MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

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Methodological guidelines
for independent work
on the subject

"English"

(for the 1-year and 2-year full-time and part-time students
of Power Engineering, Electrical Engineering and Electromechanics)

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UNIT 1
THE WONDER OF ELECTRICITY

1 LEAD-IN

1 What is the role of electricity in a human life?
2 How was electricity discovered?
3 What do you know about the early history of electricity?

Vocabulary to learn

1	physical phenomenon	фізичне явище
2	static electricity	статична електрика
3	electromagnetic induction	електромагнітна індукція
4	electrical current	електричний струм
5	particle	нескінченно мала частинка речовини
6	electromagnetic radiation	електромагнітне випромінювання
7	radio waves	радіохвилі
8	charge	заряд
9	electromagnetic field	електромагнітне поле
10	electric charge	електричний заряд
11	electric field	електричне поле
12	electric potential	електричний потенціал
13	electromagnet	електромагніт
14	vacuum tubes	вакуумні трубки

2 READING

THE WONDER OF ELECTRICITY

Electricity is the set of physical phenomena associated with the presence and flow of electric charge. Electricity gives a wide variety of well-known effects, such as lightning, static electricity, electromagnetic induction and electrical current. In addition, electricity permits the creation and reception of electromagnetic radiation such as radio waves.

In electricity, charges produce electromagnetic fields which act on other charges. Electricity occurs due to several types of physics:

- electric charge: a property of some subatomic particles, which determines their electromagnetic interactions. Electrically charged matter is influenced by, and produces, electromagnetic fields.

- electric field (see electrostatics): an especially simple type of electromagnetic field produced by an electric charge even when it is not moving (i.e., there is no electric current). The electric field produces a force on other charges in its vicinity.
- electric potential: the capacity of an electric field to do work on an electric charge, typically measured in volts.
- electric current: a movement or flow of electrically charged particles, typically measured in amperes.
- electromagnets: Moving charges produce a magnetic field. Electrical currents generate magnetic fields, and changing magnetic fields generate electrical currents.

In electrical engineering, electricity is used for:

- electric power where electric current is used to energize equipment;
- electronics which deals 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 since antiquity; though progress in theoretical understanding remained slow until the seventeenth and eighteenth centuries. Even then, practical applications for electricity were few, and it would not be until the late nineteenth century that engineers were able to put it to industrial and residential use. The rapid expansion in electrical technology at this time transformed industry and society.

Electricity 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.

Retrieved from
https://www.abctlc.com/downloads/courses/BasicElectricity.pdf

Answer the following questions to the text.

1 What is electricity?

2 What effects can electricity produce?

3 What is an electromagnetic field caused by?
4 What physical phenomena are connected with producing electricity?
5 What is electric potential? How is it measured?
6 What is electricity used for in electrical engineering?
7 How long have electrical phenomena been studied?

3 VOCABULARY

3.1 Match the terms with the definitions.

1	electric charge	**a**	the flow of electrical charge carriers like electrons
2	static electricity	**b**	an electromagnetic wave of radio frequency
3	electromagnetic induction	**c**	the basic unit of electric current intensity
4	electrical current	**d**	an electrical property of matter that exists because of an access or a deficiency of electrons
5	radio wave	**e**	the production of voltage or electromotive force due to a change in the magnetic field
6	electromagnetic field	**f**	an electrical charge that accumulates on an object when it is rubbed against another object
7	volt	**g**	an electric and magnetic force field that surrounds a moving electric charge
8	ampere	**h**	a unit used to measure the force of an electric current

3.2 Complete the following text with the words given below.

positively attract greater explosion of another
moving smallest repel others eliminated nucleus

What Is Static Electricity

Static means not moving. Static electricity is an electrical charge that does not move. All materials are made up of atoms. An atom is the 1) ___________ particle of a material that still contains the properties of the material. Each atom consists 2)___________ a_3)__________ charged nucleus around which one or more negative electrons move. In an idle state, the positive charge of the 4)___________ is equal to the sum of the negative charge of the electrons 5)___________ around the same nucleus. Therefore, the charge is neutral. If the nucleus loses or gains electrons, an imbalance is caused. An atom that has lost one or more electrons then has a positive charge, and an atom that has gained one or more electrons has a negative charge and is called an ion. There are only two types of charge: positive and negative. Atoms with the same type of charge 6)___________ one another, while those with the opposite type of charge 7)___________ one another.

Static electricity is a surface phenomenon and is generated when two or more surfaces come into contact with one 8)___________ and are separated again. This causes a sort of splitting, or a transfer of negative electrons from one atom to the other. The level of charge, (the field strength) is dependent on a number of factors: the material and its physical and electrical properties, temperature, humidity, pressure and speed of separation. The greater the pressure or the speed of separation, the 9)___________ the charge.

Materials can be divided into two basic groups: conductors and insulators. In a conductor, the electrons can move around freely. In principle, a conductor that is arranged in an insulated way can take on a static charge. This charge can easily be 10)___________ by connecting the conductor to earth. Non-conductive material can retain static charge for a long time, even having opposite polarities in different places. The electrons cannot move around freely. This explains why materials are attracted in some zones and repelled in 11)___________. Connecting to earth does not work because the material has non-conductive properties. Only active ionisation offers a solution to this.

In production processes, static charge can often be a severe disruption, as it means that materials get stuck to machine parts or to each other. The dust in the surrounding area is attracted by the electric charge. In explosion hazardous zones, static charge can cause a spark, which in turn can cause a fire or even an 12)___________.

Retrieved from
https://www.simco-ion.co.uk/downloads/about-static-electricity/

UNIT 2

1 LEAD-IN

1. What is energy?
2. What forms of energy do you know?
3. Can one form of energy be transferred into another form?

Vocabulary to learn

1	potential energy	потенційна енергія
2	kinetic energy	кінетична енергія
3	bonds	зв'язки
4	particle	частинка
5	chemical compound	хімічна сполука
6	biomass	біомаса
7	petroleum	нафта
8	natural gas	природний газ
9	fission	поділ
10	fusion	злиття
11	gravitational energy	енергія гравітації
12	substance	речовина
13	longitudinal wave	поздовжня хвиля

2 READING

WHAT IS ENERGY?

Energy does things for us. It moves cars along the road and boats on the water. It bakes a cake in the oven and keeps ice frozen in the freezer. It plays our favourite songs and lights our homes at night so that we can read good books. Energy helps our bodies grow and our minds think. Energy is a changing, doing, moving, working thing.

Energy is defined as the ability to produce change or do work, and that work can be divided into several main tasks we easily recognize:

Energy produces light.
Energy produces heat.
Energy produces motion.

Energy produces sound.
Energy produces growth.
Energy powers technology.

There are many forms of energy, but they all fall into two categories– potential or kinetic.

Potential Energy is stored energy and the energy of position, or gravitational energy. There are several forms of potential energy, including:

- Chemical Energy is energy stored in the bonds of atoms and molecules. It is the energy that holds these particles together. Biomass, petroleum, natural gas, and propane are examples of stored chemical energy. During photosynthesis, sunlight gives plants the energy they need to build complex chemical compounds. When these compounds are later broken down, the stored chemical energy is released as heat, light, motion, and sound.
- Stored Mechanical Energy is energy stored in objects by the application of a force. Compressed springs and stretched rubber bands are examples of stored mechanical energy.
- Nuclear Energy is energy stored in the nucleus of an atom—the energy that holds the nucleus together. The energy can be released when the nuclei are combined or split apart. Nuclear power plants split the nuclei of uranium atoms in a process called fission. The sun combines the nuclei of hydrogen atoms into helium atoms in a process called fusion. In both fission and fusion, mass is converted into energy, according to Einstein's Theory, E = mc2.

Gravitational Energy is the energy of position or place. A rock resting at the top of a hill contains gravitational potential energy. Hydropower, such as water in a reservoir behind a dam, is an example of gravitational potential energy.

Kinetic Energy is motion—the motion of waves, electrons, atoms, molecules, substances, and objects.

- Electrical Energy is the movement of electrons. Everything is made of tiny particles called atoms. Atoms are made of even smaller particles called electrons, protons, and neutrons. Applying a force can make some of the electrons move. Electrons moving through a wire are called electricity. Lightning is another example of electrical energy.
- Radiant Energy is electromagnetic energy that travels in transverse waves. Radiant energy includes visible light, x-rays, gamma rays, and radio waves. Light is one type of radiant energy. Solar energy is an example of radiant energy.
- Thermal Energy, or heat, is the internal energy in substances — the vibration and movement of atoms and molecules within substances. The faster molecules and atoms vibrate and move within substances, the more energy they possess and the hotter they become. Geothermal energy is an example of thermal energy.

- Motion Energy is the movement of objects and substances from one place to another. According to Newton's Laws of Motion, objects and substances move when a force is applied. Wind is an example of motion energy.
- Sound Energy is the movement of energy through substances in longitudinal (compression/rarefaction) waves. Sound is produced when a force causes an object or substance to vibrate. The energy is transferred through the substance in a wave.

Retrieved from
http://cse.ssl.berkeley.edu/energy/Resources/Intro%20to%20Energy%20Reading.pdf

Answer the following questions to the text.

1 How is energy defined?

2 What can energy produce?

3 What are the two categories of energy?

4 What is the potential energy?

5 What are the forms of the potential energy?

6 What is the kinetic energy?

7 What are the forms of the kinetic energy?

3 VOCABULARY

3.1 Match the terms with the definitions.

1	potential energy	**a**	the smallest constituent unit of ordinary matter that has the properties of a chemical element
2	kinetic energy	**b**	the process by which green plants and certain other organisms transform light energy into chemical energy
3	atom	**c**	the stored energy of position possessed by an object
4	molecule	**d**	any substance composed of identical molecules consisting of atoms of two or more chemical elements
5	photosynthesis	**e**	the energy that an object possesses due to its motion

6	chemical compound	**f**	matter, anything that has mass and takes up space
7	substance	**g**	penetrating electromagnetic radiation arising from the radioactive decay of atomic nuclei
8	electron	**h**	a group of two or more atoms that form the smallest identifiable unit into which a pure substance can be divided and still retain the composition and chemical properties of that substance
9	proton	**i**	the stable subatomic particle that has a positive charge
10	neutron	**j**	a form of electromagnetic radiation, similar to light but of shorter wavelength and capable of penetrating solids and of ionizing gases
11	gamma ray	**k**	the lightest stable subatomic particle known which carries a negative charge
12	x-ray	**l**	the neutral subatomic particle that is a constituent of every atomic nucleus except ordinary hydrogen

3.2 Complete the following text with the words given below.

back	***to***	***sources***	***internal***	***Industrial***	***widespread***
range	***on***	***commonly***	***introduced***	***extraction***	***combustion***

Energy and powered devices are an integral part of society. Humanity's earliest days saw the discovery of fire through wood 1) ___________, and the use of charcoal for smelting metals dates 2)___________ as early as 5000 BC. Powered devices using natural energy 3)___________ such as water and wind were 4)___________ by the Ancient Greeks and were 5)___________ used until the 18th century steam engine revolutionized the way devices could be powered. Various natural oils were used for a 6)___________ of purposes such as whale oil for lamps. The 7)___________ Revolution led 8)___________ the massive use of coal as fuel, and the 9)___________ of petroleum and various other oils became extremely important with the advent of 10)___________ combustion engines. Electrical power, also based 11)___________ fossil fuels, became 12)___________ at the end of the 19th century and the production of cleaner electrical energy through nuclear, hydropower, geothermal, and solar means is a topic even more relevant to today's world.

Retrieved from
http://ethw.org/Category:Energy?gclid=EAIaIQobChMIqr2Grp3Z2wIVwh0YCh2VLg3GEAAYASAAEgLQjfD_BwE

UNIT 3

1 LEAD-IN

1. How is electrical energy generated?
2. What kind of device is a generator?
3. What do you know about DC and AC generators?

Vocabulary to learn

1	three phase synchronous generator	трифазний синхронний генератор
2	operating principles	принципи роботи
3	applicable	застосовний, відповідний, підходящий
4	insulated coils	ізольовані котушки
5	stationary cylinder	стаціонарний циліндр
6	rotary	роторний
7	electromagnetic shaft	електромагнітний вал
8	to induce	індукувати
9	electric conductor	електричний провідник
10	to transmit	передавати
11	power station	електростанція
12	steam turbine	парова турбіна
13	internal-combustion engines	двигуни внутрішнього згоряння
14	combustion turbines	турбіни внутрішнього згоряння
15	water turbines	водяні турбіни

16	wind turbines	вітрові турбіни
17	alternator	генератор змінного струму
18	dynamo	динамо-машина
19	rotor coil	роторна котушка
20	stator	статор
21	magnitude	величина
22	electromotive force (EMF)	електрорушійна сила
23	conductor	провідник
24	unidirectional current	односпрямований струм
25	rotor shaft	роторний вал
26	sinusoidal pulses	синусоїдальні імпульси
27	rectifier	випрямляч (струму)
28	field excitation	збудження поля
29	to dissipate	розсіювати
30	residual magnetism	залишковий магнетизм

2 READING

TURNING ENERGY RESOURCES INTO USABLE ELECTRIC POWER

The primary supply of all the world's electrical energy is generated in three phase synchronous generators using machines with power ratings up to 1500 MW or more. Though the variety of electric generators is not as great as the wide variety of electric motors available, they obey similar design rules and most of the operating principles used in the various classes of electric motors are also applicable to electric generators.

A generator is a device that converts mechanical energy into electrical energy. The process is based on the relationship between magnetism and electricity. In 1831, scientist Michael Faraday discovered that when a magnet is moved inside a coil of wire, electrical current flows in the wire. A typical generator at a power plant uses an electromagnet — a magnet produced by electricity — not a traditional magnet. The generator has a series of insulated coils of wire that form a stationary cylinder. This cylinder surrounds a rotary electromagnetic shaft. When the electromagnetic shaft rotates, it induces a small electric current in each section of the wire coil. Each section of the wire becomes a small, separate electric conductor. The small currents of individual sections are added together to form one large current. This current is the electric power that is transmitted from the power company to the consumer. An electric utility power station uses either a turbine, engine, water wheel, or other similar machine to drive an electric generator — a device that converts mechanical or chemical energy to electricity. Steam turbines, internal-combustion engines, gas combustion turbines, water turbines, and wind turbines are the most common methods to generate electricity.

The vast majority of generators are AC machines (Alternators) with a smaller number of DC generators (Dynamos).

AC Generators (Alternators)

Stationary Field Synchronous AC Generator

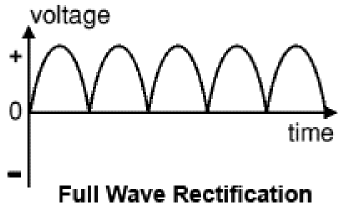
In a stationary field generator, the stator in the form of fixed permanent magnets (or electromagnets fed by DC) provides the magnetic field and the current is generated in the rotor windings.

When the rotor coil is rotated at constant speed in the field between the stator poles the EMF generated in the coil will be approximately sinusoidal, the actual waveform being dependent on the size and shape of the magnetic poles. The peak voltage occurs when the moving conductor is passing the centre line of the magnetic pole. It diminishes to zero when the conductor is in the space between the poles and it increases to a peak in the opposite direction as the conductor approaches the centre line of the opposite pole of the magnet. The frequency of the waveform is directly proportional to the speed of rotation. The magnitude of the wave is also proportional to the speed until the magnetic circuit saturates when rate of voltage increase, as the speed increases, slows dramatically.

DC Generators (Dynamos)

Direct Current (DC) Generator

The stationary field AC generator described above can be modified to deliver a unidirectional current by replacing the slip rings on the rotor shaft with a suitable commutator to reverse the connection to the coil each half cycle as the conductor passes alternate north and south magnetic poles. The current will however be a series of half sinusoidal pulses just like the waveform from a full wave rectifier as shown below.



Full Wave Rectification
(Varying DC)

The output voltage ripple can be minimised by using multipole designs. The construction of a DC generator is very similar to the construction of a DC motor. The rotor consists of an electromagnet providing the field excitation. Current to the rotor is derived from the stator or in the case of very large generators, from a separate exciter rotating on the same rotor shaft. The connection to the rotor is through a commutator so that the direction of the current in the stator windings changes direction as the rotor poles pass between alternate north and south stator poles. The rotor current is very low compared with the current in the stator windings and most of the heat is dissipated in the more massive stator structure. In self excited machines, when starting from rest, the current to start the electromagnets working is derived from the small residual magnetism which exists in the electromagnets and surrounding magnetic circuit.

Retrieved from:
https://www.abctlc.com/downloads/courses/BasicElectricity.pdf
https://www.mpoweruk.com/generators.htm

Answer the following questions to the text.

1 Where is electrical energy generated?
2 What does a generator do?
3 What principle is the work of a generator based on?
4 What was discovered by Michael Faraday in 1831?
5 How does a typical generator at a power plant function?
6 What is typically used at an electric utility power station to drive an electric generator?
7 What is the Stationary Field Synchronous AC Generator? How does it function?
8 How can the Stationary Field Synchronous AC Generator be modified to deliver a unidirectional current?

3 VOCABULARY

3.1 Match the terms with the definitions.

1	generator	**a**	material that permit electrons to flow freely from particle to particle
2	electric motor	**b**	energy per unit electric charge that is imparted by an energy source, such as an electric generator or a battery
3	electromagnet	**c**	an electrical device that converts alternating current (AC), which periodically reverses direction, to direct current (DC), which flows in only one direction
4	electric conductor	**d**	a device converting mechanical energy into electrical energy
5	electromotive force	**e**	a device that convert electrical energy to mechanical energy, usually by employing electromagnetic phenomena
6	internal-combustion engine	**f**	an electrical generator that creates direct current using a commutator
7	alternator	**g**	an engine in which the burning of a fuel occurs in a confined space called a combustion chamber alternator works with the battery to generate power for the electrical components of a vehicle, like the interior and exterior lights, and the instrument panel
8	dynamo	**h**	a type of magnet in which the magnetic field is produced by an electric current
9	wave rectifier	**i**	an engine in which the burning of a fuel occurs in a confined space called a combustion chamber

3.2 Complete the following text with the words given below.

to	***affect***	***controlling***	***versa***
by	***capture***	***regulation***	***principle***

Voltage and Frequency Regulation

Most generator applications require some way controlling the output voltage and in the case of AC machines a method of 1)___________ the frequency.

Voltage and frequency 2)___________ is normally accomplished in very large machines carrying very high currents, by controlling the generator excitation and the speed of the prime mover which drives the generator.

In smaller, stand alone systems particularly those designed to 3)___________ energy from intermittent energy flows such as wind and wave power the voltage and frequency control may be carried out electronically. In 4)___________ these control systems are similar 5)___________ Motor Controls and the various components are outlined in that section.

In grid connected systems the generator voltage and frequency are locked to the grid system. Changing the energy output from the prime mover does not 6)___________ the frequency and voltage but will cause the output current to increase resulting in an equivalent change in the generator output power. When connecting a generator to the grid, it is speed that should be run up so that it is output frequency matches the grid frequency before the connection is made.

Generator Power Handling

The mechanical shaft power P in Watts applied to a generator is given by:

$$P = \omega T$$

Where ω is the speed in radians per second and T is the torque in Newton metres.

As with electric motors, the maximum power handling capability of the generator is determined 7)___________ its maximum permissible temperature.

Voltage and frequency regulation correct for minor deviations in the generator output as noted above but large changes in the load demand (current) can only be accommodated by adjusting the torque of the prime mover driving the generator since generally, in electric machines, torque is proportional to current or vice 8)___________.

Retrieved from:

https://www.mpoweruk.com/generators.htm

UNIT 4

1 LEAD-IN

1 What theory can explain the phenomenon of electricity?

2 What are atoms made of?

3 What do you know about conductors and insulators?

Vocabulary to learn

1	matter	матерія

2	nucleus	ядро
3	particle	частинка
4	to revolve around	обертатися навколо
5	invisible shell	невидима оболонка
6	to spin	обертатися
7	electrical charge	електричний заряд
8	tabular arrangement	табличне розташування
9	halogens	галогени
10	noble gases	благородні гази
11	to be attracted to each other	притягуватися один до одного
12	to carry the charge	нести заряд
13	outermost shells	найбільш віддалені від середини, від центра оболонки
14	be pushed out of their orbits	бути виштовхнутим з їхніх орбіт

2 READING

ELECTRICITY AND ATOMIC STRUCTURE

To understand electricity, we need to think about the world at the atomic level. Air, water, living beings and matter are all made up of tiny atoms. The width of a single hair is equal to over a million atoms side by side.

Each atom has a nucleus surrounded by a definite number of electrons. An electron is a particle of negative energy that revolves around the nucleus as a satellite does around the Earth. If you could see an atom, it would look a little like a tiny center of balls surrounded by giant invisible bubbles (or shells). The electrons would be on the surface of the bubbles, constantly spinning and moving to stay as far away from each other as possible. Electrons are held in their shells by an electrical force.

A nucleus consists of protons and neutrons. The protons and electrons of an atom are attracted to each other. They both carry an electrical charge. Protons have a positive charge (+) and electrons have a negative charge (-). The positive charge of the protons is equal to the negative charge of the electrons. Opposite charges attract each other. An atom is in balance when it has an equal number of protons and electrons. The neutrons carry no charge and their number can vary.

Electrons usually remain a constant distance from the nucleus in precise shells. The shell closest to the nucleus can hold two electrons. The next shell can hold up to eight. The outer shells can hold even more. Some atoms with many protons can have as many as seven shells with electrons in them. The electrons in the shells closest to the nucleus have a strong force of attraction to the protons. Sometimes, the electrons in an atom's outermost shells do not. These electrons can be pushed out of their orbits. Applying a force can make them move from one atom to another. These moving electrons are electricity.

The number of protons in an atom determines the kind of atom, or element, it is. The electrons of certain materials, such as copper, aluminum and other metals, can easily leave their orbits; these materials are called conductors. The electrons of other materials, like ceramic, cannot escape from their orbits; these are called insulators. When we wave a magnet over a wire made of a metal such as copper, we create a movement of electrons in that wire. The electrons jump from one atom to the next in a domino effect which is what we call electric current. This is how the electricity is delivered to people's home.

Retrieved from
http://www.hydroquebec.com/learning/notions-de-base/atome.html
https://www.abctlc.com/downloads/courses/BasicElectricity.pdf

Answer the following questions to the text.

1 What is any matter made up of?
2 What is the model of an atom?
3 What does a nucleus of any atom consist of?
4 What happens to opposite charges?
5 Do the electrons in an atom's outermost shells have a strong force of attraction?
6 What determines the kind of element?
7 What materials are called conductors?
8 Why do not some materials conduct electricity?

3 VOCABULARY

3.1 Match the terms with the definitions.

1 atom — **a** a subatomic particle, symbol with no net electric charge and a mass slightly larger

			than that of a proton
2	electron	**b**	chain reaction is the cumulative effect produced when one event sets off a chain of similar events
3	proton	**c**	a material whose internal electric charges do not flow freely
4	neutron	**d**	a subatomic particle, symbol with a positive electric charge
5	conductor	**e**	a subatomic particle, symbol, whose electric charge is negative one elementary charge
6	insulator	**f**	the smallest particle of a chemical element that can exist
7	domino effect	**g**	a material or object that permits an electric current to flow easily

3.2 Complete the following text with the words given below.

right	***presented***	***arrangement***	***columns***	***on***	***between***
chemical	***rows***	***called***	***of***	***result***	***widely***

Periodic Table

The periodic table is a tabular 1)___________ of the 2)___________ elements, organized 3)___________ the basis of their atomic numbers, electron configurations (electron shell model), and recurring chemical properties. Elements are 4)___________ in order of increasing atomic number (the number of protons in the nucleus).

The standard form of the table consists 5)___________a grid of elements laid out in 18 columns and 7 6)___________, with a double row of elements below that. The table can also be deconstructed into four rectangular blocks: the s-block to the left, the p-block to the 7)___________, the d-block in the middle, and the f-block below that.

The rows of the table are 8)___________ periods; the 9)___________ are called groups, with some of these having names such as halogens or noble gases. Since, by definition, a periodic table incorporates recurring trends, any such table can be used to derive relationships 10)___________the properties of the elements and predict the properties of new, yet to be discovered or synthesized, elements.

As a 11) ___________, a periodic table — whether in the standard form or some other variant — provides a useful framework for analyzing chemical behaviour, and such tables are 12___________ used in chemistry and other sciences.

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https://www.abctlc.com/downloads/courses/BasicElectricity.pdf

UNIT 5

1 LEAD-IN

1. Where is the electric power generated?
2. How is the electric power delivered to consumers?
3. What is a power grid?

Vocabulary to learn

1	discovery	відкриття
2	electrical power	електроенергія
3	to generate power in bulk	генерувати енергію у великому обсязі
4	current magnitude	сила струму
5	distribution networks	розподільні мережі
6	power generation	виробництво електроенеогії
7	power transmission	передача електроенергії
8	transformer	трансформатор
9	hitherto	дотепер, до того часу
10	single phase	однофазний
11	balanced poly-phase system	збалансована багатофазна система
12	induction motor	асинхронний двигун
13	synchronous generators	синхронні генератори
14	three phase winding	трифазна обмотка
15	armature	арматура
16	flux	потік
17	electromagnetic pole	електромагнітний полюс
18	rotor surface	роторна поверхня

19	sinusoidal function	синусоїдальна функція
20	sinusoidal voltage	синусоїдальна напруга

2 READING

ELECTRICAL GENERATION AND TRANSMISSION

Prior to the discovery of Faraday's Laws of electromagnetic discussion, electrical power was available from batteries with limited voltage and current levels. Although complicated in construction, D.C generators were developed first to generate power in bulk. However, due to limitation of the D.C machine to generate voltage beyond few hundred volts, it was not economical to transmit large amount of power over a long distance. For a given amount of power, the current magnitude is I = P/V, hence section of the copper conductor will be large. Thus generation, transmission and distribution of D.C power were restricted to area of few kilometer radius with no interconnections between generating plants. Therefore, area specific generating stations along with its distribution networks had to be used.

In later half of eighties, in the nineteenth century, it was proposed to have a power system with 3-phase, 50 Hz A.C generation, transmission and distribution networks. Once A.C system was adopted, transmission of large power (MW) at higher transmission voltage become a reality by using transformers. Level of voltage could be changed virtually to any other desired level with transformers – which was hitherto impossible with D.C system. Nicola Tesla suggested that constructionally simpler electrical motors (induction motors, without the complexity of commutator segments of D.C motors) operating from 3-phase A.C supply could be manufactured. In fact, his arguments in favor of A.C supply system own the debate on switching over from D.C to A.C system.

A.C power can be generated as a single phase or as a balanced poly-phase system. However, it was found that 3-phase power generation at 50 Hz will be economical and most suitable. Present day three phase generators, used to generate 3-phase power are called alternators (synchronous generators). An alternator has a balanced three phase winding on the stator and called the armature. The three coils are so placed in space that their axes are mutually 120° apart. From the terminals of the armature, 3-phase power is obtained. Rotor houses a field coil and excited by D.C. The field coil produces flux and electromagnetic poles on the rotor surface. If the rotor is driven by an external agency, the flux linkages with three stator coils becomes sinusoidal function of time and sinusoidal voltage is induced in them. However, the induced voltages in the three coils (or phases) will differ in phase by 120° because the present value of flux linkage with R-phase coil will take place after 120° with Y-phase coil and further 120° after, with B-phase coil. A salient pole alternator has projected poles. It has non uniform air gap and is generally used where speed is low. On the other hand, a non salient pole alternator has uniform air gap and used when speed is high.

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https://nptel.ac.in/courses/108105053/pdf/L02(TB)(ET)%20((EE)NPTEL).pdf

Answer the following questions to the text.

1 Why were D.C generators develop?

2 Why was it not economical to transmit large amount of power over a long distance first?

3 How is the current magnitude calculated?

4 Why were generation, transmission and distribution of D.C power restricted to area of few kilometer radius first?

5 What kind of power systems were proposed in later half of eighties, in the nineteenth century?

6 When did the transmission of large power at higher transmission voltage become possible?

7 What was suggested by Nicola Tesla?

8 What power generation was found economical and most suitable?

9 What is an alternator? How does it function?

3 VOCABULARY

3.1 Match the terms with the definitions.

1	transformer	**a**	to produce in large quantities
2	voltage	**b**	a static electrical device that transfers electrical energy between two or more circuits through electromagnetic induction
3	to produce in bulk	**c**	an industrial facility for the

			generation of electric power
4	current magnitude	**d**	the number of electrons passing a point per second
5	generating station	**e**	an electromotive force or potential difference expressed in volts
6	electric power distribution	**f**	an electrical machine which converts the mechanical power from a prime mover into an AC electrical power at a particular voltage and frequency
7	induction motor	**g**	an AC electric motor in which the electric current in the rotor needed to produce torque is obtained by electromagnetic induction from the magnetic field of the stator winding
8	single phase electric power spread	**h**	the final stage in the delivery of electric power which carries electricity from the transmission system to individual consumers
9	poly-phase system	**i**	a means of distributing alternating-current electrical power where the power transfer is constant
10	synchronous generator	**j**	the distribution of alternating current electric power using a system in which all the voltages of the supply vary in unison
11	flux linkage	**k**	the linking of the magnetic field with the conductors of a coil when the magnetic field passes through the loops of the coil

3.2 Complete the following text with the words given below.

other	***connected***	***lines***	***shut down***	***through***
obvious	***power***	***spread***	***through***	***obvious***

A modern 1)___________ station has more than one generator and these generators are 2)___________ in parallel. Also there exist a large number of power stations 3)___________ over a region or a country. A regional power

grid is created by interconnecting these stations 4) ___________ transmission. In 5)___________ words, all the generators of different power stations, in a grid are in effect connected in parallel. One of the advantages of interconnection is 6)___________; suppose due **to** technical problem the generation of a plant becomes nil or less then, a portion of the demand of power in that area still can be made from the other power stations connected to the grid. One can thus avoid 7)___________ of power in an area in case of 8)___________ problem in a particular station. It can be shown that in an interconnected system, with more number of generators connected in parallel, the system voltage and frequency tend to fixed values irrespective of degree of loading present in the system. This is another welcome advantage of inter connected system. Inter connected system however, is to be controlled and monitored carefully as they may give rise to
instability leading to collapse of the system. All electrical 9)___________ appliances (fans, refrigerator, TV etc.) to be connected to A.C supply are therefore designed for a supply frequency of 50 Hz. Frequency is one of the parameters which decides the quality of the supply. It is the responsibility of electric supply company to see that frequency is maintained close to 50 Hz at the consumer 10)___________ premises.

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UNIT 6

1 LEAD-IN

1 What do you know about static and current electricity?

2 What type of electricity is the most common type used in daily lives?

Vocabulary to learn

1	static electricity	статична електрика
2	current electricity	промислова електрика, електричний струм
3	charged particle	заряджена частинка
4	charged object	заряджений об’єкт

5	the Van de Graaf generator	генератор Ван де Граафа
6	to obtain very high voltage	отримувати дуже високу напругу
7	wire	провід
8	circuit	контур; схема
9	voltage difference	різниця напруги
10	gold leaf electroscope	золотий листовий електроскоп
11	alternating current	змінний струм
12	direct current	постійний струм
13	ripple current	струм пульсації
14	variable current	змінний струм
15	power dissipation	розсіювання електроенергії

2 READING

STATIC ELECTRICITY AND CURRENT ELECTRICITY

Static electricity and current electricity are the two main types of electricity in study. These concepts are very important and play vital roles in fields such as electromagnetic theory, electricity, electrostatics, electronics and electrical engineering and physics. Static electricity is a form of electricity that does not flow whereas current electricity is a current of charged particles. It is of great importance to consider what static electricity and current electricity are, their definitions, the similarities between static electricity and current electricity, the applications of static electricity and current electricity, how static electricity and current electricity are created, and finally the difference between static electricity and current electricity.

There are charges in everything we encounter on a daily basis. These charges are balanced almost all of the time. When some charges are taken out from a neutral object, the object becomes a charged object. If there is no way to balance these charges by taking charges from outside, the object remains a charged object. These charges are stationary and known as static charges. The electrical field created by these charges is known as the static electricity.

The most common static electricity generating object is the Van de Graaf generator. Static electricity is a very useful method to obtain very high voltages. While it is almost impossible to obtain millions of volts using a current flowing circuit, it is relatively easy to create it with static electricity.

The gold leaf electroscope is one of the most common and easiest methods to identify and measure static electricity. Static electricity is not capable of creating a magnetic field. Static electricity usually builds up on a surface of an object. If the object is a conductor, the charges are always on the outer surface of the conductor.

Current electricity is the most common type of electricity used in daily lives. Current electricity consists of two points that have a voltage difference, and a current carrying connection between them. The voltage difference at two points creates a current in the current carrying wire. The magnitude of the current depends on the voltage difference between the two points and the resistance of the connecting wire.

An electrical current always creates a magnetic field which is normal to the electric current. Electric currents can be alternating currents, direct currents, ripple currents, or a variable current. It is hard to obtain very high voltages using current electricity since there is power dissipation due to the flowing current.

What is the difference between Current Electricity and Static Electricity?

- Current electricity consists of flowing charges whereas static electricity consists of stationary charges.
- There is always a magnetic field associated with current electricity, but there cannot be a magnetic field in static electricity.
- Static electricity can occur in both conductors and insulators, but current electricity cannot occur in conductors.

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https://www.differencebetween.com/difference-between-static-and-vs-current-electricity/

Answer the following questions to the text.

1 What are the two main types of electricity?
2 What is static electricity ?
3 What is current electricity?
4 When is a charged object?
5 What charges are considered to be stationary?
6 What type of electricity can very high voltages be created by?
7 How can static electricity be measured?
8 Does Static electricity create a magnetic field?

9 What type of electricity is mostly used in daily lives?

10 What are the types of electric current?

11 In what way does current electricity differ from static electricity?

3 VOCABULARY

3.1 Match the terms with the definitions.

1	static electricity	**a**	an instrument for detecting and measuring static electricity or voltage
2	current electricity	**b**	a measure of the difficulty to pass an electric current through the conductor
3	the Van de Graaf generator	**c**	a vector field that describes the magnetic influence of electrical currents and magnetized materials
4	gold leaf electroscope	**d**	an imbalance of electric charges within or on the surface of a material
5	magnetic field	**e**	an electrostatic generator which uses a moving belt to accumulate electric charge on a hollow metal globe on the top of an insulated column, creating very high electric potentials
6	resistance	**f**	a flow of electric charge
7	ripple current	**g**	the residual periodic variation of the DC voltage within a power supply which has been derived from an alternating current (AC) source

3.2 Complete the following text with the words given below.

flow direction parallel through insulating to
of requires open connected branches converts

Circuit

In order 1)___________ flow, current electricity 2)___________ a circuit: a closed, never-ending loop of conductive material. A circuit could be as simple as a conductive wire connected end-to-end, but useful circuits usually contain a mix of wire and other components which control the 3)___________ of electricity. The only rule when it comes to making circuits is they cannot have any 4)___________ gaps in them.

If you have a wire full 5)___________ copper atoms and want to induce a flow of electrons through it, all free electrons need somewhere to flow in the same general 6) ___________. Copper is a great conductor, perfect for making charges flow. If a circuit of copper wire is broken, the charges cannot flow through the air, which will also prevent any of the charges toward the middle from going anywhere.

On the other hand, if the wire were 7)___________ end-to-end, the electrons all have a neighboring atom and can all flow in the same general direction.

A circuit has conductors (wire), switch, load and a power source. A circuit starts and stops at the same point. Usually copper wires are used as conductors without insulation. It is through the conductor the current flows. A switch is used to 8) ___________ or close the circuit. When the switch is closed current flows through the circuit and when the switch is open, it breaks the circuit and no current flows 9)___________ it. The load which is also known as Resistor uses the electrical energy and 10)___________ it into some other form of energy. It can be a light bulb or anything else. If there is no load in the circuit, then it will be a short circuit. A cell can be the power source. If we put more than one cell it becomes a battery.

There are mainly two types of circuits, series and 11)___________. In series circuit electrons travel only in one path. In parallel circuit electrons travel through many 12) ___________ in it. Both series and parallel circuits consists of more than one load.

Retrieved from:
https://learn.sparkfun.com/tutorials/what-is-electricity/static-or-current-electricity

APPENDIX 1
Basic Definitions and Conventions

AC — Alternating current. Consists of a periodic oscillation between two different voltages. Usually said to look like a sine wave, but is not always.

Ampere (A) — The SI unit for the electrical current. An Ampere of current flow represents electron movement at a rate of one coulomb per second: that amount of current through one ohm of resistance with one volt applied.

Amplify — To increase the strength of the signal.

Anode — An electron collector. An anode has a more positive voltage relative to a cathode.

Attenuate — Decrease the strength of a signal.

Capacitor — An electronics component that stores energy in the form of electric charge (static electricity). It resists a sudden change in voltage.

Cathode — An electron emitter. A cathode has a more negative voltage relative to an anode.

Charge — Particles can have two possible types of charge: positive or negative. Electrons are negatively charged, protons are positively charged. Opposite charges attract, while particles with the same charge (either positive or negative) repel each other.

Choke — Another name for an inductor, specifically referring to those used in power regulation.

Circuit — The paths electrons take as they are pushed by some power source, flow through various electrical components then return to the power source.

Short Circuit exist, when there is no resistance between two points. Current flows without a change in voltage.

Open Circuit exist when there is infinite resistance between two points. Current is unable to flow, but there is still a voltage between the two points.

Coil A helix of wire. Its height, width, thickness, and material can all vary. Often used as an inductor.

Condenser Another name for capacitor.

Conductance The inverse of resistance. Measured in siemens (obsolete name mhos), which are the inverse of ohms. 1 S = 1/Ω = 1 A/V

Conductor A material that has many free electrons.

Coulomb (C) The SI unit for electric charge Q. Defined in terms of the ampere. 1 coulomb is the amount of electric charge carried by a current of 1 ampere flowing for 1 second. It is also about 6.24×1018 times the charge on an electron. 1 C = 1 A·s

Current The movement of charges in an electric field. This is perceived as a flow. It is measured in amperes.

DC Direct current. A constant voltage and a constant current flow in one direction.

Diode A one way valve for current. Semiconductor diodes typically have a voltage drop of 0.6 V (silicon) or 0.2V (germanium) when conducting in the forward direction.

Electron: The negatively charged particle in an atom orbiting the atom's nucleus.

EMF (E) A force for moving electrons. See Voltage.

Electro-Motive Force

Farad (F) The SI unit for capacitance (C). A capacitor has a capacitance of 1 The SI unit for capacitance (C). A capacitor has a capacitance of 1 Farad when a charge of 1 Coulomb raises its potential 1 Volt.

Frequency (f) Number of times a periodic waveform repeats itself in a unit time (generally seconds). Units of measurement are Hertz.

Gain A multiplier of voltage or current.

Ground Ground is defined as the point in the circuit which is at zero voltage. Voltage is relative, and is the same throughout a conductor, so any point in the circuit can be defined as ground, and all other voltages are referenced to it. Usually it is defined as the most negative point in the circuit, for convenience. Sometimes it is defined in the middle of two bi-polar rails, for "balanced" circuits. In many cases this circuit point is connected to the Earth (Ground) by a conductor.

Henry (H) The SI unit for inductance. A coil has 1 Henry of inductance if an emf of 1 Volt is induced when current through the inductor is changing at a rate of 1 Ampere per second.

Hertz (Hz) The SI unit for frequency. One Hz is one cycle per second.

Impedance A more generalized form of resistance. The impedance of a device varies with the frequency of the electricity applied. A perfect resistor will have a constant impedance for all frequencies. Capacitors and inductors have varying impedances at different frequencies. Measured in ohms or **Ω**.

Inductor An inductor is a device that stores energy in a magnetic field. It opposes a sudden change in the flow of current. Units of measurement are Henrys.

Length (l) A measure of distance usually in meters (m).

Load Resistance connected across a circuit that determines power used.

Meter (m) The SI unit for distance. The distance light travels in 1/299,792,458 second.

Ohm (Ω) The basic unit of resistance or impedance: the amount of electrical resistance limiting the current to one ampere with one volt applied.

Op-amp Short for operational amplifier. An op-amp amplifies the voltage between its two inputs.

Parallel Used to describe two or more circuits or circuit elements so connected that the total current flow is divided between them.

PCB Printed circuit board. This is a piece of plastic or fiberglass with copper attached. The copper is typically chemically etched away to leave "traces" for the electricity to be conducted through. Other electrical components are soldered to the traces.

Period The time between cycles of a periodic wave.

Power Voltage times current. The amount of work being done by a circuit.

Rectify Convert AC current to DC current.

Reactance Opposition to ac as a result of inductance or capacitance.

Resistance Properties of a circuit that impede the flow of electrons. Resistance converts electrical energy into photons that are given off as waste heat. Resistance is measured in ohms.

Reversed Biased The inverted voltage polarity on a part.

Root-Mean Squared (RMS) The effective DC value for an AC value.

Second (s) The SI unit for time.

Series Circuit: A circuit that contains only one possible path for electron flow supplied by a common voltage source.

Time (t) The symbol for time in seconds (s).

Transistor A device in which the resistance of the channel is controlled by a current or voltage at the base or gate. Can be thought of as an electronic-controlled resistor.

Volt (V) A potential due to an electric field. One volt is defined as the potential difference across a resistor that is passing one ampere and dissipating one watt. 1 V = 1 W/A

Voltage (V) An electric field between two charges. Similar to gravity this acts as an electric potential. Measured in volts.

Watt (W) A measure of power (P). A watt is a joule (1 J) of work done in a second (1 s). 1 W = 1 J/s

Wavelength (λ) The length in space occupied by one cycle of a periodic wave.

Zener Diode A pn junction diode that makes use of the breakdown properties of a pn junction. The diode is designed to conduct in the reverse direction when its value of breakdown voltage is reached. Beyond this point, the diode will maintain a relatively constant voltage despite variations in current. Widely used for voltage regulation in electronic products.

Retrieved from: http://www.clemson.edu/cecas/departments/ece/document_resource/undergrad/electronics/CInquiryLabManual.pdf

APPENDIX 2

Electrical Potential - Ohm's Law

$U = R\ I$

$U = P / I$

$U = (P\ R)1/2$

Electric Current - Ohm's Law

$I = U / R$

$I = P / U$

$I = (P / R)1/2$

Electric Resistance - Ohm's Law

$R = U / I$

$R = U2/ P$

$R = P / I2$

Electric Power

$P = U\ I$

$P = R\ I2$

$P = U2/ R$

where P = power (watts, W, J/s)

U = voltage (volts, V)

I = current (amperes, A)

R = resistance (ohms, Ω)

Electric Energy

$W = P\ t$

where W = energy (Ws, J)

t = time (s)

Alternative - power

$P = W / t$

Electrical Motors

Electrical Motor Efficiency

μ = 746 Php / Pinput_w

where μ = efficiency

Php = output horsepower (hp)

Pinput_w = input electrical power (watts)

or alternatively

μ = 746 Php / (1.732 V I PF)

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Виробничо-практичне видання

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до організації самостійної роботи
з навчальної дисципліни

«ІНОЗЕМНА МОВА» (АНГЛІЙСЬКА МОВА)

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