and gravel. 7. A picnic is arranged once a month by our club. 8. These gates aren't painted every year. 9. I'm not invited to my uncle's every weekend. 10. He isn't asked at every lesson.

3. Translate into English using the Present Simple Active or Passive.

1. Я приглашаю – Меня приглашают.
2. Он присылает – Ему присылают.
3. Она рассказывает – Ей рассказывают.
4. Они сообщают – Им сообщают.
5. Рабочий строит – Дом строится.
6. Писатель пишет книгу – Книга публикуется.
7. Студент пишет упражнение – Упражнение выполняется.
8. Студенты помогают – Студентам помогают.
9. Мы задаем вопросы – Нам задают вопросы.
10. Я советую – Мне советуют.

4. Translate the sentences paying attention to the Past Simple Passive.

1. The best machine was chosen. 2. My bike was stolen last week. 3. The police were called. 4. The book was finished yesterday. 5. The meeting was held on Monday. 6. He was not invited to the party. 7. They were introduced to my friend. 8. I was visited by the teacher last week. 9. Many questions were given to us at the lesson. 10. The letters were brought by the postman.

5. Put the verbs in brackets into the Future Simple Passive.

***Example*:** The delegation .. *will be met*.. (meet) tomorrow.

1. This program … (show) again tomorrow. 2. Your room … (clean) in a week. 3. I … (introduce) to the director soon. 4. The gates … (paint) again next year. 5. My pets … (not feed) until six o'clock. 6. You … (not bother) by that man again. 7. You … (invite) to Betty's party? 8. I … (allow) to go to Europe. 9. Many questions … (ask) to the lecturer. 10. The letter … (write) next week.

6. Put the verbs in brackets into the Present, Past or Future Simple Passive.

1. Moscow … (found) in 1147. 2. Football … (play) in summer. 3. Her new article … (finish) next year. 4. The letter … (receive) tomorrow. 5. That bone … (give) to the dog today. 6. The chair … (break) two days ago. 7. An interesting fairy-tale … (tell) tonight. 8. The boy … (take) to the zoo last month. 9. The book … (publish) in three months. 10. Many letters and telegrams … (send) every day.

7. Put the verbs in brackets into the Continuous Passive.

1. This question still … (discuss). 2. The theatre … (build) when we came to this town. 3. My friend … (ask) when the dean entered the classroom. 4. A new grammar rule … (explain) by the teacher now. 5. While the experiment … (make) we were not allowed to enter. 6. Who … (examine) now? 7. Don't switch off the TV-set. An interesting quiz program … (broadcast) now. 8. The lecture … (listen) to attentively. 9. The flowers … (water) from 2 till 3. tomorrow. 10. The glasses … (look) for everywhere now.

8. Translate the sentences paying attention to the passive forms. Identify the tense.

1. A new underground station is being constructed in our street. 2. The device was being tested when you entered the laboratory. 3. This question is not connected with the problem which is being discussed now. 4. Many various ma-

chines are being produced for our industry by this plant. 5. The art exhibition of young artists is being widely commented by the press. 6. The machines produced by this plant are being used in agriculture. 7. Masterpieces from our museum were being exhibited in different cities in June last year. 8. He is being waited for. 9. While the experiment was being carried out, nobody left the laboratory. 10. The speaker was being listened to with great interest.

9. Put the verbs in brackets into the Simple or Continuous Passive.

1. He … (ask) now. 2. We received the telegram when the letter … (type). 3. The article … (translate) into Russian in a few days. 4. A new grammar rule … usually … (illustrate) by some examples. 5. She … (laugh) at if she says it. 6. The new project … still … (work) at. 7. The document … still … (look) for. 8. Books by this writer … always much … (speak) about. 9. The meeting won't be over soon as the report … (follow) by a discussion. 10. The doctor … (send) for a minute ago.

10. Translate the sentences paying attention to the Perfect Passive forms.

1. An opening speech has been made by Mr. Brown. 2. Tom said that the conditions of work had been greatly improved. 3. The project has already been submitted to the commission. 4. He asked me if I had been invited to the party. 5. The project will have been finished by Tuesday. 6. Much attention has been paid to the further improvement of the living conditions of the people. 7. She said that her poems had been devoted to the youth. 8. Good art training has been received by these young artists. 9. She has been listened to with great attention. 10. The house will have been built by the end of the year.

11. Change from active into passive.

1. I took him for a walk. 2. She won't forget your telephone number. 3. We'll book tickets tomorrow. 4. We met her at the corner of the street. 5. We discussed such problems at our meetings. 6. They are building a new cinema in his street. 7. A young architect designed that beautiful building. 8. I rang my friend up. 9. I have just done the translation. 10. They will have passed the examinations by February.

12. Write sentences in the passive. Mind the tense form.

***Example*:** (The floor/not clean/yet) *The floor hasn't been cleaned yet*.

1. (The politician/interview/now). …….
2. (The Mona Lisa/paint/Leonardo da Vinci)……

3. (My flat/burgle/last night)…….
4. (All tickets/sell/before we got there)…….
5. (The dog/not feed/yet)……...
6. (The presents/wrap/now) ……..
7. (The prizes/award/President/tomorrow)……
8. (Tea/grow/India)……
9. (The prisoners/take/to prison/now)…….
10. (The book/read/by next week) ……

13. Fill in *by* or *with*.

1. Most children are strongly influenced …*by* …they parents.
2. The jam sandwiches were made …*with* …white bread.
3. Jake was dismissed … his boss.
4. The meal was eaten … chopsticks.
5. The lock was broken … a hammer.
6. The football fans were observed … the police.
7. My hair was cut … a top stylist.
8. My camera was loaded … a black and white film.
9. The beds were made up … clean sheets.
10. This awful mess was made … Carol's dog.

14. Put the verbs in brackets into the correct passive form.

Last week a new leisure centre 1) …*was opened*… (open) in the town of Halden. The centre 2) … (believe) to be the largest in Europe and it 3) … (hope) that it 4) … (visit) by over 40,000 people a month. The centre 5) … (plan) for over ten years, but it 6) … (only/make) possible by a large government grant. Unfortunately, it 7) … (not/finish) yet, but it 8) … (think) that it 9) … (complete) by next month. The centre includes an Olympic-size swimming pool and fifty tennis courts which 10) … (can/book) by phone. The gym 11) … (claim) to be the most modern in the country. The equipment 12) … (buy) in Germany and training 13) … (provide) by five top instructors. Entrance fees are cheap because half the cost 14) … (pay) by the local council, so many local people will be able to afford them.

PROGRESS CHECK TEST 1 (***The Passive forms***)

15. Choose the correct item.

1. Chocolate can .... or ... .
   a) eat, drink b) be eating, drinking c) be eaten, drunk
2. The cocoa plant .... by the Mayas, Toltecs and Aztecs more than 3,000 years ago.
   a) was first growing b) was first grown c) was first being grown
3. A suspicious-looking man … running away from the scene of the crime.
   a) was seen b) is seeing c) saw
4. The salad was made … lettuce, onions and cucumber.
   a) of b) by c) with
5. The curtains … by Marie.
   a) are making b) are being made c) made
6. The pool must be … on Sunday.
   a) cleans b) cleaning c) cleaned
7. These cakes are made … cherries.
   a) by b) of c) with
8. The goods … recently.
   a) has been delivered b) have been delivered c) delivered
9. The picture … to me for my birthday.
   a) was given b) gave c) is given
10. My dress … by my mother now.
    a) is being made b) is made c) made
11. The book … in a month.
    a) is publishing b) was published c) will be published
12. The cats …once a day.
    a) are being fed b) are feeding c) are fed
13. I … how to swim when I was five.
    a) will be taught b) was taught c) have been taught
14. The jewellery … in the safe.
    a) is kept b) are kept c) is keeping
15. “What is happening over there?” – “Oh, a new cinema … .”
    a) is built b) is being built c) was is built

16. Paul's car … last night.
    a) is stolen b) has been stolen c) was stolen
17. Claire's phone number … on this piece of paper.
    a) written b) be written c) is written
18. This tree … in the 19th century.
    a) plant b) was planted c) is planting
19. This piece of music … yet.
    a) has not recorded b) have not recorded c) has not been recorded
20. Not much … about this complicated subject.
    a) is known b) known c) knows
21. The new night club … by the council last week.
    a) closed b) was closed c) is closed
22. I have a beautiful jumper which … by my grandmother.
    a) knitted b) had been knitted c) was knitted
23. The instructions must … very carefully.
    a) was followed b) be followed c) is followed
24. Tickets … before we arrived.
    a) had been sold b) have been sold c) will be sold
25. The new bridge … already.
    a) is being built b) has been built c) had been built
26. Breakfast … at eight in the morning.
    a) was served b) had been served c) has been served
27. Designer clothes … in this shop.
    a) is sold b) was sold c) are sold
28. The exam … by all the children by three o'clock.
    a) was taking b) was being taken c) had been taken
29. Chinese … by more than one billion people.
    a) has spoken b) is spoken c) speak
30. The house … by the time we arrived.
    a) wasn't cleaned b) isn't cleaned c) hadn't been cleaned

TYPES OF QUESTIONS

There are five types of questions in the English language:
1. General questions
2. Special questions
3. Questions to the subject
4. Tag questions
5. Alternative questions

1. GENERAL QUESTIONS (or YES/NO QUESTIONS)

A General question is one of the main questions in the English language. It is made up to the whole sentence and requires only “yes” or “no” answers.

The word order in a general question is indirect, i.e.

An auxiliary verb or a modal verb → subject → verb…?

There are some auxiliary verbs the choice of which depends on the tense of the verb. These are:
am/is/are/was/were/do/does/did/have/has/had/shall/will.

There are some modal verbs. These are:
an/could/may/might/must/should/ought.

Examples of general questions:

1. Is he a student? – Yes, he is/No, he isn’t.
2. Are they pilots? – Yes, they are /No, they aren’t.
3. Was your brother in the cinema yesterday? – Yes, he was/ No, he wasn’t.
4. Does she know English well? – Yes, she does/No, she doesn’t.
5. Do your cats eat a lot? – Yes, they do/No, they don’t.
6. Did you buy that picture? – Yes, I did/ No, I didn’t.
7. Has he arranged the party yet? – Yes, he has/No, he hasn’t.
8. Have you got Claire’s phone number? – Yes, I have/No, I haven’t.
9. Had they travelled a lot before they visited London? – Yes, they had/ No, they hadn’t.
10. Will you show me the way to the underground? – Yes, I will/ No, I won’t.
11. Can you swim? – Yes, I can/ No, I can’t.
12. Could you see that ship? – Yes, I could / No, I couldn’t.

2. SPECIAL QUESTIONS (or WH – QUESTIONS)

A special question is made up to any part of the sentence to find out particular detailed information and requires a full answer.

The word order in a special question is:

Wh → an auxiliary verb or a modal verb → subject → verb…?

Remember the following interrogative words (Wh – вопросительные слова):

Interrogative words	Translation
What …?	Что, какой …?
Where …?	Где, куда …?
When …?	Когда …?
Why …?	Почему, зачем …?
Who …?	Кто …?
Which …?	Который …?
Whose …?	Чей …?
Whom …?	Кого, кому …?
How …?	Как …?

The most widespread interrogative words are *what*, *where*, *when*.

Besides, there are some interrogative combinations made up of two words. These are:

Interrogative combinations	Translation
What kind …?	Какой…?
What time…?	Во сколько …?
How many…?	Сколько…? (с исчисляемыми существительными)
How much…?	Сколько…? (с неисчисляемыми существительными)
How long…?	Как долго…?
How often…?	Как часто…?
How far…?	Как далеко…?
How old…?	Сколько лет…?

While asking a special question, it is a general question which is taken into account. For example, a general question to the sentence “She passed her exams successfully” is “Did she pass her exams successfully?” In order to turn this general question into a special question, just add any interrogative word to the beginning of the sentence: “**How** did she pass her exams?” or “**What** did she pass successfully?”

Examples of special questions:

1. Where does that lady keep her jewellery?
2. What should you do if you are lost?
3. How is Kevin?
4. When were you born?
5. Whose book is this?
6. What subject do you like?
7. How far from the university do you live?
8. How long have you been studying English?
9. How old is your little sister?
10. How often can you visit your grandparents?

3. QUESTIONS TO THE SUBJECT

A question to the subject deserves a special attention. It is different from special questions because **no auxiliary verb** is used in this type of questions. You should just change the subject of the sentence into *what* or *who*.

So, the word order in a question to the subject is:

Wh → verb → other parts of the sentence?

It is important here not to confuse a question to the subject with a special question beginning with *what* or *who*.

Examples of questions to the subject:

1. What happened to you?
2. Who went to the zoo?

Compare with those of special questions:

1. Who are you seeing now?
2. What are you doing?

Check yourself

Put the words in the correct order.

1. Who / about / you / it / ? / told /
2. ? / called / Who / yesterday / her /
3. tell / about / Who / ? him / can / her /
4. yet / hasn't / book / read / this / Who / ? /
5. ? / has / to / What / happened / you /

Keys:

1. Who told you about it?
2. Who called her yesterday?
3. Who can tell him about her? Who can tell her about him?
4. Who hasn't read this book yet?
5. What has happened to you?

4. TAG QUESTIONS (or DISJUNCTIVE QUESTIONS or TAIL QUESTIONS)

A tag question is made up of two parts: the first part is an affirmative or a negative sentence, the second part is a short question (tag) either positive or negative. The second part is separated from the first part with a comma (запятая). These types of questions are very popular in everyday English. They are not asked directly still they encourage an interlocutor (собеседник) to an answer. The "tags" are usually translated into Russian as "не так ли", "не правда ли", "да", "правильно".

Examples of tag questions:

1. He looks after his sister, doesn't he?
2. A girl fell into the river, didn't she?
3. The guests will come tomorrow, won't they?
4. An army officer must wear a uniform, mustn't he?
5. The secretary has been typing the letters for two hours, hasn't she?
6. Paul doesn't like his new job, does he?
7. John isn't paying for his lessons, is he?
8. These girls cannot speak French, can they?

As we can see from the examples that in the "tag" there is an auxiliary or a modal verb which we use in the first part and a pronoun which is the subject of the first part. It is also important to know that if the first part is positive, then the second part is negative and vice versa (наоборот).

The tag questions of some verbs/expressions are formed differently. Study the following examples:

I **am** →aren't I?
Open the windows, will/won't you?
Let me say, will/won't you?

Check yourself

Choose the correct letter.

1. The children are happy, …?
   a) aren't they b) don't they c) are they
2. She is your best friend, ... ?
   a) isn't she b) won't she c) doesn't she
3. There are many plates in the cupboard, …?
   a) isn't it b) aren't there c) are there

4. They could read the notice, …?
   a) could they b) couldn't they c) can't they
5. Open the book at page 20, ….?
   a) will you b) wasn't he c) didn't you
6. Each parent worries about their children, …?
   a) don't they b) doesn't he c) isn't he
7. She hasn't put an advertisement in a paper, …?
   a) hasn't she b) does she c) has she
8. Many people don't know about this new shop, …?
   a) don't they b) do they c) are they
9. Nobody will come to the beach tomorrow, …?
   a) won't they b) will they c) will he
10. He never wakes up before 10 0'clock, …?
   a) does he b) doesn't c) isn't he

Keys: 1a 2a 3b 4b 5a 6b 7c 8b 9b 10a

5. ALTERNATIVE QUESTIONS

An alternative question implies a choice between two people, things, actions, etc. This question can be asked to any part of the sentence. It is made up of two parts: the first part is a general question, the second part contains "or" and the word of choice.

Examples of alternative questions:

1. Do you live in Tomsk *or Moscow*?
2. Is she a student *or a school girl*?
3. Did you wake up at 6 *or at 7 o'clock*?

Check yourself

Identify the type of questions. Choose the correct letter (A-E).

1. Does she like to ride a bicycle in the evening?
   A) a general question
   B) a special question
   C) a question to the **subject**
   D) a tag question
   E) an alternative **question**
2. Who can help us to wash the car?
   A) a general **question**
   B) a special **question**
   C) a question **to** the subject
   D) a tag **question**
   E) an alternative question

3. This sportsman is very fast, isn't he?
   A) a **general** question
   B) a **special** question
   C) a **question** to the subject
   D) a tag question
   E) an **alternative** question

4. Do they speak English or German?
   A) a general question
   B) a **special** question
   C) a question to the subject
   D) a tag question
   E) an **alternative** question

5. Who are we waiting for?
   A) a general question
   B) a special question
   C) a question to the subject
   D) a tag question
   E) an alternative question

6. Why are you late?
   A) a general question
   B) a special question
   C) a question to the subject
   D) a tag question
   E) an alternative question

7. That house is under construction, isn't it?
   A) a general question
   B) a special question
   C) a question to the subject
   D) a tag question
   E) an alternative question

8. What was the weather like all the time?
   A) a general question
   B) a special question
   C) a question to the subject
   D) a tag question
   E) an alternative question

9. Who doesn't understand the rule?
   A) a general question
   B) a special question
   C) a question to the subject
   D) a tag question
   E) an alternative question

10. Who will meet the foreign delegation?
   A) a general question
   B) a special question
   C) a question to the subject
   D) a tag question
   E) an alternative question

Keys: 1a 2c 3d 4e 5b 6b 7d 8b 9c 10c

CONDITIONALS

*** Conditionals** are clauses introduced with ***if***.

* The main types of conditionals are: **Type 0, Type 1, Type 2 and Type 3**.

*** Type 0 Conditionals** are used to express a general truth or scientific fact. We can use ***when*** instead of ***if*** in this case.

*** Type 1 Conditionals** (real present) are used to express real or very probable situations in the present or future. We can use ***when*** instead of ***if***. If means that something may happen. ***When*** means that something will definitely happen.

If he calls, I'll tell him the news. (*but he might not call*)

When he calls, *I'll tell him the news.* (*he will definitely call*)

*** Type 2 Conditionals** (unreal present) are used to express imaginary situations which are contrary to facts in the present and, therefore, are unlikely to happen in the present or future. We can use ***were*** instead of ***was*** for all persons in the if-clauses.

*** Type 3 Conditionals** (unreal present) are used to express imaginary situations which are contrary to facts in the past. They are also used to express regrets or criticism.

* We can form conditionals by using words or expressions such as ***unless*** (***=if not***) (Type 1 conditionals), ***providing/provided that***, ***so/as long as***, ***suppose/supposing***, ***on condition that***, etc.

TYPES OF CONDITIONALS

Type	If-clause	Main clause
0	**If + present simple**	**present simple**
If/When *the sun* ***shines***, *snow* ***melts***.		
1	**If + present simple/present cont./present perfect/ present perfect cont.**	**future/imperative/can/may/might/ must/should/could present bare infinitive**
If *he* ***doesn't pay*** *the fine*, *he* ***will go*** *to prison.* ***If*** *you* ***need help***, ***come*** *and* ***see*** *me.* ***If*** *you* ***have finished*** *your work*, *we* ***can have*** *a break.*		
2	**If + past simple or past Continuous**	**would/could/might + bare infinitive**
If I had *time*, *I* ***would take up*** *a sport.* (*but I don't have time-untrue in the present*) ***If I were*** *you*, *I* ***would talk*** *to your parents about it.* (*giving advice*)		
3	**If + past perfect or past perfect continuous**	**would/could/might + have + past participle**
If *she* ***had studied*** *harder*, *she* ***would have passed*** *the test.* ***If*** *he* ***hadn't been acting*** *so foolishly*, *he* ***wouldn't have been punished***.		

EXERCISES

1. Make sentences with if (Type 1 conditional).

Example: I'm afraid the bus will be late.
→ get to work late again *If the bus is late, I'll get to work late again*.
→ lose my job *If I get to work late again, I'll lose my job.*

1. → not find another job ……
2. → lose my flat ……
3. → move back to my parents' house ……
4. → get very bored ……
5. → go swimming every day ……..
6. → look very good ……
7. → meet interesting people ……
8. → go to lots of parties ……...
9. → have a wonderful time ……..
10. → be happy ……

2. Fill in the gaps with *if* or *unless*.

1. … the weather is bad, we'll be late for the meeting.
2. … you hurry up, you will miss the train.
3. … you go there by plane, you won't reach the destination in time.
4. Your holiday on board the ship will be truly adventurous and enjoyable … you have any sailing skills.
5. … you phone me on the arrival day, I'll get upset.
6. It will take you less time … you sail from Hong Kong to England via Singapore.
7. … you look at their company's website, you won't get relevant information.
8. You'll have to pay a fine … you're caught without a ticket.
9. Children can't go in … they are with an adult.
10. You can't park here … you don't live in this street.

3. Put the verbs in brackets into the proper tense. (Type 1 Conditional)

1. You will get the feel of Sydney if you … (go) about on foot.
2. If you go abroad, you … (need) to change your money into local currency.
3. Unless the accommodation … (be) reasonably-priced, we won't afford it.
4. The town will accommodate more holiday makers if they … (construct) a new hotel.

5. If you … (not/wear) a dress or skirt, you won't be let into the temple.
6. If you come to New York, you … (experience) the excitement of one of the busiest cities in the world.
7. Unless cars … (be allowed) in the city centre, I'll have to look for a car park in the suburbs.
8. If there … (not be) any seats available, we'll stay here.
9. If it rains, we … (have) the party inside.
10. If I … (not be) free tomorrow evening, I'll see you on Friday.

4. Put the verbs in brackets into the proper tense. (Type 2 Conditional)

1. We … (need) a car if we lived in the country.
2. If we had a choice, we … (go) on a sailing tour.
3. I wouldn't mind going abroad if I … (have) enough money.
4. I think there are too many cars. If there … (not/be) so many cars, there … (not/be) traffic congestions.
5. If you … (live) nearer, we would visit you more often.
6. We … (go) on a tour by plane, if we could afford it.
7. If I were you, I … (not/buy) that car.
8. We wouldn't reach this area, if we … (not/go) by boat.
9. If dogs … (can talk), they would tell some interesting stories.
10. If he … (not travel) so much, he'd have more money.

5. Choose the correct form of the verbs.

1. If I visited Brazil, I definitely *will see/would see* the Carnival show.
2. We *will go/would go* to a campsite if the weather *is/will be* nice.
3. Unless there *were/is* a large hole in the tent, we *won't feel/will feel* comfortable.
4. If she *didn't take/doesn't take* any food along, she *is/will be* very hungry.
5. The trip *will be/would be* far more enjoyable for everyone unless the weather *is/weren't disgusting*.
6. If they *will go/go* on the "all-in" package tour, it *includes/will include* everything from food and drinks to entertainment and excursions.
7. If they *take traveller's cheques/will take traveller's cheques*, they *will be able to exchange/will can exchange* them for local money when they *arrive/will arrive* in the foreign country.
8. Unless you exceed the maximum luggage allowance, you *will pay/won't pay* an extra charge.
9. If I could find my camera, I *will take/would take* your photo.
10. Unless Pete *comes/will* come, we *won't play/wouldn't play* this game.

6. Write these sentences, putting the verbs in brackets into the correct form and adding *will* or *would*.

***Example*:** If you give me your phone number, I .*will call*. (call) you.
I ..*would drive*. (drive) to work if I had a car.

1. If I … (lose) my job, I'd go back to university.
2. If it … (rain) tomorrow, we'll cancel the barbecue.
3. Where would you live if you … (can) choose?
4. If the weather … (be) good, we often have lunch outside.
5. My mother … (worry) about me if I didn't phone her every week.
6. If you finish before 5 o'clock, I … (come) and pick you up.
7. If we … (hurry), we'll get to the shops before they close.
8. I don't know what she … (do) if she couldn't go on working.
9. What would you do if he … (ask) you to marry him?
10. He always … (complain) if I'm late.

7. Match the two halves of these sentences.

1. If the car broke down in the mountains, ...*g* …	a) we would turn back.
2. If we forgot our passports, …	b) you would catch up with me.
3. If we set off at dawn, …	c) we will catch the early train.
4. If you rode the bike faster, …	d) you would enjoy camping.
5. If you could put up with the insects,	e) we'll have to go home soon.
6. If we run out of money after a week, …	f) there'll be plenty of opportunities to take photos of wild animals.
7. If I checked in my luggage quickly,	g) I wouldn't be able to repair it.
8. If you go on a safari tour, …	h) I would have some coffee then.

8. Fill the gaps in the sentences, using the words given.

1. If I had more money, … (I/stay) at a luxurious hotel.
2. If you wanted to buy someone a really good present, what sort of things … (you/look for)?
3. How … (you/feel) if you were in my position?
4. If I were you, … (I/spend) the holiday in the countryside.
5. If you stay at one of these suites, … (it/cost) you thousands of pounds per a single night.
6. If … (you/go) on a seaside holiday, it would value for money.
7. If we went by air-conditioned coach, … (we/feel) much more relaxed.

8. If … (hitchhiking/not/be) so dangerous, it would be widely spread among young people.
9. Alex will finish his work on time if … (he/not talk) so much.
10. If the programs … (be) better, I'd watch more TV.

9. Complete the following sentences with your own ideas.

1. What will you do if you ***miss your plane***?
2. If I didn't arrive in time, they ……..
3. What would happen if I ……. …….
4. If he listened to my advice, he …….
5. Would you sell your car if ……
6. If I knew where to go, I ……
7. They wouldn't mind if we ……
8. If I were late for the appointment, I …….
9. If Alice were here, we ……..
10. If we had bikes, …….

10. Put the correct verb form (Type 3 Conditional).

***Example*:**
If I … (be) here yesterday, I would have come to see you.
If I *had been* here yesterday, I would have come to see you.

1. If Joe … (work) harder, he would have passed the exams.
2. If you … (take) a map with you, you wouldn't have got lost.
3. We would have won the game if we … (not play) so badly.
4. … you … (crash) if you had driven more slowly?
5. You … (not sleep) badly if you hadn't drunk all that coffee.
6. If you … (come) on holiday with us, you … (have) a wonderful time.
7. If my car … (not break down), I … (be) here at 8 o'clock.
8. … you … (study) harder at school last year if you … (like) the teachers?
9. She … (not get) married if she … (not want) to leave home.
10. … you … (help) me if I … (ask) you?

11. Put the correct verb form (Type 1, 2, 3 Conditionals).

1. What would you do if you … (see) a vandal destroying a painting?
2. I … (go) out if unless I'm so tired.
3. You'll miss the train if you … (wake up) late.
4. If I were you, I … (change) the route of travelling.
5. If I had been more careful, you … (visit) your old granny then.

6. You won't find the accommodation if you … (not/reserve) it in advance.
7. Unless you take an umbrella, you … (get) wet.
8. If … you, I would call the receptionist.
9. If you … (not/ fly) via Novosibirsk, it would have taken you more time.
10. If he … (not/leave) immediately, he'll miss his flight.

WISHES

	Form	Use
I wish (If only) (wish/regret about the present)	**+ Past tense**	Wish/regret about a present situation we want to be different
*I wish **you worked** harder this term. (It's a pity you don't work hard).*		
I wish (If only) (wish/regret about the present)	**+ could + bare Infinitive**	Wish/regret in the present concerning lack of ability
*I wish **I could speak** English fluently. (But I can't)*		
I wish (If only) (wish/regret about the past)	**+ Past Perfect**	regret that something happened or didn't
*I wish **I had visited** my parents last holidays. (But I didn't. It's a pity I didn't visit them).*		
I wish (If only) (impossible wish for a future change)	**+subject+would+ bare Inf.** ('wish' and 'would' should have different subjects)	wish for a future change unlikely to happen or wish to express dissatisfaction; polite request implying lack of hope
*I wish **he would drive** more carefully. (But I don't think he will).* *I wish **the children would be** more co-operative. (The children have refused to co-operate. – dissatisfaction)* *I wish **you would be** more patient with Jim. (Please be more patient with him! – request implying lack of hope)*		

*** In wishes, we go one tense back. This means that we use the Past Simple in the present or the Past Perfect in the past.**

*He's ill. He wishes he **weren't** ill. (present)*

I overslept yesterday. I wish I hadn't overslept yesterday. (past)

*** After *I wish* we can use *were* instead of *was* in all persons.**

*I wish I **was/were** richer.*

*** *If only* means the same as *I wish* but it is more dramatic.**

*If only I **was/were** richer.*

12. Fill in the gaps with an appropriate auxiliary verb.

***Example*:** She can't type but she wishes she … *could* … .

1. They didn't buy the antique vase but they wish they … .
2. I'm not going to the concert but I wish I … .
3. I'm not very tall but I wish I … .
4. I didn't go to the meeting but I wish I … .
5. I can't tell him the truth but I wish I … .
6. I don't earn much money but I wish I … .
7. She won't accept help but I wish she … .
8. They haven't got any children but they wish they … .
9. I didn't see the program but I wish I … .
10. I don't live close to the University but I wish I … .

13. Complete these sentences with the correct form of the verb in brackets. Some sentences require a negative.

1. Bruce wishes he … (have) more money so he could buy a new sweater.
2. I wish it … (snow) now that it's Christmas.
3. I wish I … (be) taller so that I could be in the basketball team.
4. I wish you … (stop) watching television while I am talking to you.
5. I wish you … (do) that. It annoys me.
6. I wish the holidays … (come) so we could go off to the seaside.
7. I wish they … (build) that block of flats right in front of our window.
8. Of course Tom wishes he … (come) with us to Paris, but he has to stay here and work.
9. I wish we … (go) to the match on Saturday but we are visiting my uncle instead.
10. If only I … (lose) all my money. Now I'm broke.

14. Here are some problems in the brackets. How could they have been avoided? Use the words and phrases to help you write two sentences about each problem using *I wish* and *If only*.

a) keep mouth shut, b) eat less, c) tell the news, d) waste water, e) drive carefully, f) keep calm, g) lose temper, h) use bins, i) take more exercise, j) take rubbish, k) recycle more paper, l) come earlier, m) save water, n) protect the forests, o) let someone else drive, p) use cars less often, q) be more disciplined for a change, r) walked more, v) play fewer computer games, w) watch less TV

1. (I've gained a lot of weight). *I wish* ……. *If only* ……. 2. (The rivers and reservoirs have dried up). *I wish* ……. *If only* ……. 3. (He crashed his car). *I wish* ……. *If only* ……. 4. (He had a row with his best friend). *I wish* ……. *If only* ……. 5. (People drop litter in the street). *I wish* ……. *If only* …….	6. (We are cutting down too many trees). *I wish* …… *If only* …… 7. (People use their cars when they don't need to). *I wish* …… *If only* …… 8. (Children don't read enough nowadays). *I wish* …… *If only* …… 9. (Now Mary knows everything). *I wish* …… *If only* …… 10. (Peter is always late). *I wish* …… *If only* ……

PROGRESS CHECK TEST 2 (*Conditionals*)

15. Choose the correct item.

1. The children always … frightened if they watch horror films.
   a) would get b) will get c) get
2. I don't know what I'd do if John … in an accident.
   a) were b) is c) will be
3. There … trouble if they try to stop him leaving.
   a) would be b) is c) will be
4. Can I take the typewriter if you … with it?
   a) will finish b) would finish c) finish
5. Shout if you … anything unusual.
   a) see b) would see c) will see
6. If you … the car, it will never break down.
   a) will look after b) look after c) would look after
7. If you … that program, you would have enjoyed it.
   a) watched b) had watched c) would watch
8. If he weren't so bad-tempered, his wife … him so soon after the marriage.
   a) won't leave b) didn't leave c) wouldn't leave

9. I … if I'd known he was so ill.
   a) won't go out b) wouldn't have gone out c) wouldn't go out
10. What … you … if I offered you a job?
   a) will …say b) would … say c) would have said
11. Tell me if there … anything wrong.
   a) is b) will be c) would be
12. The engine will start if you … this key.
   a) will turn b) turn c) would turn
13. If John had come to the football match, he … it.
   a) would have liked b) will like c) would like
14. I'll go home as soon as I … my work.
   a) carry out b) will carry out c) would carry out
15. We won't have the meeting tomorrow unless everybody … .
   a) will agree b) agree c) agrees

Keys to grammar exercises

THE PASSIVE VOICE

1 Keys: to be asked, to be read, to be written, to be invited, to be drunk, to be eaten, to be smoked, to be driven, to be seen, to be sent, to be informed, to be built, to be published, to be helped, to be advised, to be given, to be brought, to be spoken

2 Keys: 1. Много книг публикуются в России. 2. Машины проверяются полицией. 3. Меня всегда подвозит на работу мой сосед. 4. Машины проверяют перед их использованием. 5. Машину полируют раз в три месяца. 6. Бетон готовят из цемента, песка и гравия. 7. Пикник проводится один раз в месяц нашим клубом. 8. Эти ворота не красят каждый год. 9. Меня не приглашают к дяде каждые выходные. 10. Его не спрашивают на каждом уроке.

3 Keys: 1. I invite – I am invited. 2. He sends – He is sent. 3. She tells – She is told. 4. They inform – They are informed. 5. A worker builds – The house is built. 6. The writer writes a book – The book is published. 7. The student writes an exercise – The exercise is written. 8. The students help – The students are helped. 9. We ask questions – We are asked the questions. 10. I give some advice – I am given some advice.

4 Keys: 1. Выбрали лучшую машину. 2. На прошлой неделе украли мой велосипед. 3. Вызвали полицию. 4. Книгу закончили читать вчера. 5. Митинг проводился в понедельник. 6. Его не пригласили на вечеринку. 7. Их представили моему другу. 8. Меня посетил учитель на прошлой неделе. 9. Много вопросов было задано нам на уроке. 10. Письма были принесены почтальоном.

5 Keys: 1) will be shown; 2) will be cleaned; 3) will be introduced; 4) will be painted; 5) won't be fed; 6) won't be bothered; 7) will be invited; 8) will be allowed; 9) will be asked; 10) will be written

6 Keys: 1) was founded; 2) is played; 3) will be finished; 4) will be received; 5) was given; 6) was broken; 7) will be told; 8) was taken; 9) will be published; 10) are sent

7 Keys: 1) is still being discussed; 2) was being built; 3) was being asked; 4) is being explained; 5) was being made; 6) is being examined; 7) is being broadcast; 8) is/was being listened; 9) will be watered; 10) are being looked

8 Keys:1. Новая станция метро строится на нашей улице. 2. Когда вы вошли в лабораторию, испытывали прибор. 3. Этот вопрос не связан

с проблемой, которая обсуждается сейчас. 4. Много разнообразных машин для промышленности производится на нашем заводе. 5. Художественная выставка молодых художников широко комментируется прессой. 6. Машины, выпускаемые на этом заводе, используются в сельском хозяйстве. 7. Шедевры из нашего музея экспонировались в разных городах в июле прошлого года. 8. Его ждут. 9. Пока выполнялся эксперимент, никто не покидал лабораторию. 10. Оратора слушали с огромным вниманием.

9 Keys: 1) is being asked; 2) was being typed; 3) will be translated; 4) is … illustrated; 5) will be laughed; 6) is … being worked; 7) is … being looked; 8) are spoken; 9) will be followed; 10) was sent

10 Keys: 1. Вступительная речь была произнесена мистером Брауном. 2. Том сказал, что условия работы намного улучшились. 3. Проект был представлен на комиссию. 4. Он спросил меня, был ли я приглашен на вечеринку. 5. Проект подготовят ко вторнику. 6. Огромное внимание было уделено дальнейшему улучшению жизненных условий людей. 7. Она сказала, что ее поэмы посвящены молодежи. 8. Этими молодыми художниками была получена хорошая художественная подготовка. 9. Ее прослушали с огромным вниманием.

11 Keys: 1. I was taken by him for a walk. 2. Your telephone number won't be forgotten by her. 3. Tickets will be booked by us tomorrow. 4. She was met by us at the corner of the street. 5. Such problems were discussed at our meetings. 6. A new cinema is being built in his street. 7. That beautiful building was designed by a young architect. 8. My friend was rung up by me. 9. The translation has just been done by me. 10. The examinations will have been passed by February.

12 Keys: 1. The politician is being interviewed now. 2. The Mona Lisa was painted by Leonardo da Vinci. 3. My flat was burgled last night. 4. All tickets had been sold before we got there. 5. The dog hasn't been fed yet. 6. The presents are being wrapped now. 7. The prizes will be awarded by President tomorrow. 8. Tea is grown in India. 9. The prisoners are being taken to prison now. 10. The book will have been read by next week.

13 Keys: 2) with; 3) by; 4) with; 5) with; 6) by; 7) by; 8) with; 9) with; 10) by

14 Keys: 2) is believed; 3) is hoped; 4) will be visited; 5) has been planned; 6) has only been made; 7) hasn't been finished; 8) is thought; 9) will have been completed; 10) can be booked; 11) is claimed; 12) was bought; 13) is provided; 14) is paid

PROGRESS CHECK TEST 1 (The Passive forms)

15 Keys: 1) c; 2) b; 3) a; 4) c; 5) b; 6) c; 7) c; 8) b; 9) a; 10) a; 11) c ;12) c; 13) b; 14) a; 15) b; 16) c; 17) c; 18) b; 19) c; 20) a; 21) b; 22) c; 23) b; 24) a; 25) b; 26) a; 27) c; 28) c; 29) b; 30) c

CONDITIONALS

1 Keys: 1. If I lose my job, I won't find another job. 2. If I don't find another job, I'll lose my flat. 3. If I lose my flat, I'll move back to my parents' house. 4. If I move back to my parents' house, I'll get bored. 5. If I get bored, I'll go swimming every day. 6. If I go swimming every day, I'll look very good. 7. If I look very good, I'll meet interesting people. 8. If I meet interesting people, I'll go to lots of parties. 9. If I go to lots of parties, I'll have a wonderful time. 10. If I have a wonderful time, I'll be happy.

2 Keys: 1) If; 2) Unless; 3) Unless; 4) if; 5) Unless; 6) if ; 7) Unless; 8) if; 9) unless; 10) if

3 Keys: 1) go; 2) will need; 3) is; 4) construct; 5) don't wear; 6) will experience; 7) are allowed; 8) aren't; 9) will have; 10) am not

4 Keys: 1) would need; 2) would go; 3) had; 4) weren't, wouldn't be; 5) lived; 6) would go; 7) wouldn't buy; 8) didn't go; 9) could talk; 10) didn't travel

5 Keys: 1) would see; 2) will go, is; 3) are, will feel; 4) doesn't take, will be; 5) will be, is; 6) go, will include; 7) take traveller's cheques, will be able to exchange; 8) won't pay; 9) would take; 10) comes, won't play

6 Keys: 1) lost; 2) rains; 3) could; 4) is; 5) would worry; 6) will come; 7) hurry; 8) would do; 9) asked; 10) complains; 11) would tell; 12) will meet; 13) have; 14) am/'m ; 15) spoke; 16) won; 17) closed; 18) comes; 19) is; 20) was/were

7 Keys: 2) a; 3) c; 4) b; 5) d; 6) e; 7) h; 8) f

8 Keys: 1) I would stay; 2) would you look for; 3) would you feel; 4) I would spend; 5) it will cost; 6) you went; 7) we would feel; 8) hitchhiking weren't; 9) doesn't talk; 10) were

9 Student's individual answer

10 Keys: 1) had worked; 2) had taken; 3) hadn't played; 4) would you have crashed; 5) wouldn't have slept; 6) had come, would have had; 7) hadn't

broken down, would have been; 8) Would you have studied, had liked; 9) wouldn't have got, hadn't wanted; 10) Would you have helped, had asked

11 Keys:
1. I would go out unless I were so tired. 2. Why don't change the route of travelling? 3. You'll miss the train if you wake up late. 4. If I were you I would visit your old granny. 5. You won't find the accommodation unless you reserve it in advance. 6. If you don't take an umbrella, you will get wet.
7. If I were you, I would call the receptionist. 8. Unless you fly via Novosibirsk, it will take you more time. 9. It's the last time I've used that travel agent. 10. You'll miss your flight unless you leave right away. 11. I'll have a hot shower as soon as I get to the hotel. 12. Children can visit the gallery as long as they are accompanied by an adult. 13. The museum will only be able to buy that sculpture provided that the government makes a contribution. 14. I'm sure I'll never understand this painting, however much you keep explaining it to me. 15. Whatever exhibition is on in that gallery, she always goes.

WISHES

12 Keys: 1) had; 2) were/was; 3) was/were; 4) had; 5) could; 6) did; 7) would; 8) had; 9) had; 10) did

13 Keys: 1) had; 2) would snow; 3) was/were; 4) would stop; 5) wouldn't do; 6) would come; 7) wouldn't build; weren't building; 8) could come; 9) could go; 10) hadn't lost

14 Keys: 1. I wish I ate less. If only I had taken more exercise.
2. I wish people wouldn't waste water. If only people would save water. 3. I wish he would drive carefully. If only he had let someone else drive. 4. I wish he would keep calm. If only he hadn't lost his temper. 5. I wish people would use bins. If only they would take rubbish home. 6. I wish he would recycle more paper. If only we protected (would protect) the forests. 7. I wish people would use their cars less often. If only people would walked more. 8. I wish children would play fewer computer games. If only children would watch less TV. 9. I wish you would keep your mouth shut. If only I hadn't told her the news

PROGRESS CHECK TEST 2 (*Conditionals*)

15 Keys: 1) c; 2) a; 3) c; 4) c; 5) a; 6) b; 7) b; 8) c; 9) b; 10) b; 11) b; 12) b; 13) a; 14) c; 15) c

APPENDIX

Рекомендации по написанию аннотации английского текста

(Abstract)

Рекомендуемый объем аннотации — 150–200 слов.

Аннотация к тексту включает только самые основные положения и выводы, которые даются в сжатой форме.

Аннотация выполняет следующие функции:

– позволяет определить основное содержание текста (или статьи), его релевантность и решить, следует ли обращаться к полному тексту;

– предоставляет информацию о тексте (статье) и устраняет необходимость чтения его полного текста в случае, если он представляет для читателя второстепенный интерес;

В аннотации не должны повторяться предложения из текста (нельзя брать предложения из текста и переносить их в аннотацию), а также ее название.

В аннотации должны излагаться существенные факты, приведенные в тексте, и не должен содержаться материал, который отсутствует в самом тексте.

В тексте аннотации следует избегать слишком длинных предложений, а также сложных грамматических конструкций. Он должен быть лаконичен и четок.

Аннотация (abstract) состоит из:

1. Вводная часть – главная идея текста и основная информация (Кто? Что? Где? Когда?).

2. Основная часть – перечень затронутых в тексте проблем.

3. Заключительная часть, в которой пишущий высказывает свое мнение.

При написании аннотации следует использовать клишированные вводные слова:

Вводная часть:

The text deals with …

As the title implies the text describes …

The text is concerned with…

Основная часть

It is known that …

It should be noted about/that …

It is spoken in detail about…
It is reported that …
The text gives valuable information on/about…
Much attention is given to…
It is shown that…
The main idea of the text is…
It gives a detailed analysis of…
It draws our attention to…
It is stressed that…

Заключение: оценка:
The following conclusions are drawn…
The text gives valuable information about…
рекомендация:
The main idea of the text is …
The text is of great help to …
The text is of interest to …

Пример составления аннотации:

Subwavelength Plasmonic Waveguides and Plasmonic Materials

This text is concerned with surface plasmon based photonics materials to show possibility of creation such plasmonic device as plasmonic waveguide with new properties.

It should be noted that such process is still kind of obscure and requires precise investigation and research. **It is spoken in detail about** formation of plasmon-polariton metal surface as a result of extreme light irradiation and transmission through these layers. **It is shown that** free-electron model could be used for describing plasmon system inside the glass and light distribution through the plasmonic waveguide made of metal nanolayers.

The main idea of the text is to study surface plasmons and show opportunity to fabricate standalone devices to plasmonics, assisted by advanced simulation and fabrication tools, emphasizes the integration of plasmonic features into subsystems for all sorts of optical communications and information exchange.

This text is of great help to researchers involved into waveguide technologies and plasmonic waveguides devices formation.

WORD BANK

absorb	поглотить
AC	АС
accumulator	аккумулятор
alternating current	переменный ток
anthracite coal	антрацит
appliance	прибор
battery	батарея
biodiesel	биодизель
biofuel	биотопливо
biomass	биомасса
coal	каменный уголь
blackout	затемнение
boiler	котел
British thermal unit	Британская тепловая единица
capacity	способность
carbon	углерод
carbon footprint	углеродистый след
carbon tax	углеродистый налог
charcoal	древесный уголь
chemical energy	химическая энергия
clean energy	экологически чистая энергия
climate change	изменение климата
coal	уголь
coke	кокс
combustion	сгорание
conservation	сохранение
crude oil	сырая нефть
current	ток
dam	дамба
DC	постоянный ток
diesel	дизель
direct current	постоянный ток
drill	тренировка
dynamo	динамо
efficiency	эффективность
efficient	эффективный
electric	электрический
electrical	электрический
electrical grid	электрическая сетка
electromagnetic energy	электромагнитная энергия
electron	электрон
energy	энергия

engine	двигатель
engineer	инженер
entropy	энтропия
environment	окружающая среда
erg	эрг
ethanol	этанол
fossil fuel	ископаемое топливо
flexible fuel	гибкое топливо
flywheel	маховое колесо
fuel	топливо
fuel cell	топливный элемент
furnace	печь
gas	газ
gasoline	бензин
gas-turbine	газовая турбина
generate	произвести
generation	поколение
generator	генератор
geothermal	геотермический
global warming	глобальное потепление
green	зеленый
green energy	природосберегающая возобновляемая энергия
greenhouse effect	парниковый эффект
greenhouse gas	парниковый газ
grid	сетка
heat	высокая температура
heat exchange	обмен высокой температуры
high-voltage	высоковольтный
horsepower	лошадиная сила
human-powered	приведенный в действие человеком
hybrid	гибрид
hydrocarbon	углеводород
hydroelectric	гидроэлектрический
hydrogen	водород
hydrothermal	гидротермальный
industry	промышленность
internal combustion engine	двигатель внутреннего сгорания
inverter	инвертор
jet fuel	реактивное топливо
Kelvin scale	Шкала Кельвина
kilowatt	киловатт
kilowatt-hour	час киловатта
kinetic energy	кинетическая энергия

joule	джоуль
light	свет
liquefied petroleum gas	сжиженный газ
magnetic energy	магнитная энергия
megawatt	мегаватт
methane	метан
methanol	метанол
mining	горная промышленность
motor	двигатель
natural gas	природный газ
nuclear	ядерный
nuclear energy, nuclear power	ядерная энергия
nuclear reactor	ядерный реактор
nucleus	ядро
off-the-grid	быть неподключенным
oil	нефть
oil rig	нефтяная платформа
peak oil	пик добычи нефти
peat	торф
petroleum	нефть
photon	фотон
photovoltaic	фотогальванический
photovoltaic panel	фотогальваническая группа
pollution	загрязнение
potential energy	потенциальная энергия
power	мощность
power grid	энергосистема
power lines	линии электропередачи
power plant	электростанция
power station	электростанция
power transmission	передача электроэнергии
propane	пропан
public utility	предприятие коммунального обслуживания
radiant	излучающий
radiate	излучать
reactor	реактор
reciprocating engine	поршневой двигатель
reflect	отражать
renewable	возобновимый
reservoir	резервуар
shale	сланец
solar panel	солнечная батарея

solar power	солнечная энергия
static electricity	статическое электричество
steam	пар
steam engine	паровой двигатель
steam turbine	паровая турбина
sun	солнце
sunlight	солнечный свет
sunshine	свет
sustainable	жизнеспособный
temperature	температура
therm	терм
thermal energy	тепловая энергия
thermodynamics	термодинамика
tidal power	энергия приливов и отливов
transmission lines	линии передачи
transmit	передавать
turbine	турбина
utilities	утилиты
volt	В
waste	отходы
watt	ватт
wattage	потребляемая мощность
wave power	энергия волн
wind	ветер
wind farm	ветровая электростанция
windmill	ветряная мельница
wind power	энергия ветра
wind turbine	ветряной двигатель
work	работа

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Учебное издание

ПРОФЕССИОНАЛЬНЫЙ ИНОСТРАННЫЙ ЯЗЫК (АНГЛИЙСКИЙ)
Часть 1

для студентов
направления 13.03.02 «Электроэнергетика и электротехника»

Учебное пособие

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