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**до практичних занять з англійської мови
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UNIT 1. ELECTRICAL FUSE

Text A

Fuse

Before reading the text

Task 1. T**ranslate these phrases.**

electrical engineering; overcurrent protection device; overload protection; properly-selected fuses; overcurrent device ampere rating.

Task 2. Try to answer the following questions.

1. What kind of devices is commonly used to protect the circuit from overcurrents?
2. How does it operate?

Task 3. Read the text, translate it and check your answers.

In electronics and electrical engineering a fuse, short for 'fusible link', is a type of overcurrent protection device (OCPD). It has as its critical component a metal wire or strip that will melt when heated by a prescribed electric current, opening the circuit of which it is a part, and so protecting the circuit from an overcurrent condition.

A practical fuse was one of the essential features of Edison's electrical power distribution system. An early fuse was said to have successfully protected an Edison installation from tampering by a rival gas-lighting concern.

Properly-selected fuses (or other overcurrent devices) are an essential part of a power distribution system to prevent fire or damage due to overload or short-circuits. Usually the maximum size of the overcurrent device for a circuit is regulated by law. For example, the Canadian Electrical Code, the United States National Electrical Code(NFPA 70), and the UK Wiring Regulations provide limits for overcurrent device ampere

rating for a given conductor, insulation material and installation conditions. Local authorities will incorporate these national codes as part of law. An overcurrent device should normally be selected with a rating just over the normal operating current of the downstream wiring or equipment which it is to protect.

Vocabulary

fusible link – плавка вставка
melt – плавитись
open – розмикати
close – замикати
overload – перенавантаження
electrical code – електротехнічні стандарти
wiring regulations – стандарти по з'єднанням
ampere rating – номінальний струм
installation – установка

Task 4. Answer these questions about the text.

1. What is a fuse?
2. What critical component has a fuse?
3. In which way does a fuse protect the circuit from an overcurrent condition?
4. What does a fuse prevent?
5. How should an overcurrent device be normally selected?

Text B

Fuse characteristics

Before reading the text

Task 1. Match each phrase with the appropriate meaning:

A

1. fast-blow fuse	a) плавкий запобіжник з витримкою часу
2. slow-blow fuse	b) плавкий запобіжник надшвидкої дії
3. time-delay fuse	c) плавкий запобіжник швидкої дії
4. ultrafast fuse	d) виштовхувальний запобіжник
5. expulsion fuse	e) плавкий запобіжник повільної дії

B

1. time-current characteristic	a) обмежуючий струм
2. semiconductor device	b) уявна потужність
3. starting current	c) характеристика залежності струму від часу
4. current-limiting	d) пусковий струм
5. apparent power	e) напівпровідниковий прилад

Task 2. Find synonym to each word or phrase in the list given below.

1. breaker
2. breaking capacity
3. rated current
4. rated voltage
5. rated interrupting capacity
6. extinguish
7. self-resetting

quench	self-repairing
voltage rating	rupturing capacity

circuit breaker	interrupting rating
current rating	

Task 3. Translate these phrases from the text.

main and branch circuit overcurrent devices; maximum clearing; minimum melting; maximum prospective short circuit current; transient overcurrent condition.

Task 4. Try to answer what ratings and characteristics are usually taken into account when buying a fuse.

Task 5. Read the text, translate it and check your answer.

Each type of fuse (and all other overcurrent devices) has a time-current characteristic which shows the time required to melt the fuse and the time required to clear the circuit for any given level of overload current. Where the fuses in a system are of similar types, simple ratios between ratings of the fuse closest to the load and the next fuse towards the source can be used, so that only the affected circuit is interrupted after a fault. In power system design, main and branch circuit overcurrent devices can be coordinated for best protection by plotting the time-current characteristics on a consistent scale, making sure that the source curve never crosses that of any of the branch circuits. To prevent damage to utilization devices, both "maximum clearing" and "minimum melting" fuse curves are plotted.

Fuses are often characterized as "fast-blow" or "slow-blow" | "time-delay", according to the time they take to respond to an overcurrent condition. Fast-blow fuses (sometimes marked 'F') open quickly when the rated current is reached. Ultrafast fuses (marked 'FF') are used to protect semiconductor devices that can tolerate only very short-lived overcurrents. Slow-blow fuses (US household plug types are often marked 'T') can tolerate a transient overcurrent condition (such as the high starting current of an electric motor), but will open if the overcurrent condition is sustained.

A fuse also has a rated interrupting capacity, also called breaking capacity, which is the maximum current the fuse can safely interrupt. Generally this should be higher than the maximum prospective short circuit current though it may be lower if another fuse or breaker upstream can be

relied upon to take out extremely high current shorts. Miniature fuses may have an interrupting rating only 10 times their rated current. Fuses for low-voltage power systems are commonly rated to interrupt 10,000 amperes, which is a minimum capacity regulated by the electrical code in some jurisdictions. Fuses for larger power systems must have higher interrupting ratings, with some low-voltage current-limiting "high rupturing capacity" (HRC) fuses rated for 300,000 amperes. Fuses for high-voltage equipment, up to 115,000 volts, are rated by the total apparent power (megavoltamperes, MVA) of the fault level on the circuit.

As well as a current rating, fuses also carry a voltage rating indicating the maximum circuit voltage in which the fuse can be used. For example, glass tube fuses rated 32 volts should never be used in line-operated (mains-operated) equipment even if the fuse physically can fit the fuseholder. Fuses with ceramic cases have higher voltage ratings. Fuses carrying a 250V rating can be safely used in a 125V circuit, but the reverse is not true as the fuse may not be capable of safely interrupting the arc in a circuit of a higher voltage.

Fuse markings will generally convey the following information:

- ampere rating of the fuse;
- voltage rating of the fuse;
- time-current characteristic i.e. element speed;
- approvals;
- manufacturer / Part Number / Series;
- breaking capacity.

Vocabulary

clear – ліквідувати коротке замикання
affected – уражений, пошкоджений
interrupt – переривати, роз'єднувати
fault – ушкодження, коротке замикання, пробій
plot – побудова кривих
curve – крива, характеристика
blow – згорати, перегорати, плавитися
respond – реагувати, спрацьовувати
tolerate – витримувати
plug – вилка, штирковий контакт, вилочний контакт

transient – перехідний, короткочасний, нестійкий
breaker – автоматичний вимикач, переривач, роз'єднувач
fuse holder – патрон
arc – дуга
marking – маркірування
branch circuit – паралельне коло

Task 6. Answer these questions about the text.

1. What characteristic has each type of a fuse?
2. What does a time-current characteristic show?
3. How are fuses often characterized?
4. What is a rated interrupting capacity, or breaking capacity?
5. What information do the fuse markings generally convey?

Task 7. Work in pairs. Ask your partner to tell about the fast-blow, slow-blow, time-delay and ultrafast fuses.

Text C

Types of fuse

Before reading the text

Task 1. Translate these phrases.

modern current-limiting fuses; gas-evolving substances; special high rupturing capacity fuse; high voltage expulsion fuses.

Task 2. Try to recollect what types of fuses you know and where they are used.

Task 3. Read the text, translate it and check your answer.

Power circuit fuses. Fuses for power circuits are available in a wide range of ratings. Critical values in the specification of fuses are the normal rated current, the circuit voltage, and the maximum level of current available on a short-circuit. For example, in North America, some fuses have breaking capacities of 10,000 amperes, while other more modern current-limiting fuses have breaking capacities of 200,000 amperes. If this breaking capacity is exceeded by the system's available fault current, the fuse housing could break during interruption, causing a catastrophic failure inside the cabinet containing the fuse.

Fuses are used on power systems up to 115,000 volts AC. High-voltage fuses are used to protect instrument transformers used for electricity metering or for small power transformers where the expense of a circuit breaker is not warranted. For example, in distribution systems, a power fuse may be used to protect a transformer serving 1-3 houses. A circuit breaker at 115 kV may cost up to five times as much as a set of power fuses, so the resulting saving can be tens of thousands of dollars.

Large power fuses use fusible elements made of silver, copper or tin to provide stable and predictable performance. High voltage expulsion fuses surround the fusible link with gas-evolving substances, such as boric acid. When the fuse blows, heat from the arc causes the boric acid to evolve large volumes of gases. The associated high pressure (often greater than 100 atmospheres) and cooling gases rapidly extinguish (quench) the resulting arc. The hot gases are then explosively expelled out of the end(s) of the fuse. Other special High Rupturing Capacity (HRC) fuses surround one or more parallel connected fusible links with an energy absorbing material, typically silicon dioxide sand. When the fusible link blows, the sand absorbs energy from the arc, rapidly quenching it, creating an artificial fulgurite in the process.

Other types of fuse. So-called "self-resetting" fuses use a thermoplastic conductive element known as a Polymeric Positive Temperature Coefficient (or PPTC) thermistor that impedes the circuit during an overcurrent condition (through increasing the device resistance). The PPTC thermistor is self-resetting in that when the overcurrent condition is removed, the device will revert back to low resistance, allowing the circuit to operate normally again. These devices are often used in aerospace/nuclear applications where replacement is difficult. A well-

known example is the polyswitch self-repairing/resetting fuse, but there are many others.

Vocabulary

exceed – перевищувати
failure – ушкодження, відказ, неспрацьовування
performance – характеристика, робота
evolve – виділяти
pressure – тиск
explosive – вибуховий
absorb – поглинати
expel – витісняти
fulgurite – фульгурит
thermistor – термістор, терморезистор
impede – перешкоджати
remove – усувати.

Task 4. Answer these questions about the text.

1. What values in the specification of fuses for power circuits are critical?
2. Where are high-voltage fuses used?
3. What are fusible elements of large power fuses made of?
4. What surrounds the fusible link in high voltage expulsion fuses?
5. What does a self-resetting fuse use?
6. Where are the PPTC thermistors often used?

Task 5. Work in pairs. Ask your partner and let him tell about the operation of high voltage expulsion fuses.

Task 6. Find the modal verbs in the sentences. Translate these sentences.

1. An over current device should normally be selected with a rating just over the normal operating current of the down – stream wiring or equipment witch it is to protect.

2. Glass tube fuses rated at 32 volts should never be used in mains – operated equipment even if the fuse physically can fit the fuse holder.
3. The fuse may not be capable of safely interrupting the arc in a circuit of a higher voltage.
4. The fuse housing could break during interruption causing a failure inside the cabinet containing the fuse.

UNIT 2. ELECTRICAL SWITCH

Text A

A simple electrical switch

Before reading the text

Task 1. Match each word and phrase in the list on the left with the appropriate meaning on the right.

1. change over switch	a) тумблер
2. push-button switch	b) однопозиційний перемикач
3. knife switch	c) вимикач (балансир)
4. toggle (dolly) switch	d) багатопозиційний перемикач
5. rocker	e) рубильник
6. single-throw switch	f) перемикач (полюсів)
7. multi-throw switch	g) кнопковий вимикач

Task 2. Try to answer the following questions.

1. What is an electrical switch used for?
2. What types of switches do you know?

Task 3. Read the text, translate it and check your answers.

Contacts. In the simplest case, a switch has two pieces of metal called contacts that touch to make a circuit, and separate to break the circuit. The contact material is chosen for its resistance to corrosion, because most metals form insulating oxides that would prevent the switch from working. Contact materials are also chosen on the basis of electrical conductivity, hardness (resistance to abrasive wear), mechanical strength, low cost and low toxicity.

Sometimes the contacts are plated with noble metals. They may be designed to wipe against each other to clean off any contamination. Nonmetallic conductors, such as conductive plastic, are sometimes used.

Actuator. The moving part that applies the operating force to the contacts is called the actuator, and may be a toggle or dolly, a rocker, a push-button or any type of mechanical linkage.

Figure 2.1 - Triple Pole Single Throw (TPST or 3PST) knife switch used to short the windings of a 3 phase wind turbine for braking purposes. Here the switch is shown in the open position

Contact arrangements. A pair of contacts is said to be 'closed' when there is no space between them, allowing electricity to flow from one to the other. When the contacts are separated by a space, they are said to be 'open', and no electricity can flow.

Switches can be classified according to the arrangement of their contacts. Some contacts are normally open until closed by operation of the switch, while others are normally closed and opened by the switch action. A switch with both types of contact is called a changeover switch.

The terms pole and throw are used to describe switch contacts. A pole is a set of contacts that belong to a single circuit. A throw is one of two or more positions that the switch can adopt. These terms give rise to abbreviations for the types of switch which are used in the electronics industry:

- **SPST** - Single pole, single throw;
- **SPDT** - Single pole, double throw;
- **SPCO** - Single pole changeover or Single pole, centre off;

- **DPST** - Double pole, single throw;
- **DPDT** - Double pole, double throw;
- **DPCO** - Double pole changeover or Double pole, centre off.

Make-before-break, break-before-make. In a multi-throw switch, there are two possible transient behaviors as you move from one position to another. In some switch designs, the new contact is made before the old contact is broken. This is known as make-before-break, and ensures that the moving contact never sees an open circuit. The alternative is break-before-make, where the old contact is broken before the new one is made. This ensures that the two fixed contacts are never shorted to each other. Both types of design are in common use, for different applications.

Vocabulary

switch – вимикач, перемикач, комутаційний апарат
contact – контакт
corrosion – корозія
abrasive wear – абразивний знос
mechanical strength – механічна міцність
plate – металізувати, покривати гальванічним способом
contamination – забруднення
actuator – привод, пусковий механізм, пускач
linkage – з'єднання
triple pole – триполюсний
throw – положення, позиція
make-before-break – перекриваючий контакт, замикання до розмикання, установлення нового контакту до розриву старого;
break-before-make – неперекриваючий контакт, розмикання до замикання, розрив старого контакту до установлення нового

Task 4. Answer these questions about the text.

1. What does a simplest switch have?
2. What do the contacts do?

3. What must be taken into account when choosing contact materials?
4. What is an actuator?
5. When a pair of contacts is said to be “closed” (“open”)?
6. How can switches be classified?
7. What kind of switch is called a changeover switch?

Task 5. Work in pairs. Ask your partner to answer these questions.

1. What is a pole?
2. What is a throw?
3. What does “make-before-break” mean?
4. What does “break-before-make” mean?

Text B

Types of switch

Before reading the text

Task 1. Match each phrase in the left column with the appropriate meaning in the right column.

1.	biased switch	a)	перемикач з установленням контакту при натисканні кнопки
2.	push-to-make switch	b)	перемикач миттєвої дії
3.	push-to-break switch	c)	перемикач із зміщенням пускового механізму
4.	parasitic inductance	d)	аналоговий ланцюг
5.	parasitic capacitance	e)	логічний ланцюг
6.	analogue circuit	f)	паразитна індуктивність
7.	logic circuit	g)	паразитна ємність
8.	momentary switch	h)	перемикач з розривом контакту при натисканні кнопки

Task 2. Translate these phrases from the text.

insulating oxides; triple pole single throw knife switch; momentary push-button switch; damped sinusoidal oscillations; released contact; changeover push-button switch.

Task 3. Try to explain the operation of the most commonly used switch.

Task 4. Read the text, translate it and check your answer.

Biased switches. A biased switch is one containing a spring that returns the actuator to a certain position. The "on-off" notation can be modified by placing parentheses around all positions other than the resting position. For example, an (on)-off-(on) switch can be switched on by moving the actuator in either direction away from the centre, but returns to the central off position when the actuator is released.

The momentary push-button switch is a type of biased switch. The most common type is a push-to-make switch, which makes contact when the button is pressed and breaks when the button is released. A push-to-break switch, on the other hand, breaks contact when the button is pressed and makes contact when it is released. An example of a push-to-break switch is a button used to release a door held open by an electromagnet. Changeover push button switches do exist but are even less common.

Power switching. When a switch is designed to switch significant power the transitional state of the switch as well as the ability to stand continuous operating currents must be considered. When a switch is on its resistance is near zero and very little power is dropped in the contacts, when a switch is in the off state its resistance is extremely high and even less power is dropped in the contacts. However when the switch is flicked the resistance must pass through a state where briefly a quarter (or worse if the load is not purely resistive) of the loads rated power is dropped in the switch.

For this reason most power switches (most light switches and almost all larger switches) have spring mechanisms in them to make sure the transition between on and off is as short as possible regardless of the speed at which the user moves the rocker.

Contact bounce. Contact bounce (also called chatter) is a common problem with mechanical switches and relays. Switch and relay contacts are usually made of springy metals that are forced into contact by an actuator. When the contacts strike together, their momentum and elasticity act together to cause bounce. The result is a rapidly pulsed electrical current instead of a clean transition from zero to full current. The waveform is then further modified by the parasitic inductances and capacitances in the switch and wiring, resulting in a series of damped sinusoidal oscillations. This effect is usually unnoticeable in AC mains circuits, where the bounce happens too quickly to affect most equipment, but causes problems in some analogue and logic circuits that are not designed to cope with oscillating voltages.

Changeover switch. A changeover switch provides two distinct events, the making of one contact and the breaking of the other. These can be used to feed the inputs of a flip flop. This way the press will only be detected when the pressed contact is made and the release will only be detected when the released contact is made. When the switch is bouncing around in the middle no change is detected. To get a single logic signal from such a setup a simple RS flip flop can be used.

Variable resistance. Normal switches are designed to give a hard on-off but it is also possible to design one that varies more gradually between the hard-on and hard-off states. This keeps the output changes caused by bouncing. Then by feeding the output to a Schmitt trigger the effect of those bounce based changes can be eliminated.

Vocabulary

biased switch – перемикач із зміщенням пускового механізму
resting position – стан спокою
release – відпускати, розмикати, звільняти, роз'єднувати
momentary – миттєвої дії
flipflop – тригер
RS flipflop – RS тригер (з окремими входами R та S)
bounce – відскакувати
flick – різко вимикати
chatter – вібрація, дрижання
damped – затухаючий
oscillation – коливання
hard-on (-off) state – стійке (жорстке) положення "ввімкнуто", "вимикнуто"
Schmitt trigger – тригер Шміта

Task 5. Answer these questions about the text.

1. What is a biased switch?
2. What is the most common type of a biased switch?
3. What does a push-to-make switch do?
4. What does a push-to-break switch do?
5. What must be considered when a switch is designed to switch a significant power?
6. Why do most power switches have spring mechanisms?
7. What is a contact bounce?
8. What causes bounce of contacts?

Task 6. Work in pairs.

1. **Ask your partner to tell about the problems caused by a contact bounce (chatter) in mechanical switches.**

2. Let your partner answer the following questions.

1. What does a changeover switch provide?
2. What can the making of one contact and the breaking of the other be used for?
3. Is it possible to design a switch that varies gradually between the hard-on and hard-off states?

UNIT 3. RELAY

Text A

Relay

Before reading the text

Task 1. Match these phrases with the appropriate meaning.

1. solid-state relay	a) екрануюче кільце
2. shading ring	b) світлодіод
3. light-emitting diode	c) фототранзистор
4. relaxed position	d) напівпровідникове реле
5. phototransistor	e) вільне положення

Task 2. Translate these phrases from the text.

solid-state switching device; resulting magnetic field; mechanically linked armature; industrial motor starters.

Task 3. Find synonym to each word or phrase in the list given below.

1. enable
2. energize
3. de-energize
4. resetting
5. trip breaker
6. package

enclosure	deactivate
trip circuit breaker	actuate
operate	recovery

Task 4. Try to answer the following questions.

1. What does a relay do in an electrical circuit?
2. Is there any difference between a relay and an electrical switch?

Task 5. Read the text, translate it and check your answers.

A relay is an electrical switch that opens and closes under the control of another electrical circuit. In the original form, the switch is operated by an electromagnet to open or close one or many sets of contacts. It was invented by Joseph Henry in 1835. Because a relay is able to control an output circuit of higher power than the input circuit, it can be considered, in a broad sense, to be a form of an electrical amplifier.

Operation. When a current flows through the coil, the resulting magnetic field attracts an armature that is mechanically linked to a moving contact. The movement either makes or breaks a connection with a fixed contact. When the current to the coil is switched off, the armature is returned by a force approximately half as strong as the magnetic force to its relaxed position. Usually this is a spring, but gravity is also used commonly in industrial motor starters. Most relays are manufactured to operate quickly. In a low voltage application, this is to reduce noise. In a high voltage or high current application, this is to reduce arcing

If the coil is energized with DC, a diode is frequently installed across the coil, to dissipate the energy from the collapsing magnetic field at deactivation, which would otherwise generate a spike of voltage and might cause damage to circuit components. If the coil is designed to be energized with AC, a small copper ring can be crimped to the end of the solenoid. This "shading ring" creates a small out-of-phase current, which increases the minimum pull on the armature during the AC cycle.

By analogy with the functions of the original electromagnetic device, a solid-state relay is made with a thyristor or other solid-state switching device. To achieve electrical isolation, a light-emitting diode (LED) is used with a photo transistor.

Vocabulary

gravity – тяжіння, сила тяжіння
spike – пік, сплеск, викид
crimp – кріпити без пайки
thyristor – тиристор

Task 6. Answer these questions about the text.

1. What is a relay?
2. What does the resulting magnetic field do when current flows through the coil?
3. When is the armature returned to its relaxed position?
4. How is the armature returned to its relaxed position in industrial motor starters?
5. What is the diode installed for across the coil if it is energized with AC?
6. What does a shading ring creates when a coil is energized with AC?
7. What is a solid-state relay made with?
8. What is used to achieve electrical isolation in solid-state relay?

Text B

Types of relay

Part 1

Before reading the text

Task 1. Find the meaning of these phrases in the list given below.

1. latching relay (keep relay)
2. cam mechanism
3. transfer machine
4. sequence control
5. control panel
6. programmable logic controller
7. pulse controller
8. contactor relay
9. heavy-duty

реле-контактор
реле з механічним блокуванням
програмований логічний контролер
пульт управління
з важким режимом роботи (потужний)
імпульсний контролер
послідовне управління
кулачковий механізм
передавальний механізм

Task 2. Translate these phrases from the text.

machine tool relay; very heavy-duty relay; overload protection device; overload sensing device; heat operated relay; be-metal strip.

Task 3. Try to answer if you know any type of relay and where it is used.

Task 4. Read the text, translate it and check your answer.

Latching relay. A latching relay has two relaxed states (bistable). These are also called 'keep' relays. When the current is switched off, the relay remains in its last state. This is achieved with a solenoid operating a ratchet and cam mechanism, or by having two opposing coils with an over-center spring or permanent magnet to hold the armature and contacts in position while the coil is relaxed, or with a remnant core. In the ratchet and cam example, the first pulse to the coil turns the relay on and the second pulse turns it off. In the two coil example, a pulse to one coil turns the relay on and a pulse to the opposite coil turns the relay off. This type of relay has the advantage that it consumes power only for an instant, while it is being switched, and it retains its last setting across a power outage

Machine tool relay. A machine tool relay is a type standardized for industrial control of machine tools, transfer machines, and other sequential control. They are characterized by a large number of contacts (sometimes extendable in the field) which are easily converted from normally-open to normally-closed status, easily replaceable coils, and a form factor that allows compactly installing many relays in a control panel. Although such relays once were the backbone of automation in such industries as automobile assembly, the programmable logic controller mostly displaced the machine tool relay from sequential control applications

Contactor relay. A contactor is a very heavy-duty relay used for switching electric motors and lighting loads. With high current, the contacts are made with pure silver. The unavoidable arcing causes the contacts to oxidize and silver oxide is still a good conductor. Such devices are often used for motor starters. A motor starter is a contactor with an overload protection devices attached. The overload sensing devices are a form of heat operated relay where a coil heats a bi-metal strip, or where a solder pot melts, releasing a spring to operate auxiliary contacts. These auxiliary contacts are in series with the coil. If the overload senses excess current in the load, the coil is de-energized. Contactor relays can be extremely loud to operate, making them unfit for use where noise is a chief concern.

Vocabulary

latch – затвор
bistable – бістабільний, з двома стабільними станами (положеннями)

ratchet – храповий механізм
outage – виключення, відсутність енергії
consume – споживати
control – управляти, регулювати
replaceable – змінний
contactor – контактор
sense – відчувати, реагувати
solder – припій
auxiliary – допоміжний

Task 5. Answer these questions about the text.

1. How many relaxed states has a latching relay?
2. What state does the relay remain in when the current is switched off?
3. How is this achieved that the relay remains in its last state when the current is switched off?
4. What advantage has this type of relay?
5. What is a machine tool relay used for?
6. What displaced the machine tool relay from sequential control applications?

Task 6. Work in pairs. Ask your partner to answer the following questions:

1. What is a contactor relay used for?
2. Why are the contacts of this type of relay made with pure silver?
3. What does a motor starter consist of?
4. How does the overload sensing device operate?

Text C

Types of relay

Part 2

Before reading the text

Task 1. Match each phrase on the left with the appropriate meaning on the right.

A

1. forced-guided contacts	a) підлеглі контакти
2. positive-guided contacts	b) зчеплені (з'єднані) контакти
	c) контакти примусової дії
3. captive contacts	d) контакти позитивної примусової дії
4. locked contacts	

B

1. transistor-transistor logic	a) масляний трансформатор
2. heatsink	b) блокуюче реле, захисне реле
3. oil-filled transformer	c) транзисторно-транзисторна логіка
4. shutdown	d) охолоджувач, радіатор
5. safety relay	e) вимикати, зупиняти

Task 2. Translate these phrases from the text.

solid state contactor relay; very heavy-duty solid state relay; microprocessor controls; forced-guided contacts relay; mechanically linked together; long-term reliability; collective voltage drop.

Task 3. Try to explain what a term "solid state" means. Give some examples of solid state devices.

Task 4. Read the text, translate it and check your answer.

Solid state contactor relay. A solid state contactor is a very heavy-duty solid state relay, including the necessary heat sink, used for switching electric heaters, small electric motors and lighting loads; where frequent on/off cycles are required. There are no moving parts to wear out and there is no contact bounce due to vibration. They are activated by AC control signals or DC control signals from Programmable logic controller (PLCs), PCs, Transistor-transistor logic (TTL) sources, or other microprocessor controls.

Buchholz relay. A Buchholz relay is a safety device sensing the accumulation of gas in large oil-filled transformers, which will alarm on slow accumulation of gas or shut down the transformer if gas is produced rapidly in the transformer oil.

Forced-guided contacts relay. A forced-guided contacts relay has relay contacts that are mechanically linked together, so that when the relay coil is energized or de-energized, all of the linked contacts move together. If one set of contacts in the relay becomes immobilized, no other contact of the same relay will be able to move. The function of forced-guided contacts is to enable the safety circuit to check the status of the relay. Forced-guided contacts are also known as "positive-guided contacts", "captive contacts", "locked contacts", or "safety relays".

Solid-state relay. A solid state relay (SSR) is a solid state electronic component that provides a similar function to an electromechanical relay but does not have any moving components, increasing long-term reliability. With early SSRs, the tradeoff came from the fact that every transistor has a small voltage drop across it. This collective voltage drop limited the amount of current a given SSR could handle. As transistors improved, higher current SSRs, able to handle 100 to 1,200 amps, have become commercially available.

Vocabulary

controls – засоби управління
alarm – сигналити
enable – дозволяти, вмикати

Task 5. Answer these questions about the text.

1. What is a solid-state contactor?
2. What does a solid-state contactor include?
3. What are solid state contactors used for?
4. How are they activated?
5. What is a Buchholz relay?
6. What has a force - guided contacts relay?
7. How does it operate?

Task 6. Work in pairs. Ask your partner to answer the following questions.

1. What is a function of forced-guided contacts?
2. How are forced-guided contacts known?
3. What function does a solid state relay provide?
4. What limits the amount of current a solid state relay can handle?

Text D

Types of relay

Part3

Task 1. Before reading the text try to explain how relays are classified according to the number of poles and throws.

Task 2. Read the text, translate it and check your answer.

Overload protection relay. One type of motor overload protection relay is operated by a heating element in series with the motor. The heat generated by the motor current operates a bi-metal strip or melts solder,

releasing a spring to operate contacts. Where the overload relay is exposed to the same environment as the motor, a useful though crude compensation for motor ambient temperature is provided.

Pole & Throw.

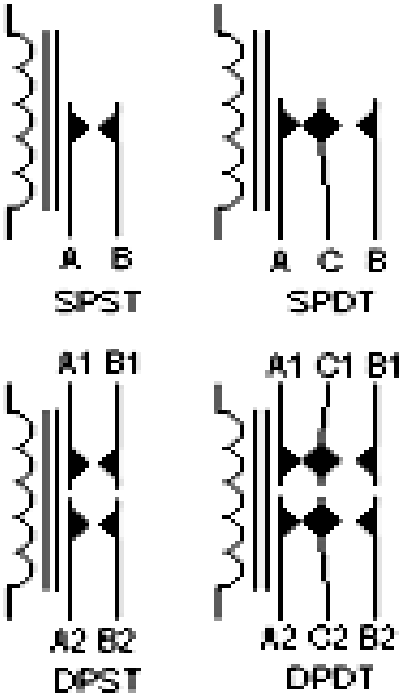

Figure 3.1- Circuit symbols of relays. "C" denotes the common terminal in SPDT and DPDT types

Since relays are switches, the terminology applied to switches is also applied to relays. According to this classification, relays can be of the following types

- SPST - Single Pole Single Throw. These have two terminals which can be switched on/off. In total, four terminals when the coil is also included.
- SPDT - Single Pole Double Throw. These have one row of three terminals. One terminal (common) switches between the other two poles. It

is the same as a single change-over switch. In total, five terminals when the coil is also included.

- DPST - Double Pole Single Throw. These have two pairs of terminals. Equivalent to two SPST switches or relays actuated by a single coil. In total, six terminals when the coil is also included. This configuration may also be referred to as DPNO.
- DPDT - Double Pole Double Throw. These have two rows of change-over terminals. Equivalent to two SPDT switches or relays actuated by a single coil. In total, eight terminals when the coil is also included.
- QPDT - Quadruple Pole Double Throw. Often referred to as Quad Pole Double Throw, or 4PDT. These have four rows of change-over terminals. Equivalent to four SPDT switches or relays actuated by a single coil or two DPDT relays. In total, fourteen terminals when the coil is also included. Voltage rating of contacts - typical control relays rated 300 VAC or 600 VAC, automotive types to 50 VDC, special high-voltage relays to about 15,000 V

The contacts can be either Normally Open (NO), Normally Closed (NC), or change-over (CO) contacts

- Normally-open contacts connect the circuit when the relay is activated , the circuit is disconnected when the relay is inactive. It is also called Form A contact or "make" contact. Form A contact is ideal for applications that require to switch a high-current power source from a remote device.
- Normally-closed contacts disconnect the circuit when the relay is activated; the circuit is connected when the relay is inactive. It is also called Form B contact or "break" contact. Form B contact is ideal for applications that require the circuit to remain closed until the relay is activated.
- Change-over contacts control two circuits: one normally-open contact and one normally-closed contact with a common terminal. It is also called Form C contact or "transfer" contact.

Vocabulary

normally-open contact – нормально розімкнутий (замикаючий) контакт

normally-closed contact – нормально замкнутий (розмикаючий) контакт

change-over (transfer) contact – перемикаючий (неперекриваючий) контакт

Task 3. Answer these questions about the text.

1. What types of relay do you know?
2. What kinds of contacts do you know?
3. What do normally-open contacts do when the relay is activated?
4. What do normally-closed contacts do when the relay is activated?
5. What function do change-over contacts perform?

Text E

Types of relay

Part 4

Before reading the text

Task 1. Translate these phrases.

solenoid-type operator; telephone-relay style contacts; timed overcurrent protective relay; microprocessor-based instrument; ANSI Device Numbers; ANSI Device Designation Number; specific current level.

Task 2. Try to explain what the term "microprocessor-based device" means.

Task 3. Read the text, translate it and check your answer.

Protective relay. A protective relay is a complex electromechanical apparatus, often with more than one coil, designed to calculate operating conditions on an electrical circuit and trip circuit breakers when a fault was found. Unlike switching type relays with fixed and usually ill-defined

operating voltage thresholds and operating times, protective relays had well-established, selectable, time/current (or other operating parameter) curves. Such relays were very elaborate, using arrays of induction disks, shaded-pole magnets, operating and restraint coils, solenoid-type operators, telephone-relay style contacts, and phase-shifting networks to allow the relay to respond to such conditions as over-current, over-voltage, reverse power flow, over- and under- frequency, and even distance relays that would trip for faults up to a certain distance away from a substation but not beyond that point. An important transmission line or generator unit would have had cubicles dedicated to protection, with a score of individual electromechanical devices. Each of the protective functions available on a given relay is denoted by standard ANSI Device Numbers For example, a relay including function 51 would be a timed overcurrent protective relay.

Design and theory of these protective devices is an important part of the education of an electrical engineer who specializes in power systems. Today these devices are nearly entirely replaced (in new designs) with microprocessor-based instruments (numerical relays) that emulate their electromechanical ancestors with great precision and convenience in application. By combining several functions in one case, numerical relays also save capital cost and maintenance cost over electromechanical relays. However, due to their very long life span, tens of thousands of these "silent sentinels" are still protecting transmission lines and electrical apparatus all over the world.

Overcurrent relay. An "Overcurrent Relay" is a type of protective relay. The ANSI Device Designation Number is 50 for an Instantaneous Overcurrent (IOC), 51 for a Time Overcurrent (TOC). In a typical application the overcurrent relay is used for overcurrent protection, connected to a current transformer and calibrated to operate at or above a specific current level. When the relay operates, one or more contacts will operate and energize a trip coil in a Circuit Breaker and trip (open) the Circuit Breaker.

Vocabulary

trip – розмикати, роз’єднувати, переривати
trip circuit breaker – вимикач
threshold – поріг, рівень, границя
operating voltage threshold – порогова робоча напруга

phase-shifting network – фазозсуваючий ланцюг, коло
shaded-pole magnet – магніт з екранованими полюсами
over-frequency – перевищена частота, максимальна частота
under-frequency – недостатня частота, мінімальна частота
microprocessor – мікропроцесор
numerical relay – цифрове реле

Task 4. Answer these questions about the text.

1. What a protective relay is designed for?
2. What is the difference between switching type relays and protective relays?
3. How are protective functions of a given relay denoted?
4. What kind of instruments replaced protective relays today?
5. What type is an over current relay?
6. What is a typical application of the over current relay?
7. How does it operate?

Text F

Applications

Before reading the text

Task 1. Match each word and phrase in the left column with the appropriate meaning in the right column.

1. time delay relay	a) паразитний магнітний зв'язок
2. panel mount	b) штепсельна панель
3. through- panel mount	c) реле часу
4. rail mount	d) безпечний
5. oil-splash resistant	e) вибухобезпечний
6. explosion proof	f) контрольна (сигнальна) лампа
7. touch-safe	g) наскрізний монтаж на панелі
8. pilot lamp	h) монтаж на рейках
9. plug board	i) монтаж на панелі
10. stray magnetic linkage	j) захищений від розбризкування масла

Task 2. Translate these phrases from the text. Look carefully at the compound nouns before you start.

special high-voltage relay; radioactive waste handling machinery; printed circuit board; typical control relay.

Task 3. Try to summarize the applications of relays and functions they perform.

Task 4. Read the text, translate it and check your answer.

Relays are used:

- to detect and isolate faults on transmission and distribution lines by opening and closing circuit breakers (protection relays)
- to perform logic functions. For example, the Boolean AND function is realized by connecting NO relay contacts in series, the OR

function by connecting NO contacts in parallel. The change-over or Form C contacts perform the XOR (exclusive or) function. Similar functions for NAND and NOR are accomplished using NC contacts. Due to the failure modes of a relay compared with a semiconductor, they are widely used in safety critical logic, such as the control panels of radioactive waste handling machinery;

- to perform time delay functions. Relays can be modified to delay opening or delay closing a set of contacts. A very short (a fraction of a second) delay would use a copper disk between the armature and moving blade assembly.

Relay application considerations. Selection of an appropriate relay for a particular application requires evaluation of many different factors:

- number and type of contacts - normally open, normally closed, changeover (double-throw):
- rating of contacts - small relays switch a few amperes, large contactors are rated for up to 3000 amperes, alternating or direct current;
- voltage rating of contacts - typical control relays rated 300 VAC or 600 VAC, automotive types to 50 VDC, special high-voltage relays to about 15,000 V;
- coil voltage - machine-tool relays usually 24 VAC or 120 VAC, relays for switchgear may have 125 V or 250 VDC coils, "sensitive" relays operate on a few milliamperes;
- package/enclosure - open, touch-safe, double-voltage for isolation between circuits, explosion proof, outdoor, oil-splash resistant;
- mounting - sockets, plug board, rail mount, panel mount, through-panel mount, enclosure for mounting on walls or equipment;
- switching time - where high speed is required;
- contact protection - suppress arcing in very inductive circuits;
- isolation between coil circuit and contacts;
- accessories such as timers, auxiliary contacts, pilot lamps, test buttons;
- stray magnetic linkage between coils of adjacent relays on a printed circuit board.

Vocabulary

detect – знаходити, виявляти
function – функція

logic function–логічна функція
logic functions: **AND** – і
NO – не
OR – або
XOR – що виключає або
NAND – і-не
NOR – або-не
delay – затримка
time delay – час затримки
outdoor – відкритого типу
mounting – монтаж
suppress – подавляти, гасити
accessories – допоміжні прилади
timer – таймер, регулятор витримки часу, реле часу
waste – відходи
handling machinery – вантажно-розвантажувальні пристрої

Task 5. Work in pairs. Ask your partner to answer these questions.

1. What functions do relays perform?
2. When selecting a relay for a particular application what factors are to be evaluated?

UNIT 4. CIRCUIT BREAKER

Text A

Circuit breaker

Before reading the text

Task 1. Find the meaning of these phrases in the list given below.

1. thermal breaker
2. thermomagnetic circuit breaker
3. distribution board
4. pilot device
5. arc divider
6. arc chute
7. blow-out coil
8. switchgear cabinet
9. switchboard
10. power switchboard

комутаційна панель
катушка для магнітного зривання дуги
розподільний щит
тепловий вимикач
розсіювач дуги
силовий розподільний щит
іскрогасильна камера
магнітно-тепловий вимикач
сигнальний пристрій
шкаф з комутаційною апаратурою

Task 2. Translate these phrases from the text. Look carefully at the compound nouns before you start.

hydraulic time delay feature; motor control circuits; longer-term overcurrent conditions; maximum prospective short circuit current; breaker interrupting capacity rating; gas-insulated switchgear line-up.

Task 3. Try to answer the following questions.

1. What kind of instruments a circuit breaker is related to?
2. Where are circuit breakers used?

Task 4. Read the text, translate it and check your answers.

A circuit breaker is an automatically-operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit. Unlike a fuse, which operates once and then has to be replaced, a circuit breaker can be reset (either manually or automatically) to resume normal operation. Circuit breakers are made in varying sizes, from small devices that protect an individual household appliance up to large switchgear designed to protect high voltage circuits feeding an entire city.

Operation. *Magnetic circuit breakers* are implemented using a solenoid (electromagnet) which pulling force increases with the current. The circuit breaker contacts are held closed by a latch and, as the current in the solenoid increases beyond the rating of the circuit breaker, the solenoid pull releases the latch which then allows the contacts to open by spring action. Some types of magnetic breakers incorporate a hydraulic time delay feature wherein the solenoid core is located in a tube containing a viscous fluid. The core is restrained by a spring until the current exceeds the breaker rating. During an overload, the solenoid pulls the core through the fluid to close the magnetic circuit, which then provides sufficient force to release the latch. The delay permits brief current surges beyond normal running current for motor starting, energizing equipment, etc. Short circuit currents provide sufficient solenoid force to release the latch regardless of core position thus bypassing the delay feature. Ambient temperature affects the time delay but does not affect the current rating of a magnetic breaker.

Thermal breakers use a bimetallic strip, which heats and bends with increased current, and is similarly arranged to release the latch. This type is

commonly used with motor control circuits. Thermal breakers often have a compensation element to reduce the effect of ambient temperature on the device rating.

Thermomagnetic circuit breakers, which are the type found in most distribution boards, incorporate both techniques with the electromagnet responding instantaneously to large surges in current (short circuits) and the bimetallic strip responding to less extreme but longer-term overcurrent conditions.

Circuit breakers for larger currents are usually arranged with pilot devices to sense a fault current and to operate the trip opening mechanism.

Under short-circuit conditions, a current many times greater than normal can flow (see maximum prospective short circuit current). When electrical contacts open to interrupt a large current, there is a tendency for an arc to form between the opened contacts, which would allow the flow of current to continue. Therefore, circuit breakers must incorporate various features to divide and extinguish the arc. In air-insulated and miniature breakers an arc chute structure consisting (often) of metal plates or ceramic ridges cools the arc, and blowout coils deflect the arc into the arc chute. Larger circuit breakers such as those used in electrical power distribution may use vacuum, an inert gas such as sulfur hexafluoride or have contacts immersed in oil to suppress the arc.

The maximum short-circuit current that a breaker can interrupt is determined by testing. Application of a breaker in a circuit with a prospective short-circuit current higher than the breaker interrupting capacity rating may result in failure of the breaker to safely interrupt a fault. In a worst-case scenario the breaker may successfully interrupt the fault, only to explode when reset, injuring the technician.

Small circuit breakers are either installed directly in equipment, or are arranged in a breaker panel. Power circuit breakers are built into switchgear cabinets. High-voltage breakers may be free-standing outdoor equipment or a component of a gas-insulated switchgear line-up.

Vocabulary

solenoid – соленоїд
feature – пристрій, засіб
restrain – стримувати, обмежувати
surge – викид струму (напруга), перенапруга

ridge – виступ
blow-out – задування, гасіння
deflect – відхиляти
inertgas – інертний газ
line-up – схема, система.

Task 5. Answer these questions about the text.

1. What is a circuit breaker?
2. What is a circuit breaker designed for?
3. What is the difference between a fuse and a circuit breaker?
4. How are magnetic circuit breakers having a solenoid implemented?
5. What allows the contacts to open?
6. How does a magnetic breaker incorporating a hydraulic time delay feature operate?
7. What pulls the solenoid during an overload?
8. What provides sufficient force to release the latch?
9. What does the delay permit?
10. What do short circuit currents provide?
11. Does ambient temperature affect the current rating of a magnetic breaker?
12. What do thermal breakers use?
13. Where is this type of breakers commonly used?
14. What have thermal breakers to reduce the effect of ambient temperature on their rating?

Task 6. Work in pairs. Ask your partner to answer the following questions.

1. What techniques are incorporated in thermomagnetic circuit breakers?
2. What are circuit breakers for larger currents usually arranged with? Why?
3. What is formed between electrical contacts which open to interrupt a large current?
4. What does the arc between the open contacts allow?

5. What must circuit breakers incorporate to divide and extinguish the arc?
6. What may circuit breakers applied in electrical power distribution use?
7. How is the maximum short-circuit current that a breaker can interrupt determined?
8. What may result in an application of a breaker in a circuit with a prospective short – circuit current higher than the breaker interrupting capacity rating?
9. Where are small power and high-voltage circuit breakers installed?

Text B

Types of circuit breaker

Part 1

Before reading the text

Task 1. Match each phrase with the appropriate meaning.

1. instantaneous tripping current	a) автоматичний вимикач у відлитому корпусі
2. miniature circuit breaker	b) вакуумний автоматичний вимикач
3. moulded case circuit breaker	c) повітряний автоматичний вимикач
4. vacuum circuit breaker	d) струм миттєвого вимикання
5. air circuit breaker	e) малогабаритний автоматичний вимикач

Task 2. Translate these phrases from the text. Look carefully at the compound nouns before you start.

high-voltage AC circuit breaker; medium-voltage range; microprocessor controlled model; longer life expectancy; draw-out enclosure; trip threshold.

Task 3. Try to answer what types of circuit breakers are in general used in domestic and industrial applications.

Task 4. Read the text, translate it and check your answer.

There are many different technologies used in circuit breakers and they do not always fall into distinct categories. Types that are common in domestic, commercial and light industrial applications at low voltage (less than 1000V) include:

- MCB (Miniature Circuit Breaker) — rated current not more than 100 A. Trip characteristics normally not adjustable. Thermal or thermal-magnetic operation;
- MCCB (Moulded Case Circuit Breaker) — rated current up to 1000A. Thermal or thermal-magnetic operation. Trip current may be adjustable.

Electric power systems require the breaking of higher currents at higher voltages. Examples of high-voltage AC circuit breakers are:

- vacuum circuit breaker - rated current up to 3000A. These breakers interrupt the current by creating and extinguishing the arc in a vacuum container. These can only be practically applied for voltages up to about 35,000V, which corresponds roughly to the medium-voltage range of power systems. Vacuum circuit breakers tend to have longer life expectancies between overhaul than do air circuit breakers;
- air circuit breaker - rated current up to 10,000A. Trip characteristics often fully adjustable including configurable trip thresholds and delays. Usually electronically controlled, though some models are microprocessor controlled. Often used for main power distribution in large industrial plant, where the breakers are arranged in draw-out enclosures for ease of maintenance.

Vocabulary

expectancy – передбачуваний термін служби
maintenance – експлуатація, обслуговування, профілактичний ремонт
overhaul – капітальний ремонт, ретельний огляд

Task 5. Answer these questions about the text.

1. What types of circuit breakers are common in domestic, commercial and light applications at low voltages?
2. Give examples of high-voltage AC circuit breakers used in electric power systems?
3. Where can vacuum circuit breakers be applied?
4. Where are air circuit breakers used?
5. Which of these two types of circuit breakers have longer life expectancy?

Text C

Types of circuit breaker

Part 2

Before reading the text

Task 1. Translate these phrases. Look carefully at the compound nouns before you start.

electrical power transmission network; current sensing protective relay; protection relay scheme; live tank circuit breaker; dead tank circuit breaker enclosure; present high – voltage circuit breakers; low energy spring-loaded mechanisms.

Task 2. Try to answer if there any difference between law-voltage and high-voltage circuit breakers.

Task 3. Read the text, translate it and check your answer.

High-voltage circuit breakers. Electrical power transmission networks are protected and controlled by high-voltage breakers. The definition of "high voltage" varies but in power transmission network is usually thought to be 72,500 V or higher, according to a recent definition by the International Electrotechnical Commission (IEC). High-voltage breakers are nearly always solenoid-operated, with current sensing

protective relays operated through current transformers. In substations the protection relay scheme can be complex, protecting equipment and busses from various types of overload or ground/earth fault.

High-voltage breakers are broadly classified by the medium used to extinguish the arc:

- oil-filled (dead tank and live tank)
- oil-filled, minimum oil volume;
- air blast;
- sulfur hexafluoride.

High voltage breakers are routinely available up to 765 kV AC.

Live tank circuit breakers are where the enclosure that contains the breaking mechanism is at line potential, that is, "Live". *Dead tank* circuit breaker enclosures are at earth potential.

Interrupting principles for high-voltage circuit-breakers. High-voltage circuit-breakers have greatly changed since they were first introduced about 40 years ago, and several interrupting principles have been developed that have contributed successively to a large reduction of the operating energy.

Current interruption in a high-voltage circuit-breaker is obtained by separating two contacts in a medium, such as sulfur hexafluoride (SF_6), having excellent dielectrical and arc quenching properties. After contact separation, current is carried through an arc and is interrupted when this arc is cooled by a gas blast of sufficient intensity.

Gas blast applied on the arc must be able to cool it rapidly so that gas temperature between the contacts is reduced from 20,000 K to less than 2000 K in a few hundred microseconds, so that it is able to withstand the transient recovery voltage that is applied across the contacts after current interruption. Sulfur hexafluoride is generally used in present high-voltage circuit-breakers (of rated voltage higher than 52 kV).

In the 1980s and 1990s, the pressure necessary to blast the arc was generated mostly by gas heating using arc energy. It is now possible to use low energy spring-loaded mechanisms to drive high-voltage circuit-breakers up to 800 kV.

Vocabulary

substation – підстанція
live – знаходиться під напругою

dead – не знаходиться під напругою
airblast – вибухова хвиля, повітряний удар
transient voltage – перехідна напруга
transient recovery voltage (TRV) – перехідна напруга при відновленні
spring-loaded mechanism – пружинний привідний механізм.

Task 4. Answer these questions about the text.

1. What type of circuit breakers is used to protect and control electrical power transmission networks?
2. How are high-voltage breakers operated?
3. How are high-voltage breakers classified by the medium used to extinguish the arc?
4. What is a live tank circuit breaker?
5. What is a dead tank circuit breaker?
6. In which way is current interruption obtained in a high-voltage circuit breaker?

Task 5. Work in pairs. Ask your partner to answer the following questions.

1. In which way is current interrupted after contact separation?
2. What is used to cool the arc rapidly?
3. What is used to quench the arc in present high-voltage circuit breakers of rated voltage higher than 52 KV?
4. What is now possible to use to drive high-voltage circuit breakers up to 800 KV?

Text D

Types of circuit breaker

Part 3

Before reading the text

Task 1. Translate these phrases. Look carefully at the compound nouns before you start.

innovative interrupting principles; breaking chamber; interrupting chamber; low energy spring-operated mechanism; self-blast circuit breaker; generator circuit breaker; high breaking capacity; medium voltage range; thermal blast technique; overhead power distribution systems; short duration fault; higher rated breaking current.

Task 2. Try to answer if you know any innovative interrupting principles.

Task 3. Read the text, translate it and check your answer.

Thermal blast chambers. New types of SF_6 breaking chambers, which implement innovative interrupting principles, have been developed over the past 15 years, with the objective of reducing the operating energy of the circuit-breaker. One aim of this evolution was to further increase the reliability by reducing the dynamic forces in the pole. Developments since 1996 have seen the use of the self-blast technique of interruption for SF_6 interrupting chambers.

These developments have been facilitated by the progress made in digital simulations that were widely used to optimize the geometry of the interrupting chamber and the linkage between the poles and the mechanism.

This technique has proved to be very efficient and has been widely applied for high voltage circuit breakers up to 550 kV. It has allowed the development of new ranges of circuit breakers operated by low energy spring-operated mechanisms.

The technique, known as “self-blast” has now been used extensively since 1996 for the development of many types of interrupting chambers. The increased understanding of arc interruption obtained by digital simulations and validation through breaking tests, contribute to a higher reliability of these self-blast circuit breakers. In addition the reduction in operating energy, allowed by the self-blast technique, leads to longer service life.

Thermal blast chamber with arc-assisted opening. In this interruption principle arc energy is used, on the one hand to generate the blast by thermal expansion and, on the other hand, to accelerate the moving part of the circuit breaker when interrupting high currents. The overpressure produced by the arc energy downstream of the interruption zone is applied on an auxiliary piston linked with the moving part. The resulting force accelerates the moving part, thus increasing the energy available for tripping.

With this interrupting principle it is possible, during high-current interruptions, to increase by about 30% the tripping energy delivered by the operating mechanism and to maintain the opening speed independently of the current. It is obviously better suited to circuit-breakers with high breaking currents such as Generator circuit-breakers.

Generator circuit-breakers. Generator circuit-breakers are connected between a generator and the step-up voltage transformer. They are generally used at the outlet of high power generators (100 MVA to 1800 MVA) in order to protect them in a reliable, fast and economic manner. Such circuit breakers must be able to allow the passage of high permanent currents under continuous service (6.3 kA to 40 kA), and have a high breaking capacity (63 kA to 275 kA). They belong to the medium voltage range, but the TRV withstand capability required by ANSI/IEEE Standard C37.013 is such that the interrupting principles developed for the high-voltage range must be used. A particular embodiment of the thermal blast technique has been developed and applied to generator circuit-breakers.

Autorecloser. A type of circuit breaker which closes again after a delay. These are used on overhead power distribution systems, to prevent short duration faults from causing sustained outages.

Future perspectives. In the near future, present interrupting technologies can be applied to circuit-breakers with the higher rated

breaking currents (63 kA to 80 kA) required in some networks with increasing power generation.

Self-blast or thermal blast circuit breakers are nowadays accepted worldwide and they are in service for high voltage applications since about 15 years, starting with the voltage level of 72.5 kV. Today this technique is also available for the voltage levels 420/550/800 kV.

Vocabulary

thermal blast chamber – камера з використанням дії теплового удару
self-blast chamber – камера з використанням дії надмірного тиску
arc-assisted opening – розмикання з використанням енергії дуги
piston – поршень
autorecloser – самовмикач (автомат)
overhead – надземний, підвісний

Task 4. Answer these questions about the text.

1. What was the objective of the development of the new types of sulfur hexafluoride breaking chambers?
2. What was the aim of the further evolution of circuit breakers?
3. What kind of technique of interruption for sulfur hexafluoride chambers have been seen since 1996?
4. What was used to optimize the geometry of the interrupting chamber and the linkage between the poles and the mechanism?
5. Where has this technique been widely applied?
6. What has it allowed?
7. What does the digital simulation contribute to?
8. What does the reduction in operating energy lead to?
9. What is arc energy used for in thermal blast chamber with arc – assisted opening?
10. Where is the overpressure produced by the arc energy applied?

Task 5. Work in pairs.

1. Ask your partner to answer the following questions.

- What increases the energy for tripping?

- What type of circuit breakers is this principle better suited to?
- Where are generator circuit breakers connected?
- Where are they generally used for?
- What must such circuit breakers be able to allow?
- What breaking capacity must they have?
- What voltage range do they belong to?
- What is an autorecloser?
- Where is this type of circuit breaker used?
- What are they used for?

2. Let your partner explain:

- Application of self-blast or thermal blast circuit breakers nowadays.
- Future perspectives of present interrupting technologies.

UNIT5. CONTACTOR

Text A

Contactor

Before reading the text

Task 1. Match these words and phrases with the appropriate meaning.

1. contactor	a) підігрівач, економайзер
2. magnetic blowouts	b) контактор з механічним блокуванням
3. economizer	c) контактор
4. latching contactor	d) контактор з магнітним зриванням дуги

Task 2. Translate these phrases from the text. Look carefully at the compound nouns before you start.

direct-current contactor coil; large alternating current contactor coils; large lighting installations; power circuit contacts.

Task 3. Try to compare a contactor with a circuit breaker.

Task 4. Read the text, translate it and check your answers.

A contactor is an electrical device used for switching a power circuit. A contactor is activated by a control input which is a lower voltage/current than that which the contactor is switching. Contactors come in many forms with varying capacities and features. Unlike a circuit breaker a contactor is not intended to interrupt a short circuit current.

Contactors range from having a breaking current of several amps and 110 volts to thousands of amps and many kilovolts. The physical size of a contactor ranges from those which are as large as a small car and those which are small enough to fit inside electrical equipment.

Contactors are used to control electric motors, lighting, heating, capacitor banks, and other electrical loads

Construction. Magnetic blowouts are sometimes used to increase the amount of current a contactor can successfully break. The field produced by the magnets in proximity to the contact forces the arc produced while breaking current to flow through the field which is curved and a greater distance than the straight path between the contacts. The magnetic blowouts can break current from 600 Amps to 1500 Amps.

Sometimes an **Economizer** circuit is also installed to reduce the power required to keep a contactor closed. A somewhat greater amount of power is required to initially close a contactor than is required to keep it closed thereafter. Such a circuit can save a substantial amount of power and allow the energized coil to stay cooler. Economizer circuits are nearly always applied on direct-current contactor coils and on large alternating current contactor coils.

Contactors are often used to provide central control of large lighting installations, such as an office building or retail building. To reduce power consumption in the contactor coils, latching contactors are used, with two coils. One coil, momentarily energized, closes the power circuit contacts, the second opens the contacts.

A basic contactor will have a coil input (which may be driven by either an AC or DC supply depending on the contactor design) and generally a minimum of two poles which are controlled.

Task 5. Answer these questions about the text.

1. What is a contactor?
2. What is a contactor activated by?
3. What differs a contactor from a circuit breaker?
4. How do contactors range?
5. How does the physical size of a contactor range?
6. What are the contactors used for?
7. What are magnetic blowouts used for?
8. What is the principle of operation of magnetic blowouts?

Task 6. Work in pairs. Ask your partner to answer the following questions.

1. What is an economizer circuit installed for?
2. What does the economizer circuit allow?
3. Where are economizer circuits applied?
4. What is used to reduce power consumption in the contactor coils?
5. What do contactor coils do when energized?
6. What does a basic contactor have?

Task 7. Refer back to the text and find the sentences with <u>that</u> and <u>those</u>. Decide their functions.

Text B

Operating Principle

Before reading the text

Task 1. Find the meaning of these words and phrases in the list given below.

1. optional
2. inductive impedance
3. shading coil
4. controller
5. duty cycle
6. general purpose
7. definite purpose
8. life cycle

спеціальний	тривалість служби, довговічність
нестандартний	екрануюча обмотка
робочий цикл	універсальний
регулятор, контролер	індуктивний опір

Task 2. Translate these phrases from the text. Look carefully at the compound nouns before you start.

general-purpose relay; optional auxiliary low current contacts; motor control contactors; modern medium-voltage motor controllers; maximum fault withstand current; general purpose motor control contactor; heavy starting duty; air-conditioning compressor motor starting.

Task 3. Try to compare a contactor with other protective devices.

Task 4. Read the text, translate it and check your answer.

A contactor is a type of electrical relay. Unlike general-purpose relays, contactors are designed to be directly connected to high-current load devices, not other control devices. Relays tend to be of much lower capacity and are usually designed for both Normally Closed and Normally Open applications. Devices switching more than 15 amperes or in circuits rated more than a few kilowatts are usually called contactors. Apart from optional auxiliary low current contacts, a contactor normally only has Normally Open contacts fitted.

When current passes through the electromagnet, a magnetic field is produced which attracts ferrous objects, in this case the moving core of the contactor is attracted to the stationary core. Since there is an air gap initially, the electromagnet coil draws more current initially until the cores meet and reduce the gap, increasing the inductive impedance of the circuit.

For contactors energized with alternating current, a small part of the core is surrounded with a shading coil, which slightly delays the magnetic flux in the core. The effect is to average out the alternating pull of the magnetic field and so prevent the core from buzzing at twice line frequency. Most motor control contactors at low voltages (600 volts and less) are "air break" contactors, since ordinary air surrounds the contacts and extinguishes the arc when interrupting the circuit. Modern medium-voltage motor controllers use vacuum contactors.

- Motor control contactors can be fitted with short-circuit protection (fuses or circuit breakers), disconnecting means, overload relays and an enclosure to make in combination a starter. In large industrial plants many contactors may be assembled in motor control centers.

Ratings. Contactors are rated by designed load current, maximum fault withstand current, duty cycle, voltage, and coil voltage. A general purpose motor control contactor may be suitable for heavy starting duty on large motors; so-called "definite purpose" contactors are carefully adapted to such applications as air-conditioning compressor motor starting. North American and European ratings for contactors follow different philosophies, with North American contactors generally emphasizing

simplicity of application while European rating philosophy emphasizes design for the intended life cycle of the application.

Task 5. Answer these questions about the text.

1. What differs a contactor from a general-purpose relay?
2. What are relays usually designed for?
3. How are devices switching more than 15 amperes or in circuits rated more than a few kilowatts usually called?
4. What contacts normally has a contactor?
5. What is a principle of a contactor operation?
6. Can the contactors be energized with alternating current? What delays the magnetic flux in these contactors?
7. What kind of motor control contactors are used at low voltages? Why?
8. What kind of contactors modern medium-voltage motor controllers use?

Task 6. Work in pairs.

1. Ask your partner to answer the following questions.

- Can the motor control contactors be fitted with protection devices? Give examples.
- How are the contactors rated?
- What may a general-purpose motor control contactor be suitable for?
- What applications a definite purpose contactor adapted to?

2. Let your partner explain what emphasizes North American and European contactors rating philosophy.

TEST

(Unit 1. Fuse. Unit 2. Electrical switch. Unit 3. Relay. Unit 4. Circuit breaker. Unit 5. Contactor)

Choose the correct answer

1. Which of the following a fuse marking does not include?
   A. Fuse holder
   B. Current rating
   C. Breaking capacity
   D. Time-current characteristic
   E. Voltage rating

2. If the rated interrupting capacity of the fuse is exceeded by the fault current in the system, what happens?
   A. Fuse protects the system
   B. Fuse housing could break and cause a failure inside the cabinet containing the fuse
   C. Fuse measures the electricity
   D. Fuse absorbs the energy
   E. Nothing
3. Which of the following is not a standard switch type?
   A. SPST
   B. SPDT
   C. DPST
   D. DPDT
   E. None of the above

4. What is the term for a switch where the old contact is broken before the new one is made?
   A. Shorting
   B. Nonshorting
   C. Rotary
   D. Make-before-break
   E. None of the above

5. Which of the momentary switches makes contact when the button is pressed and breaks when the button is released?
   A. Break-before-make
   B. Flicked
   C. Push-to-make
   D. Damped
   E. None of the above

6. What does a relay consist of?
   A. A coil and a fuse
   B. A coil and a diode
   C. R and C components
   D. Electromagnet and a set of switch contacts
   E. None of the above

7. Why is a diode placed across the coil of a relay?
   A. To protect the relay against incorrect polarity
   B. To speed up switching
   C. To protect the relay from high-voltage transients when the magnetic field collapses
   D. To increase the current flow
   E. None of the above

8. When should a fuse be replaced with a higher rated unit?
   A. When the original value is not available
   B. If it blows
   C. Never
   D. When fuses of the original value blow as soon as they are replaced
   E. None of the above

9. What differs a circuit breaker from a fuse?
   A. Can be reset to resume normal operation
   B. Can not interrupt short-circuit currents
   C. Its contacts melt when current flows
   D. Causes overload
   E. No difference

10. A contactor is not designed to
    A. Extinguish the arc
    B. Interrupt a short-circuit current
    C. Be connected to other control devices
    D. Be directly connected to high-current load devices
    E. None of the above