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Кафедра иностранных языков

ТЕХНИЧЕСКИЙ ИНОСТРАННЫЙ ЯЗЫК
ЭЛЕКТРОЭНЕРГЕТИКА И ЭЛЕКТРОТЕХНИКА

Методические указания к практическим занятиям для студентов магистратуры специальности 13.04.02

ENGLISH FOR SPECIFIC PURPOSES
ELECTRICAL POWER ENGINEERING

САНКТ-ПЕТЕРБУРГ
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ТЕХНИЧЕСКИЙ ИНОСТРАННЫЙ ЯЗЫК. Электроэнергетика и электротехника: Методические указания к практическим занятиям для студентов магистратуры специальности 13.04.02. / Санкт-Петербургский горный университет. Сост. *А.Ю. Маевская*. СПб, 2023. 32 с.

Методические указания предназначены для магистрантов, обучающихся по специальности 13.04.02 «Электроэнергетика и электротехника», всех направленностей и согласованы с программой по иностранному языку для студентов неязыковых вузов.

Предлагаемый материал направлен на совершенствование навыков профессионально-ориентированного чтения на английском языке. Данные методические указания включают тексты на языке оригинала, а также комплекс лексических упражнений и заданий, способствующих развитию речевой, языковой, социокультурной и информационной компетенций студентов, необходимых для общения в сфере профессиональных интересов. Предназначены для практических занятий со студентами по английскому языку.

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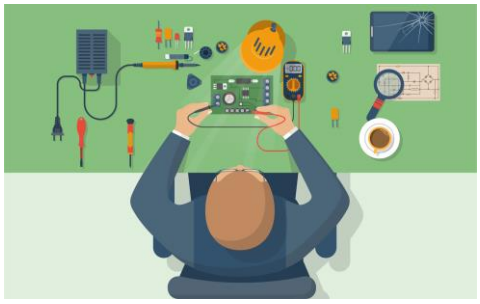
ПРЕДИСЛОВИЕ

Данные методические указания предназначены для учебно-методического сопровождения курса английского языка для студентов неязыковых вузов, обучающихся по специальности 13.04.02 «Электроэнергетика и электротехника» всех направленностей.

Методические указания содержат тексты научно-технического характера по энергетике и комплекс заданий с учетом профессиональных интересов обучаемых и соблюдением принципа междисциплинарности обучения. Изучение предложенного материала направлено на развитие умений просмотрового и изучающего чтения текстов по направлению подготовки, а также их перевода на русский язык с последующим использованием полученной информации для речевой практики; совершенствование навыков и умений всех видов чтения (изучающего, ознакомительного, поискового и просмотрового) и перевода специальной научно-технической литературы для извлечения информации, ознакомление с узкоспециализированной терминологией на английском языке.

Методические указания состоят из 4 разделов, включающих разное количество текстов по энергетике и электротехнике, а также для работы предлагаются разнообразные виды упражнений. Предложенные материалы предназначены как для работы в аудитории, так и для самостоятельной работы.

UNIT I. ELECTRICAL ENGINEERING



1. Read the following statement and say if you agree or disagree with it.

Engineering is about creating things. Whether it is traditional, physical buildings – from bridges and robots to power transmission systems and race cars – or a 'virtual' product like Facebook or an iPhone app, engineering requires you to conceive of something that doesn't yet exist and then make it happen . . . It's about inventing, creating, and building.

– Mikell Taylor, Robotics Engineer

2. Translate the extract into Russian and explain the words in bold.

Engineers design and develop

- the **tools** that entertain and connect us with one another
- the **technologies** that keep us safe and comfortable
- the **systems** that transport us across town or to elsewhere in our galaxy
- the **devices** that help detect, monitor, and treat illness and injury and enhance our quality of life
- the **structures** that shelter us, and
- the **processes** that deliver electricity, fossil fuels, and every other type of energy to power our modern lives.

3. Read the text and discuss in pairs the following points.

Electrical Engineers: They Get a Charge out of Their Careers

Electrical engineers are the brainiacs behind a variety of electrically powered products and systems. They design and develop equipment that supplies, generates, or transmits electricity. If you **appreciate** the following, you can thank electrical engineers:

- *lighting and wiring in buildings*
- *radar and navigation systems*
- *broadcast and communications systems*
- *electric motors*
- *machinery controls and*
- *power generation and transmission equipment, such as that used by electric utilities.*

On a day-to-day basis, electrical engineers may:

- *plan electrical circuits and wiring*
- *test electrical products, installations, and systems to diagnose and correct malfunctions*
- *make design improvements*
- *oversee electrical maintenance and*
- *design, develop, test, and supervise electrical equipment manufacturing.*

4. Watch the video about electrical engineering https://www.youtube.com/watch?v=hqlN1L4BG6I&t=131s and answer the following questions:

1. What is electrical engineering?
2. How is electrical engineering applied?
3. What electronic devices are presented in the video?
4. Why did these people choose electrical engineering as a career?
5. What things are required in electrical engineering?
6. What is STEM?
7. According to the video, where can you work in the field?

5. Work in groups of three to four. Discuss the following engineering quotes and give reasons employing the phrases from the table below.

Useful Language: Phrases to Express Opinion

- *In my opinion, ...*
- *To my mind, ...*
- *From my point of view, ...*
- *As far as I am concerned, ...*
- *My view / opinion / belief / impression / conviction is that ...*
- *I think / consider / find / feel / believe / suppose / presume / assume that ...*
- *I hold the view that …*
- *It goes without saying that ...*
- *I have no doubt that ...*
- *It seems to me that ...*
- *I am under the impression that …*
- *I dare say that …*
- *My own feeling on the subject is that …*
- *I am sure / I am certain that ...*

Engineering Quotes

- “Scientists dream about doing great things. Engineers do them.” – *James A. Michener, American author*
- "What we usually consider as impossible are simply engineering problems ... there's no law of physics preventing them." – *Michio Kaku, American theoretical physicist*
- "The walls between art and engineering exist only in our minds." – *Theo Jansen, Dutch artist*
- "The story of civilization is, in a sense, a story of engineering – that long and arduous struggle to make the forces of nature work for man's good." – *Lyon Sprague de Camp, American science fiction writer*
- "Science can amuse and fascinate us all, but it is engineering that changes the world." – *Isaac Asimov, American author*
- "Scientists study the world as it is, engineers create the world that never has been." – *Theodore von Karman, Hungarian-American NASA engineer*

- "The scientist discovers a new type of material or energy and the engineer discovers a new use for it." – *Gordon Lindsay Glegg, Scottish mechanical engineer*
- "This is not the age of pamphleteers. It is the age of engineers. The spark-gap is mightier than the pen. Democracy will not be salvaged by men who talk fluently, debate forcefully and quote aptly." – *Lancelot Hogben, British zoologist*
- "There can be little doubt that in many ways the story of bridge building is the story of civilization. By it we can readily measure an important part of a people's progress." – *Franklin D. Roosevelt, 32nd U.S. President*

6. Read the text below and decide which word from the box best fits each space.

circuit, global positioning systems, deals with, personalities, appliances, branch

What is Electrical Engineering?

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

The interest in this branch usually develops from an interest of dealing with different electric circuits and components. From resistors to transformers, this branch of engineering is the root to most of the electric _____ at home and the many complicated components at an electric power station!

Early experiments with electricity included primitive batteries and static charges. However, the actual design, construction and manufacturing of useful devices and systems started with the implementation of *Michael Faraday's Law of Induction*, which essentially states that the voltage in a _____ is proportional to the rate of change in the magnetic field through the circuit.

Some of the most famous _____ in electrical engineering include *Thomas Edison* known for the invention of the electric light bulb, *George Westinghouse* known for the invention of alternating current, *Nikola Tesla* known for the invention for a simple induction motor, *Guglielmo Marconi* known for the invention of radio and *Philo T. Farnsworth* known for the invention of a television. These devices, which are so common in the daily usage of a human being were initially developed with one itself.

What does an electrical engineer do?

Merging with the beautiful concepts of physics, mathematics and electronics theory, an electrical engineer is usually the one who develops, designs, and manages the simple electronic appliances and circuits.

"Electronics engineers design and develop electronic equipment, such as broadcast and communications systems – from portable music players to _____(GPS)." states the U.S. Bureau of Labor Statistics

What is the difference between electrical and electronic engineers?

Electrical engineering is the branch of engineering which gives a full-fledged overview of everything which involves the concept of electricity. This branch is spread over topics like

1. Voltage and Current
2. High frequency circuits
3. Digital and Analog Circuits
4. Medicated technology
5. Measurement and control
6. Power and Energy Systems
7. Microcontrollers
8. Generators
9. Battery management
10. Control Systems and many more….

Electronic engineering is the _____ which conceptualizes the working of these circuits. In simple words, one can say that Electronics is a subset of the Electrical part.

Electronics basically is more or less about transistors, diodes and similar components, arranged or kept in miniaturized integrated circuits and alike. Electronics is boxed till the applications of simple devices on a circuit board. Anything and everything you find in a computer, some

component of a car and even a smartphone! Here, the voltage in most cases is limited to the extent of 5V, with low current.

7. Translate the following words and phrases. Make up your own sentences with them on the topic of the text.

Voltage and current; medicated technology; invention; useful devices; circuit board; alternating current; induction motor.

8. Find the English equivalents for the following word combinations.

Закон Ома	
Индукционный мотор	
Закон Фарадея	
Высокочастотная цепь	
Управление батареями электропитания	
Слабый/низкий ток	
Переменный ток	

9. Think and answer.

1. Where do you study at? (University, Institute, course, major, etc.)
2. When was your major set up at the University? Who is the head of your department? What famous graduates of your department do you know?
3. What subjects are taught at your faculty?
4. Do you take part in scientific research work, conferences? What do you do? What have you done (achieved) so far?
5. Why did you decide to become an electrical engineer? Did anybody advise you to choose a career in this field?
6. What does engineering mean to you?
7. What can you say about the role of an electrical engineer in the industrialized society?
8. What skills and abilities should an electrical engineer have?
9. Do you have any experience in electrical engineering?
10. What are your future career goals?

10. Prepare a short report about your future profession.

UNIT II. THE NATURE OF ELECTRICITY

1. Read the text and fill in the gaps with the correct choice.

Electricity is the set of physical phenomena associated 1_____ the presence and motion of matter that has a property of electric charge. Electricity is 2_____ to magnetism, both being part of the phenomenon of electromagnetism, as described by Maxwell's equations. Various common phenomena are related to electricity, including lightning, static electricity, electric heating, electric discharges and many others.

The presence of an electric charge, which can be either positive or negative, produces an electric field. The movement of electric charges is an electric current and produces a magnetic field.

When a charge is placed in a location with a non-zero electric field, a force will act on it. The magnitude of this force is given by Coulomb's 3_____. If the charge moves, the electric field would be doing work on the electric 4_____. Thus, we can speak of electric potential at a certain point in space, which is equal to the work done by an external agent in carrying a unit of positive charge from an arbitrarily chosen reference point to that point without any acceleration and is typically measured in volts.

Electricity is at the heart of many modern technologies, being used for:

- Electric power where electric current is used to energize equipment;
- Electronics which 5_____with electrical circuits that involve active electrical components such as vacuum tubes, transistors, diodes and integrated circuits, and associated passive interconnection technologies.

Electrical phenomena have been studied 6_____antiquity, though progress in theoretical understanding remained slow until the seventeenth and eighteenth centuries. The theory of electromagnetism was developed

in the 19th century, and by the end of that century electricity was being put to industrial and residential use by electrical engineers. The rapid expansion in electrical technology at this time transformed industry and society, becoming a driving force for the Second Industrial Revolution.

Electricity's extraordinary versatility means it can be put to an almost limitless set of applications which include transport, heating, lighting, communications, and computation. Electrical power is now the backbone of modern industrial society.

1.	and	with	up
2.	related	relate	being relate
3.	law	tip	advice
4.	flash	table	charge
5.	dealt	deal	deals
6.	for	since	more

2. Read the text below and give Russian equivalents for the following international words.

Energy, electricity, transportation, communication, production, element, atom, electron, proton, orbit

Nature of Electricity and Concept of Electricity

Electricity is the most common form of energy. Electricity is used for various applications such as lighting, transportation, cooking, communication, production of various goods in factories and much more. None of us exactly know that what is electricity. The concept of electricity and theories behind it, can be developed by observing its different behaviors. For observing nature of electricity, it is necessary to study the structure of matters. Every substance in this universe is made up of extremely small particles known as molecules. The molecule is the smallest particle of a substance into which all the identities of that substance are present. The molecules are made up of further smaller particles known as atoms. An atom is the smallest particle of an element that can exist.

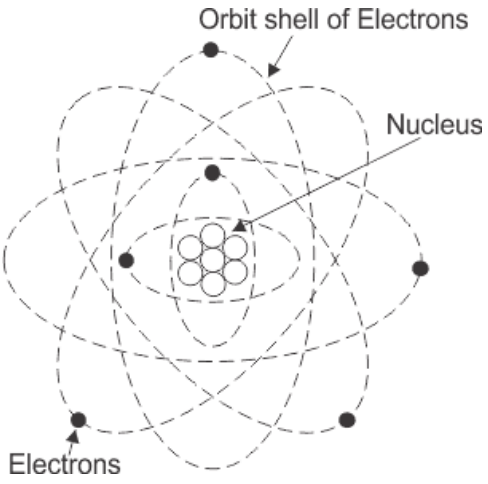
There are two types of substances. The substance, that’s molecules are made of similar atoms is known as an element. The matter whose molecules consisting dissimilar atoms, is called a compound. The

concept of electricity can be achieved from the atomic structures of substances.

Structure of Atom

An atom consists of one central nucleus. The nucleus is made up of positive protons and charge less neutrons. This nucleus is surrounded by numbers of orbital electrons. Each electron has a negative charge of -1.602×10^{-19} Coulomb and each proton in the nucleus has a positive charge of $+1.602 \times 10^{-19}$ Coulomb. Because of the opposite charge there is some attraction force between the nucleus and orbiting electrons. Electrons have relatively negligible mass compared to the mass of the nucleus. The mass of each proton and neutrons is 1840 times the mass of an electron.

As the modulus value of each electron and each proton are same, the number of electrons is equal to the number protons in an electrically neutral atom. An atom becomes positively charged ion when it loses electrons and similarly an atom becomes negative ion when it gains electrons.



Atoms may have loosely bonded electrons in their outermost orbits. These electrons require a very small amount of energy to detach themselves from their parent atoms. These electrons are referred as free electrons which move randomly inside the substance and transferred from one atom to another. Any piece of substances which as a whole contains an unequal number of electrons and protons is referred as electrically charged. When there is a greater number of electrons compared to its protons, the substance is said to be negatively charged and when there is a greater number of protons compared to electrons, the substance is said to be positively charged.

The basic nature of electricity is, whenever a negatively charged body, is connected to a positively charged body by means of a conductor,

the excess electrons of negative body start flowing towards the positive body to compensate the lack of electrons in that positive body.

3.Translate the following sentences into English using the Passive Voice.

1.Каждое вещество во вселенной состоит из чрезвычайно маленьких частиц. 2. Эти электроны называются свободными электронами, которые случайным образом перемещаются внутри вещества и передаются от одного атома к другому. 3. Ядро состоит из положительных протонов и нейтронов без заряда. 4. Ядро окружено множеством орбитальных электронов. 5. Электричество используется для таких применений, как освещение, транспорт, приготовление пищи, связь, производство различных товаров на фабриках. 6. Концепция электричества и теории, лежащие в его основе, могут быть разработаны путем наблюдения за его различным поведением. 7. Понятие электричества может быть получено из атомных структур веществ.

4. Match the words (1-10) with their definitions (a-j).

1. conductor	a. the central part of an atom or cell
2. atom	b. a way in which something can be used for a particular purpose
3. nucleus	c. a substance that allows electricity or heat to go through it
4. application	d. a type of energy that can produce light and heat, or make machines work
5. particle	e. the smallest unit that an element can be divided into
6. proton	f. the physical substances that exist in the universe
7. matter	g. a part of an atom with a positive electrical charge
8. electricity	h. a very small piece of something
9. compound	i. an extremely small piece of an atom with a negative electrical charge
10. electron	j. a substance that is a combination of two or more elements

5. Watch the video about electricity https://www.youtube.com/watch?v=ru032Mfsfiq and fill in the gaps with correct words.

Electricity is 1) _____ to our civilization.
To really understand electricity, we must go 2) _____ and look inside an 3) _____.
Atoms consist of protons and neutrons; these form the 4) _____ of the atom.
Atoms of 5) _____ element all have the same number of 6) _____ but can have different numbers of neutrons and electrons.
Electrons which are far 7) _____ than the protons in the nucleus, can relatively easily move.
And this is 8) _____ because the movement of electrons is what forms an 9) _____.
When the atom has fewer electrons than protons, it becomes positively 10) _____.
Each 11) _____ of an atom can hold a maximum of number of electrons.
The number of electrons on the outermost shell determines the 12) _____ of the atom.
Insulators do not easily give up electrons but can get a local charge when electrons from a 13) _____ are rubbed off on them.
Now, when you touch a metal object, for instance a door knob, you get 14) _____.
A commonplace where you can see an insulator and conductor working together is a simple 15) _____.

6. According to the video, mark the sentences as TRUE or FALSE.

1. More electrons than protons mean the atom is negatively charged.
2. When the outermost shell is full, the atom isn't stable.
3. Carpets are often made from a material with the properties of insulator.
4. Nature always seeks a neutral charge equilibrium, a net charge of zero.
5. Materials with high electron mobility are called insulators.

6. The battery pushes out electrons from one end and attracts them from the other.

7. Answer the questions.

1. What is electricity?
2. What is the Bohr Model?
3. What forms an electric current?
4. What is the difference between insulators and conductors?
5. What is static electricity and how does it occur?

8. Read and translate the text. Four sentences have been removed from the text. Choose from sentences, (A-E), the one that best fits each gap (1-4) to complete the text. There is one extra sentence you do not need to use.

A the mechanical energy from your finger rubbing against the object provided enough energy for some of the electrons in the object to escape.
B giving the electron enough energy to escape from the attractive force of the protons in the atom.
C In fact, the quality of attraction and repulsion is exactly what we call 'electric charge'.
D Valence electrons are the farthest from the nucleus…
E on the type of atom and also how that atom is chemically bonded to other atoms.

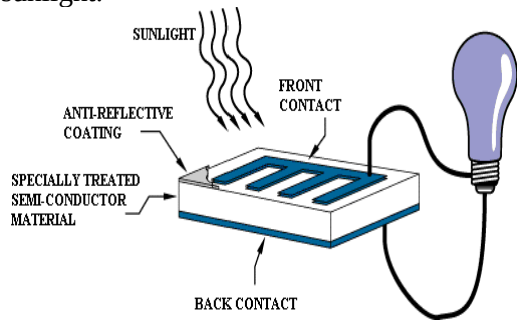
How Atoms Lose Their Electrons

In order for electrical activity to occur, an atom must lose an electron. This happens by 1) _____.

Let's say you push against or rub your finger on an object. You might be able to rub some of the electrons off the object, which is exactly what happens with static electricity. In this case, 2) _____.

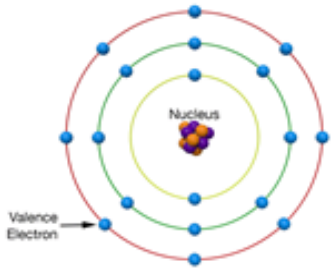
Any kind of energy can separate an electron from its atom. Chemical energy from a chemical reaction commonly separates electrons from atoms. Energy from light shining on an object can also separate electrons from their atoms; this is called the photoelectric effect. The

photoelectric effect is how solar cells are able to generate electricity from sunlight.



Solar panels use energy from sunlight to produce electricity.

In general, the electrons that do the interacting are the outermost electrons, called valence electrons.



3) _____ so it takes the least amount of energy to separate a valence electron from its atom. Whenever you remove one electron from an atom, it takes much more energy to remove a second electron from the same atom. Most of the time, atoms only contribute one electron to electrical activity.

In addition, some atoms hold on to their electrons more tightly than others. Some electrons take a huge amount of energy to remove from their atom, and others don't take much at all. It depends 4) _____.

These atomic properties translate into material properties when we are dealing with normal-scale objects like wires in a circuit.

9. Define if the following sentences are true or false.

1. In order for electrical activity to occur, an atom must lose an electron.
2. Not any kind of energy can separate an electron from its atom.

3. Solar panels use energy from wind power to produce electricity.
4. The electrons that do the interacting are the outermost electrons, called valence electrons.
5. When you remove one electron from an atom, it takes less energy to remove a second electron from the same atom.

10. Read and translate the text.

Man-Made Electricity

Static electricity and lightning are great ways to introduce some of the important concepts related to electricity. In our homes, schools, and workplaces, we use electricity that is intentionally generated, transmitted, and used in specific ways. Electricity is typically generated at power plants, and is then transmitted to our homes and businesses so that we can use it.

Electric Circuits

Man-made electricity is used in electric circuits. From the point of generation to the final usage, the electricity flows through different circuits that each play a role in making the electricity as useful as possible.

Circuits are paths for electricity to flow in that allow us to engineer specific properties and functions. They allow us to do useful things with electricity.

Circuits contain conductors that form a path for electrons, and components like resistors, capacitors, and transistors to create a system that does something useful with electricity.

Light bulbs

If you've ever turned on a light in your house, you know how to use a switch to close and energize a circuit. The light switch is a device that is identical in function to any other electrical switch. A switch allows you to connect and disconnect the two sides of a circuit – the positive and negative terminals.

When you turn a light ON, you close the circuit and enable current to flow from the positive side, through the lightbulb, to the negative side. When you turn the light OFF, you disconnect the two sides of the circuit from each other. There is nowhere for the current to flow.

This is called opening the circuit – current cannot flow until you close the circuit by flipping the switch again. When the light is OFF,

electrons are patiently waiting in the lightbulb's filament for you to reconnect them to the circuit. The electrons can't move, so there is no electric current flowing through the lightbulb.

It's not the electrons themselves but the MOVEMENT of electrons through the lightbulb that causes it to light up.

You can think of the electrons like cars sitting in traffic. When the road is clear, cars will move and traffic will flow. When you block the road, the cars cannot move anymore. Instead, they need to wait for the car in front of them to move; the traffic has stopped. Unlike cars, all of the electrons in a circuit all move at about the same *exact* time. In traffic there is always a delay as each person waits for the car in front of them to move before moving themselves.

11. Find 12 words hidden in the grid.

Capacitor, cell, current, electricity, electron, energy, flow, ion, light, matter, resistor, transistor

e	i	c	a	p	a	c	i	t	o	r	y	m	w	s
e	l	e	c	t	r	i	c	i	t	y	h	a	g	q
n	i	l	w	h	t	r	a	n	s	i	s	t	o	r
e	g	l	w	b	g	c	p	l	k	o	b	t	x	c
r	h	y	f	v	c	u	r	r	e	n	t	e	r	d
g	t	y	r	e	s	i	s	t	o	r	n	r	z	z
y	a	e	l	e	c	t	r	o	n	f	l	o	w	a

12. Match the left and the right.

Static electricity and lightning are …	… so there is no electric current flowing through the lightbulb.
When you turn a light ON …	… at power plants, and is then transmitted to our homes and businesses so that we can use it.
When you turn the light OFF ….	… great ways to introduce some of the important concepts related to electricity.

Electricity is typically generated …	… capacitors, and transistors to create a system that does something useful with electricity.
The electrons can't move …	… you disconnect the two sides of the circuit from each other.
Circuits contain conductors that form a path for electrons, and components like resistors …	… you close the circuit and enable current to flow from the positive side, through the lightbulb, to the negative side.

UNIT III. ELECTRIC MOTORS

1. Read the text and explain the words in bold. Give their synonyms.

An **electric motor** is an **electrical machine** that converts electrical energy into mechanical energy. Most **electric motors** operate through the interaction between the motor's magnetic field and **electric current** in a wire winding to generate force in the form of **torque** applied on the motor's shaft. An **electric generator** is mechanically identical to an electric motor, but operates with a reversed flow of power, converting mechanical energy into **electrical energy**.

Electric motors can be powered by direct current (DC) sources, such as from batteries, or rectifiers, or by alternating current (AC) sources, such as a **power grid**, inverters or electrical generators.

Electric motors may be classified by considerations such as power source type, construction, application and type of motion output. They can be powered by AC or DC, be brushed or brushless, single-phase, two-phase, or three-phase, axial or radial flux, and may be air-cooled or liquid-cooled.

Standardized motors provide **convenient mechanical power** for industrial use. The largest are used for ship propulsion, pipeline compression and pumped-storage applications with output exceeding 100 megawatts.

Applications include industrial fans, blowers and pumps, machine tools, household appliances, power tools, vehicles, and disk drives. Small motors may be found in electric watches. In certain applications, such as

in regenerative braking with traction motors, electric motors can be used in reverse as generators to recover energy that might otherwise be lost as heat and friction.

Electric motors produce linear or **rotary force** (torque) intended to propel some external mechanism, such as a fan or an elevator. An electric motor is generally designed for continuous rotation, or for linear movement over a significant distance compared to its size. Magnetic solenoids are also transducers that convert electrical power to mechanical motion, but can produce motion over only a limited distance.

2. Give the English equivalents of the following words and word combinations:

Электродвигатель, электрогенератор, источник питания, постоянный ток, переменный ток, проволочная обмотка, магнитное поле, непрерывное вращение, преобразователь, механическое движение, промышленное использование, генератор, небольшой мотор.

3. Answer the following questions.

1. What is an electric motor?
2. How do electric motors work?
3. What is the difference between electric motors and electric generators?
4. How are electric motors powered?
5. Can you classify electric motors?
6. Where are applications of electric motors?

4. Read and translate the text.

What is electrical drive technology?

Electrical drive technology **converts electrical energy** from the power supply system or from a battery **into mechanical energy and transmits the resulting force into motion**. Many applications that make our daily lives easier – like lifts, escalators, gate drives, washing machines, mixers, electric razors, etc. – would be unthinkable without electric drives. We can find them in both the megawatt sector in applications such as locomotives and in the microwatt sector, in wristwatches, for instance.

Electrical drive technology is also now indispensable in industrial production. There, it plays a key role in machines and plants for production and logistics processes. All in all, we can assume that electrical drive technology consumes the predominant share of our overall electrical energy.

Electrical drive technology components in industry

The driving force in machines has been the electric motor from the very start of electrical drive technology. More and more components have come into play along the path toward modern plant and automation technology. A gear unit downstream from the motor performs the role of a **mechanical converter**: The gear unit uses its gearing to change the constant **speed** supplied by the electric motor and its **torque** to the required levels based on the requirements for the machine or system to be driven. The electric motor is usually an AC motor. In gearmotors, the electric motor and gear unit components form a compact unit.

The requirements placed on electrical drive technology increase alongside the complexity of the plant technology. **Most processes also need the speed to be controllable as well as converted.** To do so, a frequency inverter can be employed, which is located upstream from the electric motor and converts the frequency and amplitude supplied by the power supply system so that the **rotational speed and direction of rotation** can be changed. The speed and direction **then become controllable variables** that can be used to control specific processes in driven machines and conveyor lines.

At the same time, however, the portfolio of modern electrical drive technology is far from complete: Nowadays, the **boundaries between drive technology and automation are fluid**. **Brakes** provide more safety by preventing movements in the system when the drive is inactive. Motor-mounted **encoders** constantly determine the predominant characteristic values of the movement produced, including the speed, torque, and current position. Depending on the complexity of the system and its requirements, suitably **powerful electronics** and **control technology** and software control the processes.

5. Translate the words in bold using a dictionary and try to explain them in English. Make up your own sentences using them.

6. Read and translate the text. Four sentences or parts of sentences have been removed from the text. Choose from sentences, (A-E), the one that best fits each gap (1-4) to complete the text. There is one extra sentence you do not need to use.

A. Laminations are used to reduce losses that would result from induced circulating eddy currents that would flow if a solid core were used.
B. magnetic fields are formed in both the rotor and the stator.
C. may pose mechanical problems in addition to noise and losses.
D. At the same time, however, the portfolio of modern electrical drive technology is far from complete.
E. AC electric motors are either asynchronous or synchronous.

In 2022, electric motor sales were estimated to be 800 million units, increasing by 10% annually. Electric motors consume ~50% of the world's electricity.

Components

The two mechanical parts of an electric motor are the **rotor**, which moves, and the **stator**, which does not. It also includes two electrical parts, a set of **magnets** and an **armature**, one of which is attached to the rotor and the other to the stator, together forming a **magnetic circuit**.

The rotor is supported by **bearings**, which allow the rotor to turn on its axis. The bearings are in turn supported by the **motor housing**.

The rotor is the moving part that delivers the mechanical power. The rotor typically holds conductors that carry currents, which the **magnetic field** of the stator exerts force on to turn the shaft. Alternatively, some rotors carry permanent magnets, and the stator holds the conductors. Permanent magnets offer high efficiency over a larger operating speed and power range.

An **air gap** between the stator and rotor allows it to turn. The width of the gap has a significant effect on the motor's electrical characteristics. It is generally made as small as possible, as a large gap weakens performance. It is the main source of the low power factor at which motors operate. The magnetizing current increases and the power factor decreases with the air gap, so narrow gaps are better. Conversely, gaps that are too small 1) _____. The **motor shaft** extends through the bearings to the outside of the motor, where the load is

applied. Because the forces of the load are exerted beyond the outermost bearing, the load is said to be overhung.

The stator surrounds the rotor, and usually holds field magnets, which are either electromagnets consisting of **wire windings** around a ferromagnetic iron core or **permanent magnets**. These create a magnetic field that passes through the rotor armature, exerting force on the windings. The **stator core** is made up of many thin metal sheets that are insulated from each other, called laminations. These **laminations** are made using electrical steel which has a specified magnetic permeability, hysteresis, and saturation. 2) _____. Mains powered AC motors typically immobilize the wires within the windings by impregnating them with varnish in a vacuum. This prevents the wires in the winding from vibrating against each other which would abrade the wire insulation causing it to fail prematurely. Resin-packed motors, used in deep well submersible pumps, washing machines, and air conditioners, encapsulate the stator in plastic resin to prevent corrosion and/or reduce conducted noise.

Electric motors operate on one of three physical principles: magnetism, electrostatics and **piezoelectricity**.

In magnetic motors, 3) _____. The product between these two fields gives rise to a force, and thus a torque on the motor shaft. One, or both, of these fields must change with the rotation of the rotor. This is done by **switching the poles on and off** at the right time, or varying the strength of the pole.

The main types are DC motors and AC motors, with the latter replacing the former. 4) _____. Once started, a synchronous motor requires synchrony with the moving magnetic field's speed for all normal torque conditions.

In synchronous machines, the magnetic field must be provided by means other than induction, such as from separately excited windings or permanent magnets.

A **fractional-horsepower motor** either has a rating below about 1 horsepower (0.746 kW), or is manufactured with a standard-frame size smaller than a standard 1 HP motor. Many household and industrial motors are in the fractional-horsepower class.

7. Translate the words in bold using a dictionary and try to explain them in English. Give their synonyms.

8. Watch the video about working principle of electric motors https://www.youtube.com/watch?v=CWulQ1ZSE3c and answer the questions.

1. How do electric motors work?
2. What devices have electric motors?
3. What is meant by conventional flow?
4. How does an electric motor work?
5. How is spinning motion produced?
6. Name some household appliances in which electric motors are used.

UNIT IV. ELECTRICAL EQUIPMENT AND POWER SUPPLY SYSTEMS FOR MINES

1. Read and translate the text given below.

MINE POWER SUPPLY

Power supply for mining operations is governed by numerous specific requirements which give such systems a special character compared with electrical systems. In addition to striking differences in the basic design, mine power supply systems also involve a number of special features relating to the installation of the system and necessitated by particular operating conditions deriving from environmental factors, difficult maintenance and repair operations, and special safety considerations. Similarly, the impact of any power failures is considerably greater as compared to aboveground installations: a power failure underground may jeopardize the entire mine (pit) and, more important, endanger human life (pit ventilation breakdowns and other accidents).

The design of mine power supply systems also poses specific requirements regarding the service life and depreciation of the installation.

Thus, the economic aspect has a particular bearing on the basic design parameters, especially where the cable network is concerned. Whereas the useful life of an aboveground cable may even exceed thirty years, in pit conditions it may be reduced to as low as one or two years,

which has a great deal of relevance to the design of the network and for the requirements to be met by other equipment.

Finally, special attention should be paid to safety considerations, particularly to the potentially hazardous atmosphere containing explosive mine gas. This potential danger necessitates that most stringent precautions be taken, lest the use of electric power should bring further possible hazards, such as fires or explosions of flammable gases or dust. Electrical installations are an integral part of mine equipment, particularly in the working zone, and are handled directly by operating personnel. Considering the limited space and difficult environmental conditions, this implies an increased potential hazard of electric contact due to possible faults in the electrical system. Therefore, protection against electric-shock hazards must be designed in such a way that no danger to mine personnel can come from such faults in the system.

2. Define if the following statements are true or false. Correct the false ones.

1. The design of mine power supply system poses specific requirements regarding reducing carbon emissions.
2. Practical aspect has a particular bearing on the basic design parameters, especially where the cable network is concerned.
3. Electrical installations are an integral part of mine equipment, particularly in the working zone.
4. Special attention should be paid to safety considerations, particularly to the potentially hazardous atmosphere containing explosive mine gas.
5. The useful life of an aboveground cable may exceed thirty years, even in pit conditions.

3. In the right column find the Russian equivalents of the word combinations.

1. flammable gas	a. срок службы
2. cable network	b. воспламеняющийся газ, горючий газ
3. operating personnel	c. особые/специальные требова-

	ния
4. special features	d. ограниченное пространство
5. power failures	e. технический персонал
6. service life	f. кабелепроводка, кабельная сеть
7. specific requirements	g. добыча открытым способом, карьерная добыча
8. limited space	h. перебой в подаче электроэнергии
9. open-pit operations	i. главная проблема
10. key challenge	j. специальные функции, особенности

4. Read the article below and answer the questions that follow.

Mining electrification and infrastructure towards all-electric mines

Reducing carbon (CO_2) emissions during open-pit operations is now a major driver for mining companies globally. Trolley assist systems are being employed to limit diesel fuel usage and lower costs, while at the same time boosting speed-on-grade.

A new generation of diesel-electric trucks has emerged. These have an electrical system on board, which makes attaching them to a trolley line relatively straightforward. This concept is becoming a commercially viable way of moving towards all-electric mines in the future.

One of the key challenges of reducing diesel fuel usage is cycle times. There is no technology today that enables miners to fill a truck's tank and complete a shift without stopping. Instead, there is a choice of increasing the speed of the mobile equipment or the size the fleet itself – both of which have a direct impact on capital expenditure.

Enter trolley assist

Trolley assist systems have returned to the market over the last three years, in locations including North and South America, Africa and Turkey. This is mainly due to CO_2 emissions taxes, the removal of tax advantages from diesel, and premiums offered by energy suppliers to incentivize companies to use electricity. Trolley lines offer huge benefits in terms of CO_2 reduction.

Mining trucks regularly carry 3,000 to 5,000 litres of diesel and consume around 300 to 400 litres per hour while travelling up a 17km ramp in half an hour. By going electric, the vehicles on-trolley only use around 30 to 50 litres an hour, saving as much as 350 litres an hour and making operations much more CO2 efficient.

In addition, the speed of the trucks will increase, meaning a higher throughput at the mine. This allows operators to think about parking some of their fleet, resulting in better planning around vehicle maintenance, availability and longevity.

Modern mine management

Diesel-electric trucks have an electrical powertrain in the wheels, meaning they can be driven fully electric. They have an electrical genset on board, so they generate electricity as they go. However, due to the limitations of existing battery technologies, it is not possible to manage large payload trucks of 280–400 tons fully battery equipped. Companies are therefore trying to close the gap between the trolley and the loading or the dumping point using battery packs and other solutions.

The transformation from diesel to electric is bringing new advantages in terms of CO2 reduction but also new constraints in terms of mine planning and fleet management. Energy costs represent almost one third of a mining company's total cost base; helping industry to manage these costs is therefore key.

1. What is a major driver for mining companies now?
2. What is a trolley assist system?
3. What advantages do trolley assist systems have?
4. How are diesel-electric trucks organized?
5. What are advantages and disadvantages of switching from diesel to electric in modern mine management?

5. Match the words (1-10) with their definitions (a-j).

1. hazard	a. a broken part or weakness in a machine or system
2. jeopardize	b. the set of necessary tools, clothing, etc. for a particular purpose
3. transformation	c. something that is dangerous
4. boost	d. to put something in situation where there is a risk of failing or being harmed

5. payload	e. a machine, usually with wheels and an engine, used for transporting people or goods, especially on land
6. vehicle	f. to increase or improve smth
7. supplier	g. a company, person, etc. that provides things that people want or need
8. fault	h. the amount of goods or people that a vehicle, such as a truck or aircraft, can carry
9. shift	i. a complete change
10. equipment	j. a change in position or direction

6. Read and translate the article below. Write out or underline the main idea in each paragraph.

Electrical Control of Coal Cutting Machine

The coal cutting machines are electrically controlled by the gate end box and the operation of the gate end box is explained briefly here. At first the isolating switch in the box is closed and the current flows through the primary of the control transformer as shown in Fig 21.26, and 20 V is supplied to the pilot circuit. Then the master switch in the coal-cutter in turned in either direction to the 'stop', 'run' and 'start' positions successively.

In the 'stop' position, the main circuit to the stator is completed, except for the main contractor in the gate-end box which is still open. In the "run" position, the low-voltage pilot circuit is closed through a resistance which does not allow sufficient current to flow to actuate the control relay.

In the "start" position, the resistance is short circuited, the full low voltage current flows through pilot circuit through the contactor-operating coil which causes the contactor to close. Then the coal cutter motor starts, the operator releases the switch handle, a spring moves the barrel of the master switch back to the running position and bring the resistance into the pilot circuit again.

The current, now flowing in the pilot circuit is sufficient to keep the control relay closed, though it was insufficient to close it when al-

ready open. However, breaking the pilot circuit by any one of several means, allows the control relay to open, whereupon the contactor opens.

Thus, the line contact is made and broken at the contactor in the gate-end box and never at the master switch in the coal-cutter except in emergencies when, for example, the contactor switch contacts are welded or fused together. The master switch makes and breaks the 20-volt pilot circuit only, and when the master switch line contacts open, no current is flowing in the main circuit.

The next point to note is that when the control relay is released, it causes the contactor to open, by any of the following means:

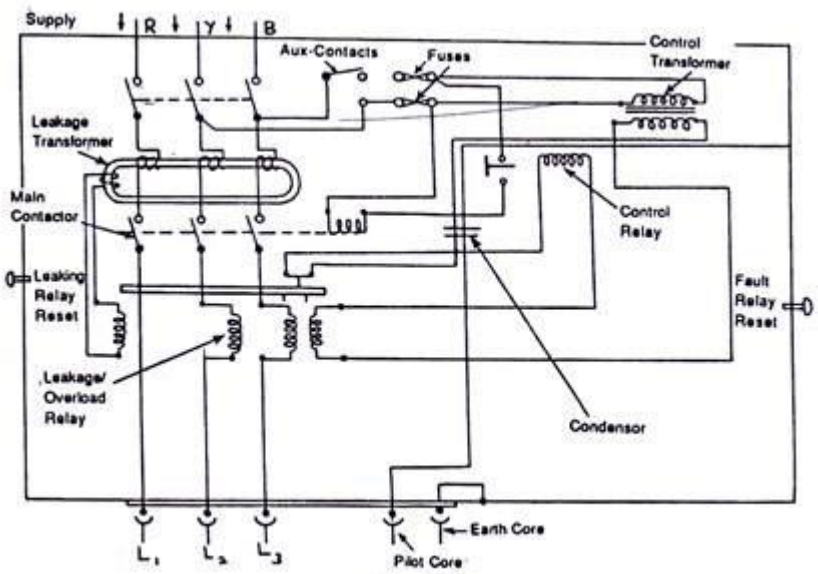


Fig. 21.26

a) Leakage from phase to earth as earth leakage causes loss of balance between phases, sets up a current in the secondary winding of the core-balance leakage transformer, and operates the leakage trip.

b) By opening the isolating switch in the gate-end box, the auxiliary contacts break the contactor coil circuit and the control transformer primary circuit, before the line contacts.

c) By moving the master switches from ‘Run’ to ‘Stop’.

d) Overload in the main circuit.
e) Low-voltage or failure of supply.
f) Any interruption in the pilot circuit like with-drawl of either plug, any break in the pilot conductor, failure of earth continuity to the load-cutter.
g) Any short in the pilot circuit or protracted holding of the switch in the starting position, or in some cases, by operating push buttons on the gate-end box, or a switch in the extension of the pilot circuit.

However, it must be noted that by whatever means the contactor is opened, the control relay is opened and the contactor will not reclose until the master switch is turned to the "START" position. Again, the leakage relay and fault relay each hold out after tripping, and are reset by knobs on the outside of the gate-end box casings. The knob for leakage-reset is in a pad-locked cover to prevent resetting by any unauthorized person.

In fact, the gate-end boxes controlling coal-cutter generally do have individual leakage protection as shown in Fig 21.26, but for control-ling conveyors, leakage protection is usually deleted from individual gate-end boxes and is provided in the oil circuit breaker controlling the supply to a group of conveyors. In the figure, the condesor shown in the low-voltage circuit is to make the circuit intrinsically safe so as to ensure that any spark caused in this circuit is not capable of igniting firedamp.

7. Work in pairs. Describe the electrical control of coal cutting machine mentioned in the text and discuss with your partner the main features, characteristics and functions of its work.

8. Make up a plan and retell the text.

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Video Links

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Electricity https://www.youtube.com/watch?v=ru032Mfsfig
How does an electric motor work? https://www.youtube.com/watch?v=CWulQ1ZSE3c

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