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ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ»**

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АНГЛИЙСКИЙ ЯЗЫК

Профессионально-ориентированный курс

**для студентов
направления 140400 «Электроэнергетика и электротехника»**

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Данное пособие представляет собой подборку аутентичных текстов, к которым составлены упражнения, предполагающие индивидуальную, парную и групповую работу, а их последовательность предусматривает практику в различных видах речевой деятельности.

Пособие подготовлено на кафедре ИЯСГТ, соответствует программе дисциплины и предназначено для студентов ИДО, обучающихся по направлению 140400 «Электроэнергетика и электротехника».

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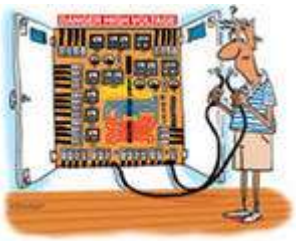
UNIT 1
What is Electrical Engineering?



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 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 he negatively charged electrons in an atom behave?
5. When is the atom is electrically neutral?
6. How do materials differ?
7. What is a conductor?

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

1. The charge can be built up by rubbing silk and glass or rubber and fur.
2. The friction between the objects causes electrons to be transferred to each other.
3. An electrically neutral object can be charged by bringing it in contact with a charged object.
4. If the charged object is positive, the neutral object gains a negative charge when some of its electrons are attracted onto the positive object.
5. A neutral conductor may be charged by induction.

Properties of Charges at Rest

Electrostatics is the study of charges, or charged bodies, at rest. When positive or negative charge builds up in fixed positions on objects, certain phenomena can be observed that are collectively referred to as static electricity. The charge can be built up by rubbing certain objects together, such as silk and glass or rubber and fur; the friction between the objects causes electrons to be transferred from one to the other-from a glass rod to a silk cloth or from fur to a rubber rod-with the result that the object that has lost the electrons has a positive charge and the object that has gained them has an equal negative charge. An electrically neutral object can be charged by bringing it in contact with a charged object: if the charged object is positive, the neutral object gains a positive charge when some of its electrons are attracted onto the positive object; if the charged object is negative, the neutral object gains a negative charge when some electrons are attracted onto it from the negative object.

A neutral conductor may be charged by induction using the following procedure. A charged object is placed near but not in contact with the conductor. If the object is positively charged, electrons in the conductor are drawn to the side of the conductor near the object. If the object is negatively charged, electrons are drawn to the side of the conductor away from the object. If the conductor is then connected to a reservoir of electrons, such as the ground, electrons will flow onto or off of the conductor with the result that it acquires a charge opposite to that of the charged object brought near it.

8. Answer the questions.

1. What is electrostatics?
2. How can the charge be built up?
3. How can an electrically neutral object be charged?
4. What will happen if a charged object is placed near but not in contact with the conductor?
5. When are electrons drawn to the side of the conductor away from the object?

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

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 electromagnetic 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.

10. 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?

GRAMMAR & VOCABULARY

11. Complete the text with the missing words from the box. The example is given.

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

12. Choose the right option (a–b) to complete the sentences (1–10). The example is given.

1. Electrical engineering is a field of engineering that generally deals ..…. 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) substunce
   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. Some individuals who live or work near high-voltage power lines …... brain cancer.
   a) have developed
   b) has developed
   c) have develop
10. Electromagnetic fields …... whenever current moves through power lines.
   a) is created
   b) are created
   c) be created

13. Match the words 1–10 with their definitions A–J. The example is given.

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

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

1	Electricity is *1 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

15. 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.

WRITING

16. Read the text and write an abstract (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.

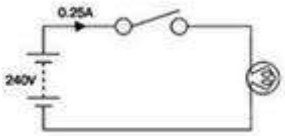
In the year 1791, Luigi Galvani proved that nerves conduct signals to the muscles in the form of electric currents, thus giving rise to the science of bio-electricity.

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

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. The example is given.

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 answer the following questions.

1. What is resistivity?
2. How is resistivity symbolized?
3. What is the unit of resistance?
4. What does the value of resistivity depend on?
5. What are the properties of dielectrics?

Resistivity

Resistivity is electrical resistance of a conductor of unit cross-sectional area and unit length. A characteristic property of each material, resistivity is useful in comparing various materials on the basis of their ability to conduct electric currents. High resistivity designates poor conductors.

Resistivity, commonly symbolized by the Greek letter rho, ρ, is quantitatively equal to the resistance R of a specimen such as a wire, multiplied by its cross-sectional area A, and divided by its length l; $\rho = RA/l$. The unit of resistance is the ohm. In the metre-kilogram-second (mks) system, the ratio of area in square metres to length in metres simplifies to just metres. Thus, in the metre-kilogram-second system, the unit of resistivity is ohm-metre. If lengths are measured in centimetres, resistivity may be expressed in units of ohm-centimetre.

The resistivity of an exceedingly good electrical conductor, such as hard-drawn copper, at 20 °C (68 °F) is 1.77×10^{-8} ohm-metre, or 1.77×10^{-6} ohm-centimetre. At the other extreme, electrical insulators have resistivities in the range 10^{12} to 10^{20} ohm-metres.

The value of resistivity depends also on the temperature of the material; tabulations of resistivities usually list values at 20 °C. Resistivity of metallic conductors generally increases with a rise in temperature; but resistivity of semiconductors, such as carbon and silicon, generally decreases with temperature rise.

Conductivity is the reciprocal of resistivity, and it, too, characterizes materials on the basis of how well electric current flows in them. The metre-kilogram-second unit of conductivity is mho per metre, or ampere per volt-

metre. Good electrical conductors have high conductivities and low resistivities. Good insulators, or dielectrics, have high resistivities and low conductivities. Semiconductors have intermediate values of both.

6. Read the text about «*Photoresistor*» and choose the right option (a–c) for every question (1–5). The example is given.

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

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 electron across the entire bandgap. Extrinsic devices have impurities, also called dopants, added 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.

7. Answer the questions

1. What is a light dependent resistor?
2. What is a photoresistor made of?
3. What is the difference between intrinsic and extrinsic semiconductors?
4. Where are photoresistors used?
5. What photoconductors are used for infrared astronomy and infrared spectroscopy?

8. 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). [2] 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.

9. Choose the right option (a–c) for every question (1–5). The example is given.

1. Superconductivity is a phenomenon of exactly zero electrical …... and expulsion of magnetic fields.

a) conductivity
b) *resistance*
c) semi conductivity

2. Superconductivity occurrs 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

GRAMMAR & VOCABULARY

10. Choose the right option (a–c) for every question (1–10). The example is given.

1. Voltage drop is the *a.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

11. 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

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

1.	Electrical engineers have contributed to the *development* 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

13. 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…… 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……...

14. 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.

WRITING

15. Read the text and write an abstract.

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) [1]. 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.

UNIT 3
The age of electricity

LEAD-IN

1. Do you know when electricity was discovered?

2. Who was the author of the discovery?

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

READING

4. Before reading the text say whether these 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 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.

5. Answer the questions.

1. When did the age of electricity begin?
2. What did M. Faraday demonstrate in 1831?
3. What was the invention of N. Tesla?
4. What significance did it have for further technological development?
5. What does power engineering deal with?
6. What is the power grid for?
7. How can you call the systems which are not connected to the grid?
8. What is the standard adaptation of the most grids?
9. Where are single-phase and three-phase electric powers used?
10. What are transformers for?
11. What is the aim of increasing voltage?
12. How can electric power be converted higher voltage?

VOCABULARY

6. Match the words to their definitions.

1	generation	A	Change
2	deal with	B	The act of sending through or across
3	resistance	C	The sending of a signal, picture, or other information from a transmitter
4	subsequent	D	The act of distributing or the condition of being distributed; apportionment
5	convert	E	the movement of electric charge periodically reverses direction. In direct current (DC), the flow of electric charge is only in one direction
6	voltage	F	One that generates, especially a machine that converts mechanical energy into
7	transmission	G	Have contact with another person or people
8	power	H	A device used to transfer electric energy from one circuit to another, especially a pair of multiply wound, inductively coupled wire coils that effect such a transfer with a change in voltage, current, phase, or other electric characteristic
9	distribution	I	a system of high tension cables by which electrical power is distributed throughout a region
10	electric generator	J	Something that fights against or stops, power
11	transmission	K	A exponent. It is a number that tells how many times another number should be multiplied by itself.

12	Transformer	L	refers to the distribution of alternating current electric power using a system in which all the voltages of the supply vary in unison
13	power grid	M	The act or process of generating; origination, production, or procreation
14	alternating current	N	Electrical energy
15	single-phase electric power	O	Next or later

7. Fill in the gaps with the words from the table.

1. The old house doesn't have enough _____ for a big air conditioner.
2. The old school was _____ into an office building.
3. The radio _____ ended when the battery died.
4. The article _____ a lot of letters to the editor.
5. The company _____ revenue by leasing cars.
6. He has to _____ many employees at work who all have different issus.
7. His first job was terrible but the _____ jobs were better and more interesting.
8. Electricians wear heavy rubber gloves because of their _____ to electricity.

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. Before reading the text say whether this 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.

READING

Components

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

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.

Transmission

The electricity is transported to load locations from a power station to a transmission subsystem. Therefore we may think of the transmission system as providing the medium of transportation for electric energy. The transmission system may be subdivided into the bulk transmission system and the sub-transmission system. The functions of the bulk transmission are to interconnect generators, to interconnect various areas of the network, and to transfer electrical energy from the generators to the major load centers. This portion of the system is called «bulk» because it delivers energy only to so-called bulk loads such as the distribution system of a town, city, or large industrial plant. The function of the sub-transmission system is to interconnect the bulk power system with the distribution system.

Transmission circuits may be built either underground or overhead. Underground cables are used predominantly in urban areas where acquisition of overhead rights of way are costly or not possible. They are also used for transmission under rivers, lakes and bays. Overhead transmission is used otherwise because, for a given voltage level, overhead conductors are much less expensive than underground cables.

The transmission system is a highly integrated system. It is referred to the substation equipment and transmission lines. The substation equipment contain the transformers, relays, and circuit breakers. Transformers are important static devices which transfer electrical energy from one circuit with another in the transmission subsystem. Transformers are used to step up the voltage on the transmission line to reduce the power loss which is dissipated on the way. A relay is functionally a level-detector; they perform a switching action when the input voltage (or current) meets or exceeds a specific and adjustable value. A circuit breaker is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit. A change in the status of any one component can significantly affect the operation of the entire system. Without adequate contact protection, the occurrence of undesired electric arcing causes significant degradation of the contacts, which suffer serious damage. There are three possible causes for power flow limitations to a transmission line. These causes are thermal overload, voltage instability, and rotor angle instability. Thermal overload is caused by excessive current flow in a circuit causing overheating. Voltage instability is said to occur when the power required to maintain voltages at or above acceptable levels exceeds the available power. Rotor angle instability is a dynamic problem that may occur following faults, such as short circuit, in the transmission system. It may also occur tens of seconds after a fault due to poorly damped or undamped oscillatory response of the rotor motion. As long as the *equal area criteria* is maintained, the interconnected system will remain stable. Should the *equal area criteria* be violated, it becomes necessary to separate the unstable component from the remainder of the system.

Distribution

The distribution system transports the power from the transmission system to the customer. The distribution systems are typically radial because networked systems are more expensive. The equipment associated with the distribution system includes the substation transformers connected to the transmission systems, the distribution lines from the transformers to the customers and the protection and control equipment between the transformer and the customer. The protection equipment includes lightning protectors, circuit breakers, disconnectors and fuses. The control equipment includes voltage regulators, capacitors, relays and demand side management equipment.

11. 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?
6. What does the transmission system do?
7. Give the definition for the world «bulk».
8. What are the forms of transmission circuits?
9. How does the system of transformers function?
10. Describe the distribution system of electric power?
11. What are the components of the protection and control equipment?

VOCABULARY

12. Match the words to their definitions.

1	analyze	A	Step by step actions
2	excitation	B	To move in a circle
3	rotate	C	The ability to do work. In living things, energy is stored as ATP, which can be used to do work in cells
4	transform	D	A ratio that compares two different measurements
5	incremental	E	To examine carefully and make a judgment
6	conversion	F	Change the shape or nature of something
7	energy	G	A change from one state or position to another, or from one form to another
8	rate	H	Intensified emotion or action

13. Fill in the gaps with the words from the table.

1. Organisms obtain _____ through the process of cellular respiration.
2. The _____ of the building, from a school into a hotel, cost a lot of money.
3. Miles per hour, heartbeats per minute, and price per pound are all _____.
4. For many years, his hair loss was _____.
5. The banker _____ the account.
6. When the moon is full he is _____ into a wolf.
7. The earth _____ around the sun.

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

voltage	rate	cost
efficiency	conversion	transformed

1. The efficiency depends on generation level and can be obtained from the heat ____ curve.
2. The operating costs of generating electrical energy is determined by the fuel cost and the of the power station.
3. The phasor diagram is an effective tool for visualizing the relationships between internal, _____ armature current, and terminal voltage.
4. Generation of electrical power is a process whereby energy _____ is into an electrical form.
5. Electromechanical energy _____ is used in converting energy from coal, petroleum, natural gas, uranium into electrical energy.
6. The operating costs of generating electrical energy is determined by the fuel _____and the efficiency of the power station.

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

One method for _____ 1 three-phase equipment on a single-phase supply is with a rotary phase __ 2, essentially a three-phase motor with special starting _____ 3 and power factor _____ 4 that produces balanced three-phase voltages. When properly designed, these rotary converters can allow ____5 operation of three-phase equipment such as machine tools on a single-phase supply. In such a device, the energy storage is performed by the _____ 6 inertia (flywheel effect) of the rotating components. An external flywheel is sometimes found on one or both ends of the shaft.	1 USE 2 CONVERT 3 ARRANGE 4 CORRECT 5 SATISEFACTION 6 MECHANIC

16. Translate the sentences from English into Russian.

1. Central processing unit (CPU) s 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. It acts like a comparator and makes decisions on the corrective action necessary to fulfil process needs according to the instructions received from the program stored in the memory and generates the output commands.
5. Memory unit is the unit that stores the data and the messages and the diagnostic information.
6. It stores all the data that defines 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. It then compares it with the reference data, which is already programmed into its memory module, analyses it and then sends a corrective signal to the process line devices, controlling temperature, pressure, speed.
10. A separate unit is used for programming and editing (e.g. a hand- held programmer or a computer).

17. Translate the sentences from Russian into English/

1. Предшествующее развитие было основано на предположении, что все параметры и переменные были выражены в единицах СИ.
2. Довольно часто крупномасштабные системные исследования и вычисления выполнены в системе за единицу измерения.
3. Таким образом, мы должны учитывать влияние вычисления за единицу на последовательность действий.
4. Такое преобразование является довольно прямолинейным из-за сходства между прямым и обратным последовательностью и фазой.
5. Соответствующие системы отсчета одинаковы для обратной или нулевой составляющей.
6. Отметим, что дополнительная приписка «pu» была добавлена, чтобы обозначить переменную за единицу; переменные в единицах СИ не имеют дополнительных обозначений.
7. Для рассмотрения трансформаторов и групп трансформаторов, мы ограничимся работой в системе за единицу.
8. Таким образом, можно пренебречь идеальным трансформатором в переходнике при расчетных условиях.

9. Эквивалентное сопротивление будь оно однофазное или трехфазное, как правило, обозначается на табличке.
10. Развитие нулевой или обратной составляющей для этих устройств не является сложным, но требует внимания к деталям в нулевой последовательности.

WRITING

18. Read the text and write anabstract.

Introduction of alternating current

The competition between the direct current (DC) of Thomas Edison and the alternating current (AC) of Nikola Tesla and George Westinghouse was known as the War of Currents. At the conclusion of their campaigning, AC became the dominant form of transmission of power. Power transformers, installed at power stations, could be used to raise the voltage from the generators, and transformers at local substations could reduce voltage to supply loads. Increasing the voltage reduced the current in the transmission and distribution lines and hence the size of conductors and distribution losses. This made it more economical to distribute power over long distances. Generators (such as hydroelectric sites) could be located far from the loads.

In North America, early distribution systems used a voltage of 2.2 kV corner-grounded delta. Over time, this was gradually increased to 2.4 kV. As cities grew, most 2.4 kV systems were upgraded to 2.4/4.16 kV, three-phase systems. In three phase networks that permit connections between phase and neutral, both the phase-to-phase voltage (4160, in this example) and the phase-to-neutral voltage are given; if only one value is shown, the network does not serve single-phase loads connected phase-to-neutral. Some city and suburban distribution systems continue to use this range of voltages, but most have been converted to 7200/12470Y, 7620/13200Y, 14400/24940Y, and 19920/34500Y.

European systems used 3.3 kV to ground, in support of the 220/380 Y volt power systems used in those countries. In the UK, urban systems progressed to 6.6 kV and then 11 kV (phase to phase), the most common distribution voltage.

North American and European power distribution systems also differ in that North American systems tend to have a greater number of low-voltage step-down transformers located close to customers' premises. For example, in the US a pole-mounted transformer in a suburban setting may supply

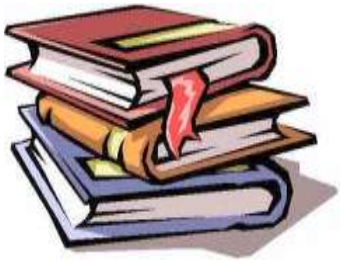
7–8 houses, whereas in the UK a typical urban or suburban low-voltage substation would normally be rated between 315 kVA and 1 MVA and supply a whole neighbourhood. This is because the higher voltage used in Europe (415 V vs 230 V) may be carried over a greater distance with acceptable power loss. An advantage of the North American setup is that failure or maintenance on a single transformer will only affect a few customers. Advantages of the UK setup are that the transformers may be fewer, larger and more efficient, and due to diversity there need be less spare capacity in the transformers, reducing power wastage. In North American city areas with many customers per unit area, network distribution will be used, with multiple transformers and low-voltage buses interconnected over several city blocks.

Rural electrification systems, in contrast to urban systems, tend to use higher voltages because of the longer distances covered by those distribution lines (see Rural Electrification Administration). 7.2, 12.47, 25, and 34.5 kV distribution is common in the United States; 11 kV and 33 kV are common in the UK, New Zealand and Australia; 11 kV and 22 kV are common in South Africa. Other voltages are occasionally used.

In New Zealand, Australia, Saskatchewan, Canada, and South Africa, single wire earth return systems (SWER) are used to electrify remote rural areas.

While power electronics now allow for conversion between DC voltage levels, AC is preferred in distribution due to the economy, efficiency and reliability of transformers. High-voltage DC is used for transmission of large blocks of power over long distances, or for interconnecting adjacent AC networks, but not for distribution to customers. Electric power is normally generated at 11–25 kV in a power station. To transmit over long distances, it is then stepped-up to 400 kV, 220 kV or 132 kV as necessary. Power is carried through a transmission network of high voltage lines. Usually, these lines run into hundreds of kilometres and deliver the power into a common power pool called the grid. The grid is connected to load centres (cities) through a sub-transmission network of normally 33 kV (or sometimes 66 kV) lines. These lines terminate into a 33 kV (or 66 kV) substation, where the voltage is stepped-down to 11 kV for power distribution to load points through a distribution network of lines at 11 kV and lower.

Self-study



LEAD-IN

1. What do you know about power distribution system?

2. What are the characteristics of power distribution system?

3. What are the problems of power distribution system

READING

3. Before reading the text say whether this sentences are true or false.

1. 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.
2. Conductors for distribution may be carried on overhead pole lines, or be buried underground.
3. In rural areas a pole-mount transformer may not serve only one customer,
4. In very dense city areas, a secondary network may be formed with many transformers feeding into a common bus at the utilization voltage.
5. 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.
6. If all conductive objects are bonded to the same earth grounding system, the risk of electric shock is maximized.

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 suburban 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.

4. Answer the questions.

1. When does the distribution system of power begin?
2. How does the voltage for the shorter distance vary?
3. How are the distribution circuits fed?
4. What are the ways of carrying conductors for distribution?
5. Why are most utility customers connected to a transformer but not to distribution voltages?
6. What is the purpose of connecting the customers system to the ground?
7. Where do the multiple connections between the utility ground and customer ground lead?

VOCABULARY

5. Match the words to their definitions.

1	appropriate	A	Usefulness
2	minimize	B	Large amounts of something in a limited space
3	network	C	Be different from
4	protective	D	Correct for the time or place
5	utility	E	Electrical energy
6	bond	F	To connect, set up or prepare something for use
7	vary	G	To make less
8	voltage	H	Tie or hold together
9	practice	I	A group of connected parts that work together
10	dense	J	An organisms that gets its energy from other organisms because it cannot make its own energy from non-living things in the environment
11	install	K	Serves to keep safe
12	consumer	L	Usual ways of doing things

6. Fill in the gaps with the words from the table.

1. It is the company's _____ to hire local workers.
2. The old house doesn't have enough _____ for a big air conditioner.
3. My taste in music _____ greatly from my friends'.
4. All animals are _____ because they have to eat other things in order to get energy.
5. The chef will _____ a new stove in the restaurant.
6. New York City has a _____ population.
7. The city bus _____ can take you anywhere.
8. The dentist used Novocaine to _____ the pain.
9. It is not _____ to smoke in class.
10. The glue _____ the paper to the wall.
11. Swiss-Army knives have a lot of _____, you can do many things with them.
12. The _____ cap on the bottle keeps children from taking the medicine.

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

Two-phase electric power, like three-phase, gives constant power transfer to a linear load. For loads that connect each phase to neutral, _____ 1 the load is the same power draw, the two-wire system has a neutral current which is greater than neutral current in a three-phase system. Also motors are not _____ 2 linear, which means that despite the theory, motors running on three-phase tend to run _____ 3 than those on two-phase. The generators in the Adams Power Plant at Niagara Falls which were installed in 1895 were _____ 4 generators in the world at the time and were two-phase machines. True two-phase power _____ 5 is essentially obsolete. Special-purpose systems may use a two-phase system for control. Two-phase power may _____ 6 from a three-phase system using an arrangement of transformers called a Scott-T transformer.	1 ASSUME 2 ENTIRE 3 SMOOTH 4 LARGE 5 DISTRIBUTE 6 OBTAIN

8. 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. It also suih all applications, except a process industry or critical loads, which may not be able to afford a total shutdown or prolonged downtime in the event of a fault.
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.

9. Translate the sentences into English.

1. Трансформатор – электрическая машина, состоящая из набора индуктивно связанных обмоток на каком-либо магнитопроводе.
2. Трансформатор предназначен для преобразования посредством электромагнитной индукции одной или нескольких систем переменного тока в одну или несколько других систем переменного тока.
3. При преобразовании частоты систем(ы) переменного тока не изменяется.
4. Трансформатор осуществляет преобразование напряжения переменного тока и/или гальваническую развязку в самых различных областях применения – электроэнергетике, электронике и радиотехнике.
5. Конструктивно трансформатор может состоять из одной (автотрансформатор) или нескольких изолированных катушек.
6. Катушки могут быть проволочные, либо ленточные, охватываемые общим магнитным потоком.
7. Как правило, они наматываются, на магнитопровод (сердечник) из ферромагнитного магнито-мягкого материала.
8. Работа трансформатора основана на двух базовых принципах:
9. Изменяющийся во времени электрический ток создаёт изменяющееся во времени магнитное поле (электромагнетизм)
10. Изменение магнитного потока, проходящего через обмотку, создаёт электродвигающую силу в этой обмотке (электромагнитная индукция).

WRITING

10. Read the text and write an annotation.

Distribution network configurations

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 center 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 aluminium 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.

UNIT 4
AC/DC power

LEAD-IN

1. What is the difference between DC and AC?

2. Where each of them can be applied?

READING

3. Before reading the text say whether these 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 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 reasons, 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 threewire 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. 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 sacrifcies made in order to obtain something else
7	bulk	G	– Not having a strong position, opinion or favorite
8	phase	H	Obvious; easy to understand
9	voltage	I	Get rid of
10	cost	J	To create, make or produce

6. Fill in the gaps with the words from the table.

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.
11. I am _____ about this election; I don't care who wins.
12. Inventions were made in all kinds of _____ to increase the products of a day's labor in the shop. – US Grant – The Autobiography.

7. 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 multijunction 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

8. Read the text and answer the questions.

1. Can you calculate the converting of three-phase system into one-phase system?
2. What formula are used?

The *complex power S*. in a single-phase system is the complex sum of the *real* (*P*) and *reactive* (*Q*) power, expressed as follows:

$$S. = P + jQ = V.\ I.* = I.\ I.*Z. = I\ 2Z_\ \theta Z = V\ I_\ \theta V - \theta I$$

where θV is the angle associated with *V*. (with respect to any chosen reference), θI is the angle associated with *I*. (with respect to the same reference chosen), θZ is the impedance angle, *V*. is the rms voltage phasor, *I*. is the rms current phasor, and $Z. = R \pm jX$ is the complex impedance with a magnitude of *Z*. Note that $*$ stands for complex conjugate. If the voltage phasor *V*. itself is taken to be the reference, $\theta V = 0$ and θI may be replaced by θ without any subscript.

The *power factor* PF is given by the ratio of the real power *P* (expressed in watts) to the apparent power $S = _P2 + Q2$ expressed in volt-amperes,

$$\mathrm{PF} = P/S = \cos\theta$$

where $\theta = \tan{-1}\ Q/P$. Inductive loads cause current to lag voltage and are referred to as lagging power factor loads. Conversely, capacitive loads cause current to lead voltage and are referred to as leading power factor loads.

For a case with lagging power factor, the formula shows voltage and current phasors. It depicts the real, reactive, and apparent powers; and next formula gives the power triangle. Loads on the electric power system are generally inductive, which will cause the phase current to lag the corresponding applied phase voltage. The real power component represents the components of voltage and current that are in phase, whereas the reactive power component represents the components of voltage and current that are in quadrature (that is, 90° out of phase).

The power expressions for the three-phase case, in terms of the line quantities, are

$$S.3\varphi = P3\varphi + jQ3\varphi$$

in which θP is the phase angle between the voltage and the current of any particular phase, and $\cos\theta P$ is the power factor.

Under most normal operating conditions, the various components of the three-phase system are characterized by complete *phase symmetry*. If such phase symmetry is assured throughout the power system, it is desirable to simplify the analytical efforts to a great extent by the use of *per-phase*

analysis. Also recall that three-phase systems are most often represented by *single-line* (*one-line*) *diagrams*.

The *energy E* associated with the instantaneous power over a period of time *T* seconds is given by

$$E = PT$$

where *E* is the energy in joules that is transferred during the interval, and *P* is the average value of the real-power component in joules per second.

Note that the reactive-power component does not contribute to the energy that is dissipated in the load. The energy associated with the reactive power component is transferred between the electric fields (which result from the application of the sinusoidal voltage between the phase conductors and ground) and the magnetic fields (which result from the flow of sinusoidal current through the phase conductors).

Many industrial loads have lagging power factors. Electric utilities may assess penalties for the delivery of reactive power when the power factor of the customer's load is below a minimum level, such as 90 %. Capacitors are often used in conjunction with such loads for the purpose of *power factor correction or improvement*. An appropriate capacitor connected in parallel with an inductive load cancels out the reactive power and the combined load may have unity power factor, thereby minimizing the current drawn from the source.

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

The three-phase system is by far the most common polyphase system used for generation, _____1, and heavy power utilization of ac electric energy because of its economic and _____2 advantages. An ideal three-phase source generates three sinusoidal voltages of equal amplitudes _____3 from each other by an angle of 120° in time. The voltages generated by the giant synchronous generators in power stations are practically sinusoidal with a _____4 of 60 Hz in the United States, or 50 Hz in the United Kingdom and many other countries. Even though voltages and currents are sinusoidal, the power _____5 to a balanced load is constant for a three-phase system. The three-phase scheme of power transmission offers the advantages of _____6 the ac mode, constant power flow, and high power transfer capability.	1 TRANSMIT 2 OPERATE 3 PLACE 4 FREQUENT 5 DELIVER 6 USE

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.

11. Translate the sentences from Russian into English.

1. На одну из обмоток, называемую *первичной обмоткой*, подаётся напряжение от внешнего источника.
2. Протекающий по первичной обмотке переменный ток создаёт переменный магнитный поток в магнитопроводе.
3. Переменный магнитный поток в магнитопроводе создаёт во всех обмотках электродвигающую силу индукции.
4. Электродвигающая сила индукции пропорциональна первой производной магнитного потока, при синусоидальном токе сдвинутой на 90° в обратную сторону по отношению к магнитному потоку.
5. В некоторых трансформаторах, работающих на высоких или сверхвысоких частотах, магнитопровод может отсутствовать.

6. В режиме короткого замыкания, на первичную обмотку трансформатора подается переменное напряжение небольшой величины.
7. Выводы вторичной обмотки соединяют накоротко.
8. Величину напряжения на входе устанавливают такую, чтобы ток короткого замыкания равнялся номинальному (расчетному) току трансформатора.
9. В таких условиях величина напряжения короткого замыкания характеризует потери в обмотках трансформатора.
10. Мощность потерь можно вычислить, умножив напряжение короткого замыкания на ток короткого замыкания.

WRITING

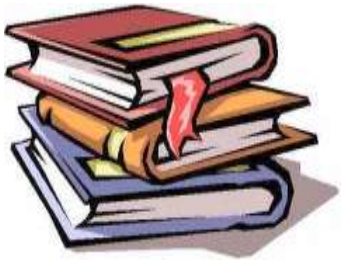
12. Read the text and write an abstract.

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 I2t 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 SOAs.

Self-study



LEAD-IN

1. What higher educational establishments train power engineers?

2. What do you know about them?

3. Why did you choose Tomsk polytechnic university to enter?

READING

4. Before reading the text say whether these sentences are true or false.

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. MPEI consists of 9 Technical Institutes, 3 special Faculties.
4. 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.
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 produce 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 (at the cities of Smolensk and Voljskiy).

5. Answer the questions.

1. What tasks does MPEI solve?
2. What are the fields of scientific interests of MPEI?
3. What equipment is there at students' disposal?
4. What place with official rating of the Ministry of Education of Russian Federation does MPEI hold?
5. How many Institutes and Faculties are there in MPEI?
6. How many students are trained there?

VOCABULARY

6. Match the word to its definition.

1	cabinet	A	An essay or written statement based on arguments
2	foreign-	B	A long-lived group, organization or practice
3	literature	C	To have a relationship with another person or group
4	thesis-	D	An official group of advisors to a head of state
5	unique	E	Of different origin
6	institution	F	From another country
7	status	G	Businesses of the same type; businesses concerned wit goods
8	affiliate	H	Legal condition
9	industry	I	– One of a kind
10	Foreign	J	Written art

7. Fill in the gaps with the words from the table.

1. He is not married; his marital _____ is single.
2. Columbia University is the oldest _____ of higher education in New York City.
3. The Asian company is _____ with another company in Europe.
4. Blood transfusions must be the same blood type because the body will attack foreign antibodies.
5. The tobacco _____ markets a very profitable product.
6. In New York it found 62.58 % of the population of the slum to be _____-born, whereas for the whole city the percentage of _____ ers was only 43.23. – J. Riis – The Battle with the Slum.
7. The president called his _____ into a meeting.
8. Some people think Moby Dick was America's first great _____.
9. Picasso was a _____ painter.
10. She wrote a _____ for her philosophy professor.

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

The principal source of energy comes from the ____1 of fossil fuels such as coal and oil to _____2 steam, which drives steam turbines, which in turn drive _____3 generators. Other important energy sources are hydroelectric and nuclear. In the former, electric generators are driven by waterwheel (hydraulic) turbines near _____4 or human-made waterfalls; in the latter, nuclear _____5 generate heat to drive the steam-turbine – generator chain. There are also other less _____6 used sources of energy such as geothermal sources, wind, sun, and tides.	1 BURN 2 GENERATION 3 ELECTRICITY 4 NATURE 5 REACT 6 WIDE

9. Translate the sentences from English into Russian.

1. The modules of identical types can also be easily interchanged and defective modules replaced by spare modules in the event of a fault.
2. Downtime is now low.
3. This arrangement is therefore recommended for all critical installations that require an uninterpted power supply and cannot downtime during operation.
4. It is most suited for installations such as power stations, refineries, petrochemical plants, fertilizers, and similar process plants.
5. Similarly, hospitals, airports, railways, etc. are also such critical areas that may experience chaos due to a disruption of utilities unless the normal supply is restored swiftly.
6. In such places this type of construction is more appropriate.
7. A draw-out assembly can be designed only in a cubicle construction and is totally compartmentalized.
8. The two types of draw – out constructions noted above can be broadly described as follows.
9. In this design the incoming and outgoing power contacts are of the draw-out type, but the control terminals are the plug-in type.
10. The plug-in contacts of the control terminal assembly are wired and left loose in the moving trolley, and are engaged manually with the fixed contacts mounted on the frame, after the trolley is racked-in and seated in its place.

10. Translate these sentences from Russian into English.

1. При подключении нагрузки к вторичной обмотке во вторичной цепи возникает ток.
2. Этот ток создает магнитный поток в магнитопроводе.
3. Поток тока направлен противоположно магнитному потоку, создаваемому первичной обмоткой.
4. В результате в первичной цепи нарушается равенство электродвигающей силы индукции и электродвигающей силы источника питания.
5. Это приводит к увеличению тока в первичной обмотке до тех пор, пока магнитный поток не достигнет практически прежнего значения.
6. Степень потерь (и снижения КПД) в трансформаторе зависит от качества, конструкции и материала «трансформаторного железа».
7. Потери в стали состоят в основном из потерь на нагрев сердечника, на гистерезис и вихревые токи.
8. Потери в трансформаторе, где «железо» монолитное, значительно больше, чем в трансформаторе, где оно составлено из многих секций (так как в этом случае уменьшается количество вихревых токов).
9. На практике монолитные сердечники не применяются.
10. Для снижения потерь в магнитопроводе трансформатора магнитопровод может изготавливаться из специальных сортов трансформаторной стали с добавлением кремния.

WRITING

11. Read the text and write an abstract.

Insulated-Gate Bipolar Transistor (IGBT)

The IGBT has the high input impedance and high-speed characteristics of a MOSFET with the conductivity characteristic (low saturation voltage) of a bipolar transistor. The IGBT is turned on by applying a positive voltage between the gate and emitter and, as in the MOSFET, it is turned off by making the gate signal zero or slightly negative. The IGBT has a much lower voltage drop than a MOSFETof similar ratings. The structure of an IGBT is more like a thyristor and MOSFET.

For a given IGBT, there is a critical value of collector current that will cause a large enough voltage drop to activate the thyristor. Hence, the device manufacturer specifies the peak allowable collector current that can flow without latch-up occurring. There is also a corresponding gate source voltage that permits this current to flow that should not be exceeded. Like the power MOSFET, the IGBT does not exhibit the secondary breakdown phenomenon common to bipolar transistors.

However, care should be taken not to exceed the maximum power dissipation and specified maximum junction temperature of the device under all conditions for guaranteed reliable operation. The on-state voltage of the IGBT is heavily dependent on the gate voltage. To obtain a low onstate voltage, a sufficiently high gate voltage must be applied. In general, IGBTs can be classified as punch-through (PT) and nonpunch-through (NPT) structures, In the PT IGBT, an Nю buffer layer is normally introduced between the Pю substrate and the NA epitaxial layer, so that the whole NA drift region is depleted when the device is blocking the off-state voltage, and the electrical field shape inside the NA drift region is close to a rectangular shape. Because a shorter NA region can be used in the punch-through IGBT, a better trade-off between the forward voltage drop and turn-off time can be achieved. PT IGBTs are available up to about 1200 V.

High voltage IGBTs are realized through a nonpunch-through process. The devices are built on an NA wafer substrate which serves as the NA base drift region. Experimental NPT IGBTs of up to about 4 KV have been reported in the literature. NPT IGBTs are more robust than PT IGBTs, particularly under short circuit conditions. But NPT IGBTs have a higher forward voltage drop than the PT IGBTs. The PT IGBTs cannot be as easily paralleled as MOSFETs. The factors that inhibit current sharing of parallel-connected IGBTs are (1) on-state current unbalance, caused by VCE(sat) distribution and main circuit wiring resistance distribution, and (2) current unbalance at turn-on and turn-off, caused by the switching time difference of the parallel connected devices and circuit wiring inductance distribution. The NPT IGBTs can be paralleled because of their positive temperature coefficient property.

Individual Home Task № 1

Variant 1

READING

***Text 1*. Read the text, and match the questions (A–F) to the numbered spaces (1–5), as in the example (0). Then, explain the words in bold.**

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 «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.

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. **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 & GRAMMAR TEST

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) resisitance
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) designes
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

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

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

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. **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

VOCABULARY & GRAMMAR TEST

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) resisits
   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

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

Read the text and write an abstract.

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

What do Electrical Engineers do?

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

G. How did the invention of the incandescent light bulb change people's life?
H. Was Edison the only one who dealt with electricity?
I. What did Thomas Edison and George Westinghouse do to control the industry?
J. What was invented by Thomas Alva Edison?
K. Why did many inventors try to perfect incandescent lamps?
L. 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.

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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.

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VOCABULARY & GRAMMAR TEST

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
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4. Electrical engineers …on many kinds of products.
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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. **Read the article. Choose the best word (A, B or C) for each space (1–8).**

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5. a. dependent	b. depend	c. dependency
6. a. conductor	b. insulator	c. indicator
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8. a. decrease	b. increase	c. measure

Text 2. **Read the text, and match the questions (A–F) to the numbered spaces (1–5), as in the example (0). Then, explain the words in bold.**

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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.

VOCABULARY & GRAMMAR TEST

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. The idea behind an electron gun is to create electrons and then ..…. them to a very high speed.
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

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

Read the text and write an abstract.

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.

Individual Home Task № 2

Variant 1

READING

Text 1. **Read the text and answer the questions below.**

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. 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. 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. 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. Bundle conductors are also used at high voltages to reduce energy loss caused by corona discharge.

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.

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. Wind speeds as low as 23 knots (43 km/h) can permit conductors to encroach operating clearances, resulting in a flashover and loss of supply.[2] Oscillatory motion of the physical line can be termed gallop or flutter depending on the frequency and amplitude of oscillation.

1. What is the conductor material?
2. Why isn't copper used for overhead transmission?
3. What allows to increase capacity and modernize transmission circuits?
4. How does conductor size range?
5. Why are thicker wires not effective?
6. What is transmission level voltage today?
7. How is voltage graded?
8. What rules are necessary to be kept to maintain safety in overhead transmission wires?

Text 2. **Read the text and decide whether the sentences are true or false.**

1. The total real power in a three-phase system can not be determined by the sum of the wattmeter readings.
2. However, in practice, this may be possible due to the nonaccessibility of the neutral of the wye connection.
3. Hence it is more desirable to have a method for measuring the total real power drawn by a three-phase load.
4. The three-phase power can be measured by three single-phase wattmeters having current coils in each line and potential coils connected across the given line and any common junction.
5. This is known as the two-wattmeter method of measuring three-phase power.
6. The method is not valid for either balanced or unbalanced circuits.

A wattmeter is an instrument with a potential coil and a current coil so arranged that its deflection is proportional to VI cos θ, where V is the voltage (rms value) applied across the potential coil, I is the current (rms value) passing through the current coil, and θ is the angle between VÏ and IÏ. By inserting such a single-phase wattmeter to measure the average real power in each phase (with its current coil in series with one phase of the load and its potential coil across the phase of the load), the total real power in a three-phase system can be determined by the sum of the wattmeter readings. However, in practice, this may not be possible due to the nonaccessibility of either the neutral of the wye connection, or the individual phases of the delta connection. Hence it is more desirable to have a method for measuring the total real power drawn by a three-phase load while we have access to only three line terminals.

The three-phase power can be measured by three single-phase wattmeters having current coils in each line and potential coils connected across the given line and any common junction. Since this common junction is completely arbitrary, it may be placed on any one of the three lines, in which case the wattmeter connected in that line will indicate zero power because its potential coil has no voltage across it. Hence, that wattmeter may be dispensed with, and three-phase power can be measured by means of only two single-phase wattmeters having a common potential junction on any of the three lines in which there is no current coil. This is known as the two-wattmeter method of measuring three-phase power. In general, m-phase power can be measured by means of m − 1 wattmeters. The method is valid for both balanced and unbalanced circuits with either the load or the source unbalanced.

GARMMAR AND VOCABULARY

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

When the load power factor is unity, corresponding to a purely _____ 1 load, both wattmeters will indicate the same wattage. In fact, both of them should read positive; if one of the wattmeters has a below-zero _____ 2 in the laboratory, an upscale deflection can be obtained by simply _____ 3 the leads of either the current or the potential coil of the wattmeter. The sum of the wattmeter readings gives the total power absorbed by the load. At zero power factor, corresponding to a purely _____ 4 load, both wattmeters will again have the same wattage indication but with the opposite signs, so that their ___5 sum will yield zero power absorbed, as it should. The transition 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 _____ 6 to the load.	1 RESIST 2 INDICATE 3 REVERSE 4 REACT 5 ALGEBRA 6 DELIVER

TRANSLATION

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. Fully draw-out type 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

Read the text and write an abstract.

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. **Read the text below and answer the questions.**

1. What are the transmission networks designed for?
2. What are the components of the transmission networks?
3. Who administrates the transmission networks?
4. What does the transmission efficiency depend on?
5. How is the change in voltage usually achieved?
6. What is a transmission grid?
7. What is the most cost-effective number of wires?

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. 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.

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.

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.

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. 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.

Text 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. Renewable energy sources such as solar photovoltaics, wind, wave, and tidal are also considered «base load».
6. The remaining power demand, if any, is supplied by peaking power plants.

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 power 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 fueled by natural gas.

GRAMMAR AND VOCABULARY

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

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 suppliers at _____4 highest demand moments). Thus distant _____5 can be _____6 than local sources (e.g., New York City buys a lot of electricity from Canada). Multiple local sources (even if more expensive and _____7 used) can make the transmission grid more fault tolerant to weather and other disasters that can _____ 8 distant suppliers.	1 TRANSMIT 2 EFFICIENCY 3 PRODUCT 4 PREDICT 5 SUPPLY 6 CHEAP 7 FREQUENT 8 CONNECTION

TRANSLATION

Translate the sentences from English into Russian.

1. When the short-circuit occurs at a current zero, Le., 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

Read the text and write an abstract.

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. **Read the text below and answer the questions.**

1. What is the average lost of transmitting electricity?
2. What lessens the resistive losses in the conductor?
3. What happens to the losses if the conductor size is reduced?
4. What is the voltage of overhead lines?
5. What measures are taken to reduce corona losses?
6. How are losses estimated?
7. What is the longest cost-effective distance between DC?

Losses

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

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 constitute transmission and distribution losses.

As of 1980, 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.

***Text 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 equal to the systems with high power factors.
6. To control reactive power flow for reduction of losses and stabilization of system voltage, utilities add capacitor banks and other components.

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

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

Long distance transmission allows remote _____1 energy resources to be used to displace fossil fuel _____2. Hydro and wind sources cannot be moved _____3 to populous cities, and solar costs are the ____4 in remote areas where local power needs are minimal. _____5 costs alone can determine whether any particular renewable alternative is economically sensible. Costs can be _____6 for transmission lines, but various _____7 for massive infrastructure ____8 in high capacity, very long distance super grid transmission networks could be recovered with modest usage fees.	1 NEW 2 CONSUME 3 CLOSE 4 LOW 5 CONNECT 6 PROHIBIT 7 PROPOSE 8 INVEST

TRANSLATION

Translate the sentences from English into Russian.

1. The content of asymmetry will depend upon the instant at which the short-circuit condition occurs on the current wave and the p.f.of the faulty circuit.
2. The higher the recovery voltage at the instant of fault, the lower will be the asymmetry (at V,, the d.c. component will be zero) and vice versa (at Vo,t he d.c. component will be the maximum).
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 Is,, 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 % of the peak value of Is, (Idc < 0.5 ZM) at that instant.
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 Is, and the asymmetrical Idc,current components.

WRITING

Read the text and write an abstract.

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*. Read the text below and answer the questions.**

1. What is HDVC used for?
2. What current is used for long distance transmissions?
3. Why DC is more cost-effective than AC?
4. What is the maximum length when AC can be applied?
5. What is the length of submarine connect?
6. What is the relation of the power transmitted by an AC line to the phase angle between source end voltage?

***High-voltage direct current* (*HVDC*)** is used to transmit large amounts of power over long distances or for interconnections between asynchronous grids. 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. 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, the capacitance between phases or, in the case of buried cables, between phases and the soil or water in which the cable is buried.

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

HVDC links are sometimes used to stabilize against control problems with the AC electricity flow. 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. Since the power flow in a DC link is controlled independently of the phases of the AC networks at either end of the link, this stability limit does not apply to a DC line, and it can transfer its full thermal rating. A DC link stabilizes the AC grids at either end, since power flow and phase angle can be controlled independently.

Text 2. **Read the text below and decide decide whether 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. If one of AC system components fail, it places sudden loads on a remaining working grid system.
3. With an HVDC line instead, such an interconnection would fail.
4. Such a system would be less prone to cascade failures if part of it were suddenly shut down.
5. There is no prominent example of such a transmission line in the Western United States.
6. Adjusting the flow of AC power is an everyday occurrence in AC systems.

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: (1) Convert AC in Seattle into HVDC. (2) Use HVDC for the three thousand miles of cross country transmission. Then (3) 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

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

The fundamental principles of electricity generation were _____1 during the 1820s and early 1830s by the British scientist Michael Faraday. His basic method is still used today: electricity is generated by the _____2 of a loop of wire, or disc of copper between the poles of a magnet. For electric utilities, it is the first process in the _____3 of electricity to consumers. The other processes, electricity transmission, distribution, and electrical power _____4 and recovery using _____ 5 storage methods are normally carried out by the _____ 6 power industry.	1 DISCOVER 2 MOVE 3 DELIVER 4 STORE 5 PUMP 6 ELECTRICITY

TRANSLATION

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

Read the text and write an abstract.

Grids for railways

In some countries where electric trains run on low frequency AC (e.g., 16.7 Hz and 25 Hz) power, there are separate single phase traction power networks operated by the railways. These grids are fed by separate generators in some traction powerstations or by traction current converter plants from the public three phase AC network.

Superconducting cables

High-temperature superconductors promise to revolutionize power distribution by providing lossless transmission of electrical power. The development of superconductors with transition temperatures higher than the boiling point of liquid nitrogen has made the concept of superconducting power lines commercially feasible, at least for high-load applications. It has been estimated that the waste would be halved using this method, since the necessary refrigeration equipment would consume about half the power saved by the elimination of the majority of resistive losses. Some companies such as Consolidated Edison and American Superconductor have already begun commercial production of such systems. In one hypothetical future system called a SuperGrid, the cost of cooling would be eliminated by coupling the transmission line with a liquid hydrogen pipeline.

Superconducting cables are particularly suited to high load density areas such as the business district of large cities, where purchase of an easement for cables would be very costly.

Single wire earth return

Single-wire earth return (SWER) or single wire ground return is a single-wire transmission line for supplying single-phase electrical power for an electrical grid to remote areas at low cost. It is principally used for rural electrification, but also finds use for larger isolated loads such as water pumps, and light rail. Single wire earth return is also used for HVDC over submarine power cables.

Wireless power transmission

Both Nikola Tesla and Hidetsugu Yagi attempted to devise systems for large scale wireless power transmission, with no commercial success.

In November 2009, LaserMotive won the NASA 2009 Power Beaming Challenge by powering a cable climber 1km vertically using a ground-based laser transmitter. The system produced up to 1 kW of power at the receiver end. In August 2010, NASA contracted with private companies to pursue the design of laser power beaming systems to power low earth orbit satellites and to launch rockets using laser power beams.

Wireless power transmission has been studied for transmission of power from solar power satellites to the earth. A high power array of microwave or laser transmitters would beam power to a rectenna. Major engineering and economic challenges face any solar power satellite project.

Security of control systems

The Federal government of the United States admits that the power grid is susceptible to cyber-warfare. The United States Department of Homeland Security works with industry to identify vulnerabilities and to help industry enhance the security of control system networks, the federal government is also working to ensure that security is built in as the U.S. develops the next generation of 'smart grid' networks.

Answer keys

The real and reactive powers of the load (motor) are:

$$PM = 25 \cdot 0{,}707 = 17{,}68 \text{ kW};$$

$$QM = 25 \sin (\cos - 10{,}707) = 17{,}68 \text{ kVAR};$$

(a) The line current of the motor, before the addition of the capacitor bank, is

$$IM = S3\varphi \sqrt{3}\ VL = 25{,}000;$$

$$\sqrt{3} \cdot 220 = 65{,}6 \text{ A}.$$

After the addition, the new value of line current is

$$I\text{corr} = PM \sqrt{3}\ VL\text{PFcorr} = 17{,}680;$$

$$\sqrt{3} \cdot 220 \cdot 0{,}9 = 51{,}55 \text{ A}.$$

(b) The corrected new value of reactive power is

$$Q\text{corr} = PM \tan(\cos - 10{,}9) = 17{,}68 \tan 25{,}8° = 8{,}56 \text{ kVAR}.$$

The kVA (kVAR) rating of the capacitor bank needed to improve the power factor from

0,707 to 0,9 lagging is then found as

$$Q\text{cap} = Q\text{corr} - QM = 8{,}56 - 17{,}68 = -9{,}12 \text{ kVAR}.$$

(c) Per-phase capacitive kVAR = 9,12/3 = 3,04 kVAR. With wye connection,

V 2 LN XC = _220/√3_2 XC = 3,04 · 103

or

XC = _220/√3_2 3,04 · 103 = 5,31 _ Hence, C = 1 2π ·60 · 5,31 = 500 μF;

(d) With delta connection,

V 2 L XC = 2202 XC = 3,04 · 103

or

XC = 2202 3,04 · 103 = 15,92 _

Hence,

C = 1 2π · 60 · 15,92 = 166,6 μF Note that Z_ = 3ZY, or C_ = (1_3)CY, as it should be for a balanced case.

WORD BANK

absorb	поглотить
AC	AC
accumulator	аккумулятор
alternating current	переменный ток
anthracite coal	антрацит
appliance	прибор
battery	батарея
biodiesel	биодизель
biofuel	биотопливо
biomass	биомасса
bituminous 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
joule	джоуль
Kelvin scale	Шкала Кельвина
kilowatt	киловатт
kilowatt-hour	час киловатта
kinetic energy	кинетическая энергия
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	ядерная энергия
nuclear power	ядерный реактор
nuclear reactor	ядро
nucleus	быть неподключенным
off-the-grid	нефть
oil	нефтяная
oil rig	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
power plant	электропередачи
power station	электростанция 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

Grammar Reference

Косвенная речь (Reported speech)
Sequence of Tenses

Косвенная речь значит, что чьи-то слова (прямая речь) сообщаются в форме косвенной речи. Предложения с косвенной речью – это сложноподчиненные предложения с дополнительными придаточными предложениями. В английском языке употребление времени глагола-сказуемого в придаточном предложении зависит от времени глагола-сказуемого в главном предложении. Это называется правилом согласования времен.

а) Если в главном предложении глагол-сказуемое стоит в одной из форм настоящего или будущего времени, то глагол-сказуемое в придаточном предложении может стоять в любой временной форме, которая требуется по смыслу.

б) Если в главном предложении глагол-сказуемое стоит в одной из форм прошедшего времени (обычно, Simple Past), то в придаточном предложении глагол-сказуемое нужно употреблять также в одной из форм прошедшего.

Direct Speech	Reported Speech
Present Simple →	Past Simple
Present Continuous →	Past Continuous
Present Perfect →	Past Perfect
Present Perfect Continuous →	Past Perfect Continuous
Past Simple →	Past Perfect
Past Continuous →	Past Perfect Continuous
Past Perfect →	Past Perfect
Past Perfect Continuous →	Past Perfect Continuous
Future Tenses (will) →	Future in the Past (would)

Direct Speech	Reported Speech
Peter: "I work in the garden."	Peter said that he worked in the garden.
Peter: "I'm working in the garden."	Peter said that he was working in the garden.
Peter: "I have worked in the garden."	Peter said that he had worked in the garden.
Peter: "I have been working in the garden."	Peter said that he had been working in the garden.
Peter: "I worked in the garden."	Peter said that he had worked in the garden.
Peter: "I was working in the garden."	Peter said that he had been working in the garden.

Peter: "I had worked in the garden."	Peter: "I had worked in the garden."
Peter: "I had been working in the garden."	Peter said that he had been working in the garden.
Peter: "I will work in the garden."	Peter said that he would work in the garden.
Peter: "I can work in the garden."	Peter said that he could work in the garden.
Peter: "I may work in the garden."	Peter said that he might work in the garden.
Peter: "I would work in the garden."(could, might, should, ought to)	Peter said that he would work in the garden. (could, might, should, ought to)

в) Когда вы переводите предложения из прямой речи в косвенную речь, часто бывает необходимо заменить некоторые местоимения и наречия в придаточном предложении. Личные местоимения изменяются в зависимости от смысла предложения.

this (evening) →	that (evening)
today/this day →	that day
these (days) →	those (days)
now →	then
here →	there
next (week) →	the following (week)
tomorrow →	the next/following day
in a few days →	a few days later
yesterday →	the day before
three days ago, a week age →	three days before, a week before
last week, last month →	the week before, the month before
last weekend →	the weekend before / the previous weekend

г) Обратите внимание на порядок слов в косвенной речи.

Word Order in Reported Speech

Statements	She said, "I live here."	She said that she lived there.
General questions	He asked, "Do you know this man?"	He asked me whether (if) I knew that man.
Special questions	He asked me, "What are you doing?"	He asked me what I was doing.
Commands	She said, "Go to your room."	She told me to go to my room
Suggestions	He said, "Let's go to the lake."	He suggested that we go to the lake. / He suggested going to the lake.

д) Если в дополнительном придаточном предложении выражена общеизвестная истина, то в придаточном предложении обычно употребляется настоящее время, несмотря на то, что в главном предложении употреблено прошедшее время.

е) Существует много глаголов вводящих придаточные в косвенной речи. Обратите внимание на использование глагола say в косвенной речи. Глагол tell всегда используется с косвенным дополнением в косвенной речи.

She said (*that*) *she was going.* ~~*She said to me she was going.*~~

She told me not to go there. ~~*She told me don't go there.*~~

She told ***us/me/the doctor/her husband*** *the news.*

Многие глаголы более «описательны», чем *say* и *tell.* Например: *explain*, *interrupt*, *demand*, *insist*, *admit*, *complain*, *warn.*

ж) Правила согласования времен должны соблюдаться, особенно в официальной устной и письменной речи и в различных устных и письменных тестах по английскому языку. Вышеуказанные изменения в придаточном предложении (если глагол в главном предложении стоит в прошедшем времени) требуются правилами согласования времен, но эти изменения также зависят от контекста и происходят не во всех случаях. Сравните:

Он сказал: «*Я навещу ее завтра*».

Он сказал, что навестит ее на следующий день. (*Если* «*завтра*» *было в прошлом в момент говорения*, *оно заменяется фразой* «*на следующий день*».)

Он сказал, что навестит ее завтра. (*Если* «*завтра*» *было все еще в будущем в момент говорения, оно остается в предложении как* «*завтра*».)

Exercises

1. Choose the appropriate alternative that matches the direct speech given.

1. "What's she doing?"
   a. I wondered what was she doing.
   b. I wondered what she was doing.
2. "Don't talk!"
   a. The teacher told us not to talk.
   b. The teacher told us to not talk.
3. "Have you finished with the computer?"
   a. She asked if had I finished with the computer.
   b. She asked if I had finished with the computer.
4. "Why did you have to wait so long?"
   a. She wanted to know why we had to wait so long.
   b. She wanted to know why did we have to wait so long.

5. "What is the time?"
   a. Can you tell me what is the time?
   b. Can you tell me what the time is?
6. "Do you play chess?"
   a. He asked me if I did play chess.
   b. He asked me if I played chess.
7. "Do not tell her what I said."
   a. He begged me to not tell her what he had said.
   b. He begged me not to tell her what he had said.
8. "Where do you live?"
   a. Tom asked me where I lived.
   b. Tom asked me where did I live.
9. "When are you going back to Russia?"
   a. He asked when I was going back to Russia.
   b. He asked when was I going back to Russia.
10. "How did you get on in this quiz?"
   a. How did I get on in this quiz is my business, not yours!
   b. How I got on in this quiz is my business, not yours!

2. Choose the appropriate alternative that matches the reported speech given.

1. Tom said, 'I want to visit my friends this weekend.'
   a. Tom said he wants to visit his friends that weekend.
   b. Tom said he wanted to visit his friends that weekend.
   c. Tom said he wanted to visit his friends this weekend.
2. Jerry said, 'I'm studying English a lot at the moment.'
   a. Jerry said he was studying English a lot at that moment.
   b. Jerry said he was studying English a lot at the moment.
   c. Jerry said I was studying English a lot at that moment.
3. They said, 'We've lived here for a long time.'
   a. They said they have lived there for a long time.
   b. They said they lived here for a long time.
   c. They said they had lived there for a long time.
4. He asked me, 'Have you finished reading the newspaper?'
   a. He asked me if had I finished reading the newspaper.
   b. He asked me if I had finished reading the newspaper.
   c. He asked me if I finished reading the newspaper.
5. Susan reassured me, 'I can come tonight.'
   a. Susan told me I could come that night.
   b. Susan told me she could come that night.
   c. Susan told me she could come tomorrow evening.

6. 'I get up every morning at seven o'clock.', Peter said.
   a. Peter said he got up every morning at seven o'clock.
   b. Peter said I got up every morning at seven o'clock.
   c. Peter said he had got up every morning at seven o'clock.
7. Cheryl asked her, 'How long have you lived here?'
   a. Cheryl asked her how long she has lived there.
   b. Cheryl asked her how long she lived there.
   c. Cheryl asked her how long she had lived there.
8. She asked me, 'When are we going to leave?'
   a. She asked me when she was going to leave.
   b. She asked me when we were going to leave.
   c. She asked me when we are going to leave.
9. Mark asked me, 'Why do you want to study Russian?'
   a. Mark asked her why I wanted to study Russian.
   b. Mark asked me why did I want to study Russian.
   c. Mark asked me why I wanted to study Russian.
10. Jason asked me, 'Are you coming with me?'
   a. Jason asked me if I came with him.
   b. Jason asked me if I was coming with him.
   c. Jason asked me if I was coming with you.

3. Make reported questions. Start with «she asked me».

1. "Is John at home?"
2. "Does Julie drink tea?"
3. "Are you working tonight?"
4. "Do the children study Chinese?"
5. "Can you help me?"
6. "Where is the post office?"
7. "What does Luke do at the weekend?"
8. "Why did you go out last night?"
9. "Where will you live after graduation?"
10. "Have you been to Paris?"

4. Make reported requests or orders. Start each sentence with «she asked me» or «she told me».

1. "Please help me carry this"
2. "Please come early"
3. "Could you please open the window?"
4. "Can you help me with my homework, please?"

5. "Do your homework!"
6. "Don't smoke!"
7. "Would you mind passing the salt?"
8. "Don't do that!"
9. "Would you bring me a cup of coffee, please?"
10. "Would you mind lending me a pencil?"

5. Make the reported speech into the direct speech.

1. She said that she was leaving the following day.
2. She told me to be quick.
3. She asked me where I lived.
4. She said that they had gone to the cinema and then to a Chinese.
5. She asked me what I was doing the following day.
6. She asked me if I worked in London.
7. She said that she had never been to Wales.
8. She said that she didn't like mushrooms.
9. She asked me how often I played sport.
10. She said that she could help me the following day.

6. Complete the sentences with «said» or «told».

1. Julie _____ that she would join us after work.
2. She _____ me that she was going running this evening.
3. John _____ us that he couldn't come to the party.
4. John _____ that he had been to the cinema at the weekend.
5. She _____ them she wanted to quit.
6. They _____ that they didn't want to meet us on Tuesday.
7. They _____ they were meeting Luke today.
8. I _____ him I wasn't impressed.
9. Lucy _____ Julie that she was leaving on Wednesday.
10. We _____ that we were going on holiday the following week.

УСЛОВНЫЕ ПРЕДЛОЖЕНИЯ

Придаточные условные предложения (Conditional Sentences) являются частью сложных предложений, которые состоят из двух простых предложений: *главного предложения* и *придаточного предложения*, соединенных подчинительной связью. Такие предложения чаще всего разделяются запятой, а придаточное предложение вводится, как правило, союзами **if** *если*, **on condition that** *при условии что* и др.

If you go right now, you will come in time. –

Если ты пойдешь прямо сейчас, то ты придешь вовремя.

Придаточное предложение выражает *условие*, а *главное – следствие*, вытекающее из этого условия.

В английском языке условные предложения делятся на следующие типы:

Тип условного предложения	**Пример**	**Перевод**
Первый тип (реальное условие)	**If I see** him tomorrow, **I'll ask** him about it.	*Если* я его завтра *увижу*, я *спрошу* его об этом.
Второй тип (маловероятное условие)	**If I were** the President, I **would forbid** exams.	*Если бы* я был президентом, я *отменил бы* экзамены.
Третий тип (нереальное условие)	**If I had been** the captain of Titanic, **I would have been** more attentive.	*Если бы я был* капитаном «Титаника», *я был бы* намного внимательнее.

Придаточное условное предложение вводится союзами:

союз	**пример употребления**	**перевод**
IF	**If** I find your book, I'll ring you up immediately.	Если я найду твою книгу, я тебе немедленно позвоню.
PROVIDED THAT	We can hold these competitions **provided that** we have enough time to prepare.	Мы можем провести эти соревнования, при условии, что у нас будет достаточно времени на подготовку.
UNLESS	We will be late for the lecture **unless** we hurry.	Мы опоздаем на лекцию, если не поспешим.
IN CASE	I always have two pens with me **in case** one of them doesn't write.	Я всегда беру с собой две ручки, на случай, если одна не будет писать.
ON CONDITION THAT	He was allowed to train **on condition that** he didn't work hard.	Ему было разрешено тренироваться, при условии, что он не будет перенапрягаться.

EVEN THOUGH	He won the game **even though** he got an injury	Он победил в этой игре, не смотря на то, что получил травму.
SUPPOSING (THAT)	**Supposing** it rains, shall we go to the country?	Мы поедем за город, если пойдет дождь?

1. Первый тип условных предложений используется для выражения будущих событий. В придаточном предложении используется одно из настоящих времён, а в главном простое будущее время или модальные глаголы:

If + **Present Tense, Future Tense**

*If I find her phone number, I**'ll** tell you.*
*If he **has** free time, he**'ll** come to me.*

2. Второй тип условных предложений выражает нереальное действие и относится к настоящему или будущему времени:

If + **Past Tense, would + simple Infinitive**

*If I **had** more money, I **would travel** much.*
*If you **took** a pill, you **would feel** better.*

Вместо *would* (краткая форма ’d) может использоваться *could* или *might* в главном предложении:

*I **might** like them more if they played football.*
*If I got more free time, I **could** read more.*

После *if* мы обычно используется *were* вместо *was* для всех лиц:

*If I **were** you, I would give it up.*

3. Третий тип условных предложений выражает нереальное действие и относится к прошлому, т.е. действие либо невозможно было выполнить, либо оно не произошло:

If + **Past Perfect, would *have* + Past Participle**

*I **would have come** to him if I **had known** his address.*

Условные предложения второго и третьего типа переводятся на русский язык с использованием частицы «бы».

*If I got more free time, I **could** read more.*
Если бы у меня было больше времени, я бы больше читал.

*I **would have come** to him if I **had known** his address.*
Я бы пришёл к нему, если бы знал его адрес.

4. Предложения с ***I wish***. Простое прошедшее время употребляется после ***I wish***, когда говорят о настоящем:

I wish + ***Past***

*I wish I **knew** your new phone number.*

Модальные глаголы ***could/would*** употребляются, когда мы говорим о вещах, которые мы хотели бы сделать или о вещах, которые мы хотели бы чтобы произошли:

I wish + could/would

I wish you ***would*** *come.* (*= I want you to come.*)

Совершённое перфектное время используется, когда выражают сожаление о уже случившемся:

I wish + ***Past Perfect***

I wish I ***hadn't told*** *it to him.*

Такие предложения обычно переводятся:
Жаль, что…
Жаль, что я сказал ему это.

Exercises

1. Match the parts to make conditional sentences.

1. You will be late …
2. I will give her a call…
3. You need not come to the party
4. I could write and ask them.
5. You would hardly recognize her.
6. He would probably give you a lift.
7. You would earn more money.
8. I would have gone for a swim with you
9. It would have cost more than $700
10. Let her know

a) If I had their address
b) If you saw her now
c) If you asked Pit
d) If you got a new job
e) If we had traveled first class
f) If I had not been ill
g) If I can remember her phone number
h) If you miss the bus
i) If you don't want to
j) If you should hear from him

2. Put the verbs in the correct tense form.

Jane: If Jack got more money, he would waste **1. (waste)** it all on stupid things.
Jack: It isn't true. If I had more money, I **2. (spend)** it on anew coat.
Ann: If I **3. (win)** a lottery, I would buy a DVD-player.
Jack: I **4. (not buy)** a DVD-player if I were you. They're expensive.
Jane: If I had more money, I **5. (save)** it for a holiday in Europe.
Jack: If I **6. (have)** a lot of money, I **7. (buy)** a motor bike.
Ann: I **8. (not buy)** a motor bike if **9. (be)** you. They are very dangerous. If I were you I **10. (travel)**

3. The following things might happen. What would you do if they happened to you? Write your answers.

1. If I found a wallet in the street, I would
2. If my boy- friend moved to another town,
3. If I saw an accident,
4. If someone offered me a new job in ashop,
5. If the lights suddenly went out,
6. If I found at your door a homeless cat,
7. If I found a passport in a bus,
8. If I spilled cherry juice on my favourite blouse.
9. If I came home and found someone burgling my neighbor's house,
10. If I felt tired,

4. Write a sentence using I *wish* ... for each of the following situations.

1. The weather's horrible.
2. We can't go skating.
3. Yesterday we went to the restaurant, and I was ill all night.
4. I wanted to go to France.
5. Pete keeps asking me for money.
6. I have to get up at 6.00 in the morning.
7. I can't afford a car.
8. Ann has short hair.
9. Nick can't play tennis.
10. My husband doesn't know how to repair CD-player.

5. Translate the sentences into Russian.

1. If it is really so, I can only say that I am sorry.
2. If he came into the room now, I would recognize him.
3. If you had worked hard, you would have finished the work long ago.
4. I wish it were summer now.
5. I wish you had been there with us.
6. Of course, you may act as you want, but if I were you, I wouldn't behave like that.
7. You are too stubborn. I'm that if you were older, you would understand me.
8. I don't trust him. If I trusted him, I would follow his advice.
9. I think you got ill. If you put on your warm coat, you would not catch (a) cold.
10. If you went to this shop, you would be able to buy an excellent sports bag.

6. Open the brackets and put the verb into the correct form.

1. I would visit you if I (not/live) so far away.
2. If I (know) history well, I would help you.
3. If your coach (be) with us now, he would give us much useful advice.
4. If he (not be) so lazy, he would pass exams much better.
5. If she (have) more free time, she would took partin city competitions.
6. If we (have) more money, we would be able to buy expensive equipment.
7. If I (practice) more, I will achive better results.
8. If he (come) to our house yesterday, he would have met his friend.
9. If she (not \pass) her examination, she would not have got a scholarship.
10. If only you had let me know, I (go) there immediately

МОДАЛЬНЫЕ ГЛАГОЛЫ

Модальные глаголы в английском языке – это глаголы, которые выражают не действие как таковое, а отношение к действию – возможность, вероятность, необходимость, долженствование и т.п. Непосредственно действие выражается в смысловом глаголе, следующем в инфинитивной форме за модальным глаголом.

Модальными глаголами являются глаголы ***can***, ***could***, ***must***, ***have to***, ***have got to***, ***may***, ***might***, ***ought***, ***shall***, ***should***, ***be to***, ***need***, ***dare***.

Глаголы ***have***, ***be***, ***should*** могут быть не только модальными, но и вспомогательными, а глаголы ***need***, ***have***, ***be***, ***get*** – также и смысловыми.

Английские модальные глаголы обладают некоторыми особенностями, которые отличают их от обычных глаголов:

1. Модальные глаголы никогда не используются без смыслового глагола. Даже если смысловой глагол не используется, он подразумевается (например, в кратких ответах на вопросы). Смысловой глагол следует после модального глагола в форме инфинитива. При этом глаголы *be to*, *ought to*, *have to*, *have got to* сочетаются с инфинитивом с частицей to, а остальные глаголы – с базовой формой инфинитива (то есть с инфинитивом без частицы to).

I can fly an aeroplane. Я умею летать на аэроплане.

He should behave. Ему следует хорошо себя вести.

"May I go now?" "Yes, you may (go)." Можно мне идти? – Да, можно. (В данном случае смысловой глагол может опускаться, но он все равно подразумевается.)

You have to finish the work today. Ты должен закончить работу сегодня.

2. По своим свойствам английские модальные глаголы, кроме *have to*, *have got to*, *be to*, *dare*, являются недостаточными, то есть не имеют личных форм, и в связи с этим не образуют сложных глагольных форм (то есть не могут иметь формы инфинитива, причастия, и герундия). Кроме того, недостаточные модальные глаголы не принимают окончания *–s/-es* в третьем лице единственного числа настоящего времени.

I can swim. Я умею плавать.

She can swim. (*A HE She cans swim.*) *Она умеет плавать.*

He may help you. Он, возможно, тебе поможет.

He may be swimming right now. Он, возможно, сейчас плавает.

3. Многие модальные глаголы не имеют формы будущего времени, некоторые не имеют формы прошедшего и настоящего времени (более подробно этот вопрос рассматривается в следующих разделах).

4. Вопросительные и отрицательные формы модальных глаголов образуются без помощи вспомогательных глаголов (за исключением глагола *have to*). Для образования вопроса модальный глагол ставится в начало предложения, а для образования отрицательного предложения используется частица *not*.

Can you come over here? Можешь подойти сюда?

May I ask you a question? Можно задать тебе вопрос?

You mustn't (= must not) talk to the teacher that way. Ты не должен так разговаривать с учителем.

I shouldn't be talking about it. Мне не следует обсуждать это.

Однако:

Do you have to go now? *Тебе нужно сейчас уходить*?

I don't have to go now. Мне не нужно сейчас уходить.

Can – является одним из самых используемых модальных глаголов в английском языке. Он имеет значение возможности или способности, как физической, так и умственной. Он может использоваться для выражения просьбы, разрешения или запрещения, а также вероятности или невероятности.

I can ride a horse. Я умею ездить на лошади. (Выражает способность.)

We can stay with my brother when we are in Paris. Когда будем в Париже, мы можем остановиться у моего брата. (Выражает возможность.)

She cannot stay out after 10 pm. Она не может гулять после 10 вечера. (Выражает запрещение.)

Can you hand me the stapler? Не можешь передать мне степлер? (Выражает просьбу.)

Any child can grow up to be president. Любой ребенок может вырасти и стать президентом. (Выражает вероятность.)

Could – имеет значение вероятности или возможности в прошлом. Он может использоваться для выражения просьбы и предложения. Также глагол *could* часто используется в условных предложениях в качестве условной формы глагола *can*.

Extreme rain could cause the river to flood the city. Из-за сильных дождей река могла затопить город. (Выражает вероятность.)

Nancy could ski like a pro by the age of 11. К 11 годам Нэнси уже умела кататься на лыжах как профессионал. (Выражает возможность в прошлом.)

You could see a movie or go out to dinner. Вы могли бы посмотреть кино или сходить пообедать. (Выражает предложение.)

Could I use your computer to email my boss? Не мог бы я воспользоваться вашим компьютером, чтобы отправить электронное письмо своему начальнику? (Выражает просьбу.)

We could go on the trip if I didn't have to work this weekend. Мы могли бы куда-нибудь съездить, если бы мне не нужно было работать в эти выходные. (Условное предложение.)

May – чаще всего используется для выражения возможности и предположения. Также он может употребляться для того, чтобы предоставить разрешение и спросить разрешение, хотя в современном английском в таком значении он используется все реже.

Cheryl may be at home, or perhaps at work. Шерил может быть дома, а может и на работе. (Выражает возможность, предположение.)

Johnny, you may leave the table when you have finished your dinner. Джонни, ты можешь встать из-за стола, когда закончишь ужинать. (Выражает разрешение.)

May I use your bathroom? Можно воспользоваться вашей ванной? (Выражает просьбу на разрешение.)

Might – чаще всего используется для выражения возможности и предположения. Также он часто может использоваться в условных предложениях. Помимо этого, *might* может использоваться для того, чтобы сделать предложение или выразить просьбу, хотя в таком значении он редко используется в американском английском.

Your purse might be in the living room. Ваша сумочка может быть в гостиной. (Выражает возможность и предположение.)

If I didn't have to work, I might go with you. Если бы мне не нужно было работать, я мог бы пойти с вами. (Условное предложение.)

You might visit the botanical gardens during your visit.Вы могли бы посетить ботанические сады во время вашего визита. (Выражает предложение.)

Might I borrow your pen? Можно мне взять вашу ручку? (Выражает просьбу.)

Must – чаще всего используется для выражения уверенности, несомненности, вероятности. Также он может использоваться для выражения необходимости, долженствования или сильной рекомендации, хотя в современном английском предпочитается более гибкая форма *have to*. *Must not* может использоваться для запрета чего-либо и имеет очень строгий оттенок, в современном языке предпочитаются менее категоричные глаголы *should not* или *ought not*.

This must be the right address! *Это, должно быть, верный адрес*! (Выражает уверенность, несомненность.)

Students must pass an entrance examination to study at this school. Студенты должны сдать вступительный экзамен, чтобы учиться в этом заведении. (Выражает необходимость.)

You must take some medicine for that cough. Вам следует принять какое-нибудь лекарство от этого кашля. (Выражает сильную рекомендацию.)

Jenny, you must not play in the street! Дженни, нельзя играть на улице! (Выражает запрет.)

Have to – (иногда называемый модальной конструкцией) употребляется для выражения обязанности или необходимости (в утвердительной или вопросительной форме) или отсутствия обязанности и необходимости (в отрицательной форме). Также глагол *have to* может выражать уверенность, несомненность, вероятность. *Have to* является синонимом модального глагола *must*, и имеет оттенок вынужденности, в силу каких-либо обстоятельств.

This answer has to be correct. Этот ответ, должно быть, правильный. (Выражает уверенность, несомненность.)

They had to leave early. Им пришлось уйти рано. (Выражает обязанность, вынужденность в силу обстоятельств.)

The soup has to be stirred continuously to prevent burning. Время от времени суп нужно помешивать, чтобы он не пригорел. (Выражает необходимость.)

Exercises

1. Complete the sentences, using <u>may</u> or <u>can</u>.

1. … I come in? 2. Let me look at your exercises. I … be able to help you. 3. I … not swim, because until this year the doctor did not allow me to be more than two minutes in the water. But this year he says I … stay in for fifteen minutes if I like, so I'm going to learn to swim. 4. Libraries are quite free, and any one who likes … get books there. 5. I … come and see you tomorrow if I have time. 6. Take your raincoat with you: it … rain today. 7. Do you think you … do that? 8. I … finish the work tomorrow if no one bothers me any more. 9. … we come and see you next Sunday at three o'clock in the afternoon? 10. What time is it? – It … – be about six o'clock, but I am not sure.

2. Complete the sentences, using may (might) or can (could).

1. … you help me? 2. I … imagine her speaking in public: I knew that she was so shy. 3. Something was wrong with the car: he … not start it. 4. A fool … ask more questions than a wise man … answer. 5. She asked me if she … use my telephone. 6. … I use your pen? 7. … I find a pen on that table? 8. You … read this book: you know the language well enough. 9. You … take this book: I don't need it. 10. … help you?

3. Translate into Russian.

1. You must work hard at your English. 2. You must learn the words. 3. Must we learn the poem today? 4. It must be very difficult to learn Chinese. 5. You must not talk at the lessons. 6. Everybody must come to school in time. 7. Don't ring him up: he must be very busy. 8. You must not make notes in the books. 9. I must help my mother today. 10. Don't worry! This is not important. – Not important! You must be joking!

4. Complete the following sentences using the most appropriate forms of the verbs.

1. Jack has got a headache. He … sleep well recently.
   a) can't
   b) couldn't have
   c) hasn't been able to
2. I … sleep for hours when I was a little girls.
   a) could
   b) am able to
   c) can
3. Tom … play tennis well but he … play a game yesterday because he was ill.
   a) couldn't, could
   b) can, was able
   c) can, couldn't
4. I didn't want to be late for the meeting. We … meet at 5 sharp.
   a) were to
   b) had to
   c) could

5. Where are my gloves? – I … put them on because it's cold today.
   a) can't
   b) have to
   c) needn't
6. You … take an umbrella today. The Sun is shining.
   a) needn't
   b) mustn't
   c) can't
7. I'm sorry, you didn't invite me to your birthday party. You … invite me next time.
   a) must
   b) should
   c) need to
8. Well, it's 10 o'clock. I … go now.
   a) can
   b) has to
   c) must
9. You … smoke so much.
   a) would
   b) can't
   c) shouldn't
10. We have got plenty of time. We … hurry.
   a) must
   b) needn't
   c) should

5. Translate the sentences into English.

1. Вы должны бросить курить.
2. Вечеринка была замечательная. Вам следовало прийти.
3. Ты можешь решить эту проблему.
4. Тебе следует навестить своего больного друга.
5. Тебе следовало навестить своего больного друга, но ты не навестил.
6. Не хотите еще чая?
7. Я вынужден был сделать это.
8. Я не знаю, почему мы спешили. Нам не нужно было спешить.
9. Я бы хотел пойти с тобой.
10. Ты можешь делать все, что хочешь.

6. Complete the following sentences using the most appropriate forms of the verbs.

1. I ___ go now because I am already late for my class.
   a) must
   b) have
   c) have to
   d) had to
2. Do you ___ clean the house every day or every week?
   a) must
   b) have
   c) have to
   d) had to
3. I ___ speak French without a problem now because I have had many lessons.
   a) may
   b) can
   c) have
   d) must to
4. They ___ do their homework today because it is a holiday at the school.
   a) must not
   b) don't have
   c) don't have to
   d) had not to
5. This isn't a difficult task, so you ___ be able to complete it by Friday.
   a) can
   b) should
   c) mustn't
   d) couldn't
6. You ___ have been really angry when your boss tried to embarrass you in front of your co-workers.
   a) can
   b) must
   c) shall
   d) won't
7. ___ you come over for dinner on Friday night? I really want to hang out with you, so I hope you can come.
   a) Can
   b) Will have
   c) Must
   d) Must have

8. We've worked long and hard today. ___ we call it a day?
   a) Must have
   b) Should have
   c) Shall
   d) Could have

9. Kendra ___ finish her homework on time, or she can't go outside to play with her friends.
   a) must
   b) can't
   c) must have
   d) shall have

10. I ___ see that you have a hole in your sneakers. You need a new pair of shoes.
   a) can
   b) must
   c) shall
   d) may

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