



МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
Національний авіаційний університет

**PROFESSIONAL ENGLISH
FUNDAMENTALS
OF HELICOPTER DESIGN**

ПРАКТИКУМ

для здобувачів вищої освіти
ОС «Бакалавр» спеціальності 134
«Авіаційна та ракетно-космічна техніка»

VIVERE!
VINCERE!
CREARE!

Київ 2021

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Практикум з англійської мови за професійним спрямуванням містить тексти, вокабуляр базової термінології з перекладом українською мовою, комплекс післятекстових лексико-граматичних вправ, комунікативні завдання.

Для здобувачів вищої освіти ОС «Бакалавр» спеціальності 134 «Авіаційна та ракетно-космічна техніка».

ПЕРЕДМОВА

Практикум з англійської мови за професійним спрямуванням “Fundamentals of Helicopter Design” призначений для здобувачів вищої освіти спеціальності 134 «Літаки і вертольоти».

Практикум знайомить студентів з конструкцією, системами та обладнанням вертольотів, технічними характеристиками сучасних гелікоптерів.

Мета практикуму — навчити майбутніх інженерів основам професійного спілкування англійською мовою, розвинути стійкі навички читання, перекладу, анотування, реферування спеціальної технічної літератури для отримання й використання інформації, необхідної в їх майбутній практичній діяльності.

Практикум складається з 4-х розділів. Кожний розділ містить базові тексти, передтекстові двомовні англо-українські термінологічні вокабуляри, комплекси вправ на закріплення основної лексики та навчальний матеріал для обговорення. Додаткові тексти з фаху передбачені як для аудиторного, так і для самостійного опрацювання.

Пропонуються різні види комунікативних лексико-граматичних вправ, які розміщено в логічній послідовності з нарощуванням складності для забезпечення ефективного засвоєння та практичного володіння лексикою з теми.

Джерелом навчального матеріалу практикуму є автентичні оригінальні неадаптовані тексти сучасних авіаційних періодичних видань.



Unit I

INTRODUCTION TO THE HELICOPTER DESIGN

Exercise 1. Memorize the basic vocabulary to text 1.

rotor	ротор; несучий гвинт (<i>гелікоптера</i>)
main/lifting rotor	несучий гвинт (<i>гелікоптера</i>)
rotorcraft/rotary wing aircraft	літальний апарат з несучим гвинтом; гвинтокрилий ЛА
lift	піднімальна сила
derive	отримувати (<i>від чогось</i>); витягувати
surface	поверхня
hover	зависати, висіти в повітрі
reaction torque	реактивний момент
spin	1. обертання; 2. обертатися
torque	обертовий момент
coaxial-rotor helicopter	вертоліт співвісної схеми
axis	вісь
cancel	скасовувати, анулювати
incline	нахиляти(ся)
blade	1. лопать; 2 лопатка
compressibility	стисненність
stall	зрив (<i>поток</i> у); звалювання (<i>гелікоптера</i>)
payload	корисне/комерційне навантаження
airframe	планер/корпус літального апарата
transmission	трансмсія, передача
transmit	передавати
antitorque	протиобертовий момент
skid	костур
float	поплавок
damper	демпфер; амортизатор, гаситель
touchdown	приземлення (ЛА); дотик (<i>землі</i>)
absorb	поглинати, амортизувати
bend	1. вигин; 2. згинати

arm	важіль; плече (<i>важеля</i>)
replaceable	замінний
heavy-duty	потужний
skid shoe	башмак костура
wear	знос; зношування
tricycle	трьохопорне (<i>шасі</i>)
swivel	1. повертати (ся); 2. поворотний, шарнірний; який обертається
rotor blade	лопать несучого гвинта
propulsion	рушійна сила
gearbox	1. редуктор; 2. коробка передач

Exercise 2. Read and translate text 1.

Text 1. HELICOPTER DESIGN

Any helicopter is a type of aircraft, so called rotorcraft or rotary wing aircraft in which lift is obtained by means of one or more power-driven horizontal propellers called rotors. The principal difference between an airplane and a helicopter is how each aircraft develops lift. The airplane source of lift is derived from the wing which is a fixed surface, while the helicopter derives lift from a rotating surface called the rotor. Aircraft are classified as either¹ fixed-wing or rotating-wing. Lift generation by a rotating wing enables the helicopter to accomplish its unique mission of hovering.

Helicopters are one of the most maneuverable types of aircraft, and while hovering, the helicopter can be moved in every possible direction or combination of directions. When the rotor of a helicopter turns it produces reaction torque which tends to make the craft spin also. On most helicopters a small rotor near the tail compensates for this torque. According to the number of rotors helicopters are divided into single-rotor, twin-rotor, multirotor and coaxial-rotor helicopters. A coaxial-rotor helicopter has one rotor mounted above the other on the same axis.

On twin-rotor craft the rotors spin in opposite directions, so their reactions cancel each other. The helicopter is propelled in a given direction by inclining the axis of the main rotor in that direction.

The helicopter speed is limited by the fact that if the blades rotate too fast they will produce compressibility effects on the blade moving forward and stall effects on the rearward moving blade at the same time.

The simplest helicopter consists essentially of 5 constructional parts. These parts include a fuselage, where the payload and crew are carried; an airframe, which houses various components, or where the components are attached; a power plant or engine; a rotor and a transmission, which, among other things, takes the power from the engine and transmits it to the main rotor, it is a lifting surface, which provides the aerodynamic forces that make² the helicopter fly. Then, to keep the helicopter from turning due to torque, there must be some type of antitorque system. There is the landing gear, which could be skids, wheels, skis, or floats.

The most common landing gear is a skid type gear, which is suitable for landing on various types of surfaces. Some types of skid gear are equipped with dampers so touchdown shocks are not transmitted to the main rotor system. Other types absorb the shocks by the bending of the skid attachment arms. Landing skids may be fitted with replaceable heavy-duty skid shoes to protect them from excessive wear.

Helicopters can also be equipped with floats for water operations, or skis for landing on snow or soft terrain. Wheels are another type of landing gear. They may be in a tricycle or four-point configuration. Normally, the nose or tail gear is free to swivel as the helicopter is taxied on the ground.

Notes:

¹either ... or ...—або ..., або ...

²make ... do ... — змушувати робити (щось)

Exercise 3. Give Ukrainian equivalents.

Lift, propeller, transmission, hovering, blade, payload, damper, airframe, crew, compressibility, rotorcraft, skis, float, wheel, skid, main rotor, rotating surface, reaction torque, single-rotor, opposite direction, tail rotor, fixed surface, horizontal propeller, lifting surface, constructional part, aerodynamic force, rotary wing aircraft, twin-rotor craft, rearward moving blade, coaxial-rotor helicopter.

Exercise 4. *Translate the following word combinations with the terms: gearbox, rotor, blade, transmission, gear.*

- a) helicopter gearbox, propeller gearbox, main rotor gearbox, rear gearbox, tail gearbox, intermediate gearbox;
- b) helicopter rotor, tail rotor, upper rotor, front rotor, lifting rotor, front main rotor, rear main rotor, jet-driven rotor, lower coaxial rotor, power-driven rotor, upper coaxial rotor, high-speed rotor, twin-bladed rotor, three-bladed rotor, dual main rotors;
- c) rotor blade, helicopter blade, propeller blade, airscrew blade, all-metal blade, main rotor blade, tail rotor blade;
- d) rotor transmission, pressure transmission, power transmission, command transmission, digital transmission, sound transmission;
- e) float gear, ski gear, skid gear, wheel gear.

Exercise 5. *Read and translate the following "noun + noun" collocations.*

Turboprop helicopter, turboshaft helicopter, winged helicopter, multirotor helicopter, coaxial-rotor helicopter, multi-engine helicopter, dual-rotor helicopter, four-rotor helicopter, rocket-boost helicopter, rocket-powered helicopter, shaft-driven helicopter, tail-rotor helicopter, turbine-engine helicopter, twin-engine helicopter, twin-rotor helicopter, single-engine helicopter, single main rotor helicopter, four-blade rotor helicopter.

Exercise 6. *Derive nouns from the following verbs. Translate the pairs.*

Operate, rotate, transmit, propel, differ, develop, construct, classify, generate, accomplish, produce, combine, direct, compensate, react, limit, attach, provide, land, equip, protect, compress, employ, arrange, add, move, control, compensate, create, locate, couple, carry, absorb, divide, lift, replace.

Exercise 7. *Define by suffixes and endings the parts of speech noun, adjective, adverb, verbal form the following words belong to, translate them.*

Designed, principal, hovering, transmission, operational, maneuverable, fixed, controllability, dependence, capability, difference, movable, activity, manufacture, used, productivity, action, instruction, considerable, performance, direction, manually, acting, storage,

mechanical, designer, compressibility, aerodynamically, essentially, produced, structure, indicator, normally, stabilizer, horizontal, constructive, equipment, referring, structural, combination, stabilizing, vertical, mobility, widely, installation, combined, usually, movement, absorber, constructing, propulsion, stability, equally, absorber, equipped, reliability, technically, attachment, replaceable, depending, operation.

Exercise 8. Translate the following verb-object combinations.

To develop lift, to accomplish unique mission of hovering, to produce reaction torque, to make the craft spin, to incline the axis of the main rotor, to produce compressibility effect, to consist of constructional parts, to include a cabin, to house various components, to take the power from the engine, to transmit the power to the main rotor, to provide the aerodynamic forces, to make the helicopter fly, to keep the helicopter from turning due to torque.

Exercise 9. Translate with the help of a dictionary and memorize the terms referring to the main structural units of helicopter desing.

Fuselage: nose part, cockpit/pilot's cabin, canopy, windscreen, passenger cabin, cargo compartment, tail boom/beam.

Rotor: blade, blade tip, blade spar, trimmer, main rotor hub, hinge, rotor-blade hinge, flapping hinge, drag hinge, compensation tank, deicing system, swashplate/wobble plate.

Transmission: gearbox/reductor, main gearbox, intermediate gearbox, tail gearbox, shaft.

Undercarriage: nose gear, left/port gear, right/starboard gear, shock absorber, wheel, tyre, tube, braking chock, bearing, strut / brace, forward strut / brace, drag strut/ brace, tail bumper.

Power plant: engine (turboprop, turbojet, turboshaft), auxiliary power unit (APU), oil cooler, oil filter, fuel filter, oil tank, oil pump, fuel pump, dust-protection device, engine mount, propulsion.

Exercise 10. Match the following terms with corresponding definitions.

- | | |
|------------------|--|
| 1. Propulsion | a) A type of aircraft with large metal blades on top which turn around very quickly to make it fly |
| 2. Gearbox | b) An assembly of horizontally rotating blades of a helicopter propeller |
| 3. Shaft | c) A drive or a gear which transmits power from the engine to the rear axle of a motor vehicle |
| 4. Stabilizer | d) A flat wide part of an object that pushes against air or water |
| 5. Drag | e) A landing gear of an aircraft or a helicopter |
| 6. Torque | f) A source of power where electric power is also generated for distribution |
| 7. Helicopter | g) The pressure of air that keeps something such as an aircraft up in the air or lift it higher |
| 8. Power plant | h) A twisting force causing rotation |
| 9. Undercarriage | i) The force of air that pushes against aircraft or a vehicle that is moving forward |
| 10. Blade | j) A device to keep an aircraft or helicopter steady, free from rolling or pitching |
| 11. Transmission | k) A system of gears in a vehicle |
| 12. Rotor | l) A bar or rod joining parts of a machine, or transmitting power |
| 13. Lift | m) A propelling force by means of engines |

Exercise 11. Give definitions of the following terms.

Helicopter, rotor, transmission, blade, power plant, undercarriage, torque, lift, stabilizer, shaft, propulsion, gearbox, drag.

Exercise 12. Work with a partner. Ask and answer the questions.

1. What is the principal difference between an airplane and a helicopter? 2. What are aircraft classified as? 3. How does the helicopter accomplish its unique mission of hovering? 4. What constructional parts does the simplest helicopter consist of? 5. What does the helicopter

produce when its rotor turns? 6. Where does the helicopter derive lift from? 7. What system must there be to keep the helicopter from turning due to torque? 8. What is the most common helicopter landing gear type? 9. What can helicopters be equipped with for water operations? 10. What makes helicopter spin?

Exercise 13. *Compose a summary of text 1.*

Exercise 14. *Memorize the basic vocabulary to text 2.*

rivet	1. заклепка; 2. клепати
suspend	1. вішати; 2. призупиняти; 3. виключати
tray	піддон
deck	палуба; настил; пол (у гелікоптері)
canopy	ліхтар (кабіни пілотів)
weld	1. зварювання; 2. зварювати
tubing	система трубопроводів
odd	непарний
pipeline laying	укладання трубопроводу
patrolling	патрулювання
aerial photography	аерофотозйомка
oil industry	нафтова промисловість
timber industry	лісна промисловість
allow	дозволяти, вирішувати
honeycomb	стільниковий заповнювач
confine	обмежувати

Exercise 15. *Read, translate, entitle and give the gist of text 2*

Text 2

In modern helicopters nearly the whole airframe is riveted from light aluminum alloy sheet. In some helicopters thin stainless steel is employed to form a box under the power plant, steel tubes suspend the aircraft from the main rotor and honeycomb is used in the central fin.

In the helicopter the basic structure is completed by the addition of light bulkheads, a metal floor and the fire resistant sheet-steel tray on which the engine is mounted. Flight controls pass along the starboard side. The electricity passes down the port side. Power is provided by a turbine unit mounted completely externally on the deck at the rear of the forward fuselage. The canopy structure is welded from aluminum tubing.

To carry heavy loads the number of rotors in a helicopter is increased. If a helicopter has 2 or 4 rotors they can rotate in pairs in opposite directions. If there are 3 rotors, arrangements are made to balance the torque of the odd rotor.

An advantage to the helicopter is its ability to take off and land on a confined area. Helicopters are used in a variety of commercial operations such as corporate transport, pipeline laying and patrolling, news and traffic reporting, aerial photography, sightseeing tours in addition, helicopters play an important role in the oil, timber, and agriculture industries.

Exercise 16. Put 7 key questions on the text.

Exercise 17. Memorize the words and word-combinations in order to translate the sentences in exercise 18.

propulsive force	рушійна сила
stages of flight	етапи польоту
drive	1. привід; 2. приводити в дію
angle	кут
blade angle	кут установки лопатів
swashplate/wobble plate	автомат перекосу
shift	1. зміщення; 2. здвигати
hinged joint	шарнірне з'єднання
semirigid coupling	напівжорстке з'єднання
constant frequency	постійна частота
power	потужність
rotor pitch	крок несучого гвинта
axial hinge	осьовий шарнір
intermediate gearbox of rotor column	проміжний редуктор колонки несучого гвинта

opposite action to reaction torque	протидія реактивному моменту
directional control	керування за курсом
tail rotor/ anti-torque rotor	рульовий гвинт
coaxial lay-out of main rotors	співісна схема несучих гвинтів
flight mode	режим польоту

Exercise 18. Translate these sentences into English.

<p>1. Гелікоптер — це гвинтокрилий літальний апарат вертикального зльоту і посадки, у якого підйомна і рушійна сили на всіх етапах польоту створюються одним або декількома несучими гвинтами з приводом від одного або декількох двигунів.</p>
<p>2. Подібно до крила літака, лопаті несучого гвинта гелікоптера знаходяться під кутом до площини обертання гвинта, який називається кутом установки лопатей. На відміну від нерухомого літакового крила, кут установки лопатей вертольота може змінюватися в широких межах (до 30°).</p>
<p>3. Несучий гвинт вертольота оснащений автоматом перекоосу, який для управління польотом забезпечує зміщення центру тиску гвинта у випадку шарнірного з'єднання лопатей або ж нахилляє площину обертання гвинта у випадку напівтвердого з'єднання.</p>
<p>4. Автомат перекоосу жорстко з'єднується з осьовим шарніром для зміни кута атаки лопатей. У схемах з трьома і більше несучими гвинтами автомат перекоосу може бути відсутнім.</p>
<p>5. Лопаті вертольота в усіх режимах польоту обертаються з постійною частотою, збільшення або зменшення потужності несучого гвинта залежить від кроку гвинта.</p>
<p>6. Обертання гвинта зазвичай передається від одного або двох двигунів через трансмісію і проміжний редуктор колонки несучого гвинта. При цьому виникає реактивний момент, який прагне закрутити вертоліт в сторону, протилежну від обертання несучого гвинта.</p>
<p>7. Для протидії реактивному моменту, а також для керування за курсом, використовується або кермовий гвинт, або співвісна схема несучих гвинтів, що обертаються в різних напрямках.</p>

Exercise 19. Match the synonyms in the left and right columns.

- | | |
|----------------------|-------------------------|
| 1) coupling | a) brace |
| 2) main rotor | b) central body |
| 3) tail rotor | c) wobbled plate |
| 4) gearbox | d) no-run take-off |
| 5) cockpit | e) manufacture |
| 6) rotorcraft | f) rotary wing aircraft |
| 7) production | g) pilot's cabin |
| 8) vertical take-off | h) reductor |
| 9) swashplate | i) antitorque rotor |
| 10) fuselage | j) lifting rotor |
| 11) strut | k) non-retractable |
| 12) fixed | l) clutch |
| 13) beam | m) boom |

Exercise 20. Read, translate and memorize *Aviacopter AC-313* performance terminology.

Modification	AC313
Main rotor diameter, m	18.90
Tail rotor diameter, m	4.00
Length, m	23.0
Height, m	6.74
Width, m	4.60
Weight, kg:	
- empty	6750
- maximum takeoff	13000
Engine type	3 GTE Pratt & Whitney Canada PT6B-67A
Power, h.p.	3×1220
Maximum speed, km/h	250
Cruising speed, km/h	220
Practical range, km	1050
Practical ceiling, m	4500
Static ceiling, m	3400
Crew, people	2-3
Payload:	18-27 passengers or 15 injured stretchers or 6.000 kg of cargo in the cab or on the suspension

Exercise 21. Find information on performance data of other helicopters and prepare a brief presentation.

Exercise 22. Choose nouns among the following words. Put their first letters into the cells below in the same order. Read and translate the word obtained.

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Move, height, hover, equipment, long, empty, landing, ensure, main, indicator, provide, low, crew, create, vertical, organization, modern, protect, payload, static, fixed, torque, opposite, operate, engine, differ, rotor, rotate.

Exercise 23. Memorize the basic vocabulary to text 3.

hub	втулка
collective pitch	спільна відстань (несучого гвинта гелікоптера)
cyclic pitch	циклічний крок
circuit	ланцюг (електричний)
feathering hinge	горизонтальний шарнір (лопаті несучого гвинта гелікоптера)
planned trajectory	задана траєкторія
layout	компоновка
support	1. опора; 2. підтримувати
coupling	1. з'єднання, зв'язок 2. штуцер, роз'єм; муфта
brake	гальмо
rotor brake	гальмо несучого гвинта
frame	каркас; рама
engine attachment point	точка кріплення двигуна
relieve	полегшувати навантаження; звільнювати
landing gear well	ніша шасі
lateral layout helicopter	гелікоптер поперечної схеми
controllability	здатність до керування, керованість
eliminate	усувати

Exercise 24. Read and translate text 3.

Text 3. MAIN UNITS OF THE HELICOPTER

The main rotor is designed to create lift and propulsion, as well as to control the flight. It consists of blades and a hub that transmits torque from the shaft of the main gearbox to the blades.

The tail rotor serves to compensate the reaction torque of the main rotor and the directional control of a single-rotor helicopter. It contains blades and a hub attached to the tail gearbox.

The swashplate provides control of the collective and cyclic pitches of the main rotor by transmitting a control signal from the control circuit to the feathering hinge of the main rotor hub.

The control system is designed to create forces and moments necessary for the helicopter to fly along a planned trajectory.

The transmission is designed to transfer power from the engines to the main and tail rotors and auxiliary units. The transmission scheme is determined by the helicopter layout, the number and location of the engines. The transmission consists of the primary, intermediate and tail gearboxes, shafts and their supports, couplings, rotor brakes.

The fuselage is used to accommodate the crew, passengers, cargo, equipment, fuel, etc. The landing gear, gearbox frames, engine attachment points, empennage, etc. are attached to the fuselage.

The wing creates additional lift by relieving the main rotor, that allows to increase flight speed. The wing can accommodate fuel tanks, equipment, landing gear wells. In the lateral layout helicopters the wing supports the main rotors.

The empennage is designed to ensure the stability and controllability of the helicopter. It is divided into horizontal and vertical stabilizers.

The power plant is used to create power for driving the main and tail rotors and auxiliary units. It is a complex of engines (piston, gas turbine or electric engines) with systems that ensure their stable operation at all flight modes.

Exercise 25. Paraphrase the sentences according to the model and translate them.

Model:	The main rotor creates lift and propulsion. The main rotor serves for creating lift and propulsion. The main rotor is used to create lift and propulsion. The function of the main rotor is to create lift and propulsion.
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1. The tail rotor compensates the reaction torque of the main rotor and the directional control of a single-rotor helicopter. 2. The swashplate provides control of the collective and cyclic pitches of the main rotor by transmitting a control signal from the control circuit to the feathering hinge of the main rotor hub. 3. The transmission transfers power from the engines to the main and tail rotors and auxiliary units. 4. The fuselage accommodates the crew, passengers, cargo, equipment, fuel, etc. 5. The wing creates additional lift by relieving the main rotor. 6. The wing accommodates fuel tanks, equipment, landing gear wells. 7. In the lateral layout helicopters the wing supports the main rotors. 8. The empennage ensures the stability and controllability of the helicopter. 9. The power plant creates power for driving the main and tail rotors and auxiliary units. 10. The new developed tools eliminate the factors causing nearly half of all serious helicopter crashes. 11. The lifting surface provides the aerodynamic forces to make the helicopter fly.

Exercise 26. *Work with a partner. Ask and answer the questions.*

1. What is the main rotor used for? 2. What is the function of the tail rotor? 3. What does the transmission serve for? 4. What is the function of the fuselage? 5. What does the wing serve for? 6. What is the function of the empennage? 7. What is the power plant used for? 8. What does the swashplate serve for? 9. What is the function of rotor fast-turning metal blades? 10. What is the function of the antitorque system?

Exercise 27. *Translate the following sentences and put questions on the italicized words.*

1. *The present-day helicopters* have flight endurance up to 4–5 hours. 2. *The display processor* being the heart of the helicopter equipment controls *the management of avionics, the fire control system, navigation and communication functions.* 3. *Rotorcraft* are made *to fly by fast-rotating rotors.* 4. The Mi-38 helicopter carries *up to 30 passengers.* 5. The main advantages of helicopters are *the ability to take off and land vertically, to fly backwards, to transport very bulky cargo on external sling, to perform installation work.* 6. The main disadvantages in all rotorcraft are *lower maximum flight speed, increased specific fuel consumption and complexity of control.* 7. *Each blade* moves up and down independently of the others. 8. The rotor system consists of *a single main rotor or dual rotors.* 9. *The developers of helicopters* provide modification

of the "Flying Hospital" helicopter with *various types of medical and rescue equipment*. 10. *The new developed tools eliminate the factors causing nearly half of all serious helicopter crashes*. 11. *Nikolai Kamov's group of designers have developed multipurpose helicopters which have proved their main advantages: great maneuverability, small size, high payload and great effectiveness*.

Exercise 28. *Complete the sentences.*

1. The present-day helicopters have flight endurance ... 2. The main advantages of helicopters are ... 3. The transmission is designed to ... 4. The main disadvantages of all rotorcraft are ... 5. The rotor system consists of ... 6. The swashplate provides control of ... 7. The main rotor is designed to ... 8. The tail rotor serves for ... 9. The simplest helicopter consists essentially of ... 10. The most common helicopter landing gear is ...

Exercise 29. *Act as an interpreter.*

1. Чим відрізняється гвинтокрилий літальний апарат від літака?	1. The principal difference between an airplane and a helicopter is how each aircraft develops lift.
2. Які основні конструктивні частини гелікоптера?	2. The primary components of the helicopter are the airframe (the fuselage, the tail boom, the stabilizer and the undercarriage) and the power plant.
3. Яка тривалість польоту у гелікоптерів?	3. The present-day helicopters have flight endurance up to 4–5 hours.
4. Яка їх максимальна швидкість?	4. The maximum speed of the helicopter is 250 km/h.
5. Для чого використовується автомат перекосу?	5. The swashplate provides control of the collective and cyclic pitches of the main rotor by transmitting a control signal from the control circuit to the feathering hinge of the main rotor hub.
6. Що таке трансмісія?	6. The transmission is designed to transfer power from the engines to the main and tail rotors and auxiliary units.

<p>7. Для чого слугують несучий та хвостовий гвинти?</p>	<p>7. The main rotor is designed to create lift and propulsion and to control the flight. The tail rotor serves to compensate the reaction torque of the main rotor and the directional control of a single-rotor helicopter.</p>
<p>8. З чого складається блок несучого гвинта?</p>	<p>8. The main rotor consists of blades and a hub that transmits torque from the shaft of the main gearbox to the blades.</p>
<p>9. З чого складається блок хвостового гвинта?</p>	<p>9. The tail rotor contains blades and a hub attached to the tail gearbox.</p>
<p>10. Які переваги гвинтового літального апарата?</p>	<p>10. The main advantages of helicopters are the ability to take off and land vertically, to hover, to fly backwards, to transport very bulky cargo on external sling, to perform installation work.</p>
<p>11. Які недоліки у гвинтового літального апарата?</p>	<p>11. The main disadvantages in all rotorcraft are lower maximum flight speed, low flight endurance, increased specific fuel consumption and complexity of control.</p>
<p>12. Які проблеми вирішують розробники гелікоптерів?</p>	<p>12. The problems of lessening the vibration, simplification of the controls, improving stability, increasing safety and making maintenance easier are being discussed by the helicopter developers.</p>
<p>13. Які розроблено модифікації гелікоптерів співвісної схеми?</p>	<p>13. The coaxial rotor helicopters have been produced in some versions: rescue, research, ambulance and ecological (monitoring the environment).</p>

Exercise 30. *Change the verbs from the Passive to Active form after the model. Mind the Tenses of the verbs (Simple Present, Present Perfect, Simple Past, Present Continuous).*

Model:	<p>1. Advanced technologies for helicopter industry are developed by researchers. Researchers develop advanced technologies for helicopter industry. Researchers have developed advanced technologies for helicopter industry this year. Researchers developed advanced technologies for helicopter industry last year. Researchers are developing advanced technologies for helicopter industry now.</p> <p>2. Multipurpose helicopters are developed. The group of designers develop multipurpose helicopters. The group of designers have developed multipurpose helicopters this year. The group of designers developed multipurpose helicopters last year. The group of designers are developing multipurpose helicopters now</p>
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1. The coaxial rotor of KA-226 is produced in four versions: rescue, research, ambulance and monitoring the environment. 2. The well known "Super Puma" is served by a crew of three. 3. The synthetic vision system (SVS) has been used by the representatives of helicopter manufacturers "Boing", "Sikorsky", "Russion". 4. The sand blaster system for helicopters was developed to help pilots land in the brownout conditions. 5. The problems of the helicopter flight, namely the lessening of vibration, simplification of the controls, improving stability, increasing safety and performing maintenance easier are being discussed by developers of present-day helicopters. 6. The rotor theory was developed by the Russian scientists Yuriev and Sabinin in 1911. 7. The first two coaxial helicopters were built by the designer Sikorsky in 1908–1910. 8. The pitch of the main rotor blades is controlled by two separate controls: "collective" and "cyclic". 9. The rotor system is classified as fully articulated, semirigid

and rigid. 10. Each rotor blade is attached to the rotor hub by a horizontal hinge. 11. The VIP version of some helicopters is equipped with video sets, satellite, auxiliary power unit for external-ground power supply, air conditioning.

Exercise 31. *Memorize the basic vocabulary to text 4.*

appearance	зовнішній вигляд
counteract	протидіяти
slot	щілина, проріз
fail	відмовляти, виходити з ладу
feature	1. особливість; 2. показувати; описувати
solid-state	твердий стан
rotor system	система несучих гвинтів
twist	1. крутити; вертити; викривляти; 2. крутка (<i>лопати, крила</i>)
piezoelectric	1. пьезоелектрик; 2. пьезоелектричний
linkage	1. з'єднання, зв'язок; 2. проводка (<i>системи управління</i>)
failure	відмова, вихід з ладу;
tilt	1. нахил; відхилення; 2. повертати, змінювати кут нахилу або установки
tiltrotor	конвертоплан
airborne	що знаходиться в повітрі
tip	нахилити(ся)
aloft	1. зверху; на висоті, 2. нагору

Exercise 32. *Read and translate text 4. Give your views on it.*

Text 4. HELICOPTER INNOVATIONS

The modern helicopter, like any complex machine, is an accumulation of innovations from numerous inventors and engineers. Some of these modifications improve performance significantly without changing the overall appearance of the aircraft.

One significant advancement in the last decade has been the no-tail rotor, or NOTAR, helicopter. As you now know, vertical-lift flight is impossible without a tail rotor to counteract the torque produced by the main rotor.

The much-smaller tail rotor makes a lot of noise and is often easily damaged. The NOTAR helicopter solves both of these problems. A large fan at the rear of the fuselage blows spent air from the main rotor down the tail boom. Slots along the side of the tail boom and at the end of the boom allow this air to escape. This creates a sideways force that counteracts the main rotor torque.

Some helicopters started receiving the second engine, which can operate the main rotor if the main engine fails. For example, the UH-60 Black Hawk helicopter, the workhorse of the U.S. Army, features this design improvement. Either engine can keep the aircraft aloft on its own¹, enabling the pilot to land safely in the event of an emergency.

Scientists have made efforts to simplify the main rotor assembly which is one of the most complex parts of a helicopter. In the late 1990s, researchers developed a solid-state adaptive rotor system incorporating piezoelectric sheets.

A piezoelectric material is one in which its molecules bend and twist in response to an electric field. In a rotor assembly, piezoelectric sheets — not mechanical linkages — twist sections of the blade root, thereby changing the pitch of the blades as they rotate.

This eliminates parts in the rotor hub and decreases the chance of a mechanical failure.

Finally, it's worth mentioning those strange machines, known as tiltrotors, that bring together the best features of helicopters and airplanes. A tiltrotor aircraft takes off like a helicopter, with its two main rotors upright².

But when it's airborne, the pilot can tip the rotors forward 90 degrees, enabling the machine to fly like conventional turboprop airplane. The V-22 Osprey, which completed a successful test flight in 1989, operates in this fashion.

Notes:

¹on its own – самостійно, без допомоги;

²upright – стояти вертикально, прямо.

Exercise 33. Choose verbs among the following words. Put their first letters into the cells below in the same order. Read and translate the word obtained.

--	--	--	--	--

Fashion, upright, prevent, machine, conventional, include, rotor, assembly, effort, transmit, airborne, forward, complete, complex, aloft, safe, hover, emergency, chance.

Exercise 34. *Speak on:*

1. Helicopter design features.
2. Types of helicopters.
3. Helicopter advantages and disadvantages.
4. Helicopter performance terminology.
5. Helicopter innovations.

Unit II

HELICOPTER ENGINES

Exercise 1. *Memorize the basic vocabulary to text 1.*

reciprocating engine	поршневий двигун
piston	поршень
produce power	виробляти потужність
rotate	обертатися
crankshaft	колінчастий вал
four-stroke engine	чотиритактний двигун
undergo	піддаватися
intake stroke	упускний хід, такт упускання
mixture	суміш
combustion chamber	камера згорання
cylinder head	головка циліндра
compression	стискання
spark plug	запальна свічка, свічка запалювання
ignite	запалювати (ся), займатися
power stroke	робочий хід
exhaust stroke	випускний хід, такт випускання

expell	виштовхувати
exhaust valve	вихлопний клапан
timing	відлік часу
gearbox	коробка передач; редуктор
assembly	складання
atomize	розпилювати
inject	впорскувати, нагнітати
output shaft	вивідний вал

Exercise 2. Read and translate text 1.

Text 1. TYPES OF HELICOPTER ENGINES

The two most common types of engines used in helicopters are the reciprocating engine and the turbine engine. Reciprocating engines, also called piston engines, are generally used in smaller helicopters. Most training helicopters use reciprocating engines because they are relatively simple and inexpensive to operate. Turbine engines are more powerful and are used in a wide variety of helicopters. They produce a tremendous amount of power for their size but are generally more expensive to operate.

The reciprocating engine consists of a series of pistons connected to a rotating crankshaft. As the pistons move up and down, the crankshaft rotates. The reciprocating engine gets its name from the back-and-forth movement of its internal parts. The four-stroke engine is the most common type, and refers to the four different cycles the engine undergoes to produce power.

When the piston moves away from the cylinder head on the intake stroke, the intake valve opens and a mixture of fuel and air is drawn into the combustion chamber. As the cylinder moves back towards the cylinder head, the intake valve closes, and the fuel/air mixture is compressed. When compression is nearly complete, the spark plugs fire and the compressed mixture is ignited to begin the power stroke. The rapidly expanding gases from the controlled burning of the fuel/air mixture drive the piston away from the cylinder head, thus providing power to rotate the crankshaft. The piston then moves back toward the cylinder head on the exhaust stroke where the burned gases are expelled through the opened exhaust valve.

When the engine is operated at a low speed, the four-stroke cycle takes place several hundred times each minute. In a four-cylinder engine, each cylinder operates on a different stroke. Continuous rotation of a crankshaft is maintained by the precise timing of the power strokes in each cylinder.

The gas turbine engine mounted on most helicopters is made up of a compressor, combustion chamber, turbine, and gearbox assembly. The compressor compresses the air, which is then fed into the combustion chamber where atomized fuel is injected into it. The fuel/air mixture is ignited and allowed to expand. This combustion gas is then forced through a series of turbine wheels causing them to turn. These turbine wheels provide power to both the engine compressor and the main rotor system through an output shaft.

Exercise 3. *Give Ukrainian equivalents.*

Stroke, piston, valve, gearbox, shaft, power, size, crankshaft, movement, cycle, mixture, fuel, oil, air, cylinder, compression, combustion, gas, speed, rotation, timing, rotor, compressor, chamber, turbine, assembly, wheel, intake, exhaust, operation, burning, engine, difference.

Exercise 4. *Translate the following "noun + noun" collocations.*

Engine operation, helicopter engine, piston engine, gas turbine engine, intake valve, cylinder head, power stroke, fuel air mixture, engine compressor, spark plug, gearbox assembly, turbine wheel, rotor system, intake stroke, exhaust stroke, combustion chamber, exhaust valve, exhaust gases.

Exercise 5. *Give corresponding nouns and translate the pairs.*

To ignite, to produce, to connect, to rotate, to move, to maintain, to assemble, to atomize, to inject, to burn, to compress, to expand, to extract, to provide, to locate, to direct, to press, to transmit, to fuel, to change, to heat, to collect, to operate, to mix, to vary, to differ.

Exercise 6. *Use the following verb combinations in sentences of your own.*

To use in helicopters, to produce a tremendous amount of power, to consist of a series of pistons, to move up and down, to produce power, to move away from the cylinder head, to move back, to expand gases, to

control burning of the fuel/air mixture, to drive the piston, to expel through the opened exhaust valve, to operate at a low speed, to take place, to operate on a different stroke, to mount on helicopters, to compress the air, to atomize fuel.

Exercise 7. *Put questions on the italicized words.*

1. *Reciprocating* engines are generally used in *smaller helicopters*.
2. *The reciprocating engine* consists of a *series of pistons connected to a rotating crankshaft*. 3. *The four-stroke engine* is the most common type, and refers to the *four different cycles the engine undergoes to produce power*. 4. *When compression is nearly complete*, the spark plugs fire and the *compressed mixture is ignited to begin the power stroke*. 5. *When the engine is operated at a low speed*, the four-stroke cycle takes place *several hundred times each minute*. 6. *Continuous rotation of a crankshaft* is maintained by the *precise timing of the power strokes in each cylinder*. 7. *The compressor* compresses the air. 8. *The fuel/air mixture* is ignited and allowed to expand. 9. *The turbine wheels* provide power to both the *engine compressor and the main rotor system through an output shaft* (3 questions).

Exercise 8. *Work with a partner. Ask and answer the questions.*

1. What are the most common types of engines used in helicopters?
2. What are reciprocating engines also called? 3. What helicopters are piston engines generally used in? 4. Are turbine engines more powerful? Why? 5. How do the pistons move? 6. What engines do training helicopter use? Why? 7. The reciprocating engine consists of a series of pistons connected to a rotating crankshaft, doesn't it? 8. When does the crankshaft rotate? 9. What is the four-stroke cycle? 10. How often does the four-stroke cycle take place? 11. How do cylinders operate in a four-cylinder engine? 12. What engine is mounted on most helicopters? 13. What does the gas turbine engine consist of? 14. What is the function of the compressor? 15. Where is the fuel atomized and ignited? 16. What provides power to both the engine compressor and the main rotor system through an output shaft?

Exercise 9. *Compose a summary of text 1.*

Exercise 10. Write out of the text words that can function both as nouns and verbs. Give their translation. There are more than 20 such words.

Exercise 11. Choose verbs among the following words. Put their first letters into the cells below in the same order. Read and translate the word obtained.

--	--	--	--	--	--	--

Common, purpose, provide, engine, ignite, internal, turbine, serve, stroke, movement, powerful, translate, mixture, compressor, operate, cylinder, reciprocating, valve, new, normalize, name.

Exercise 12. Memorize the words and word-combinations in order to do exercise 13.

synchronize	синхронізувати
forward speed	поступальна швидкість
airflow	обдув
water-cooled engine	двигун водяного охолодження
air-cooled engine	двигун повітряного охолодження
forced airflow fan	вентилятор примусового обдуву
level flight	горизонтальний політ
jerk	ривок
rigid coupling	жорстке з'єднання
cam clutch	кулачкова муфта
friction clutch	фрикційна муфта
idling	холостий хід, робота на холостому ході
engine starting	запуск двигуна
shut down	вимикати
transmit	передавати

Exercise 13. Translate these sentences into English.

- | |
|---|
| 1. Двигун гелікоптера слугує для обертання несучого гвинта. |
| 2. Якщо на гелікоптері є кілька несучих гвинтів, то вони можуть приводитися в обертання від одного загального двигуна, або кожен від окремого двигуна, але таким чином, аби обертання гвинтів було строго синхронізоване. |

3. Призначення двигуна на гелікоптері відрізняється від призначення двигуна на літаку, оскільки несучий гвинт створює як тягу, так і підйомну силу.
4. Гелікоптер може літати за відсутності поступальної швидкості, тобто висіти нерухомо у повітрі.
5. При зависанні гелікоптеравідсутні обдув і охолодження двигуна, водяного радіатора і маслорадіатора, внаслідок чого можливий перегрів двигуна і вихід його з ладу.
6. На гелікоптері доцільніше застосовувати двигун не водяного, а повітряного охолодження.
7. Двигун повітряного охолодження повинен мати привід для вентилятора примусового обдуву, який забезпечує охолодження двигуна на режимі зависання та при горизонтальному польоті
8. Регулювання температури двигуна і масла може здійснюватися шляхом зміни величини вхідного або вихідного отворів.
9. Авіаційний поршневий двигун зазвичай має кількість обертів — 2000 у хв.
10. На літаку двигун завжди жорстко з'єднаний з гвинтом.
11. Міцний, малого діаметра суцільнометалевий гвинт легко витримує ривки під час запуску поршневого двигуна.
12. Гвинт гелікоптера, який має великий діаметр, не розрахований на різкі змінні навантаження в площині обертання; при запуску може відбутися пошкодження лопатей від пускових ривків.
13. У момент запуску несучий гвинт гелікоптера від'єднаний від двигуна, тому двигун запускається вхолосту, без навантаження.
14. У конструкції двигуна є фрикційна і кулачкова муфти, які перед запуском двигуна вимкнені, при цьому обертання валу двигуна на несучий гвинт не передається.
15. Коли двигун вже запущений, його необхідно з'єднати з несучим гвинтом за допомогою фрикційної муфти.

Exercise 14. Memorize the basic vocabulary to text 2.

axial compressor	осьовий компресор
centrifugal compressor	відцентровий компресор
spindle	шпindelь
pressure stage	ступінь тиску/стиснення
impeller	крильчатка, нагнітач; робоче колесо (компресора двигуна)
diffuser	дифузор
manifold	колектор; патрубок
forge	ковати; штампувати
disc	диск
accelerate	прискорювати; збільшувати обороти, розкручувати(ся)
rate	швидкість
continuous	безперервний
igniter plug	запальна свічка, свічка запалювання
interruption	переривання
cease	припиняти, призупиняти
relight	повторний запуск (двигуна); запалювання палива при повторному запусканні
relight (relit – relit)	повторно запускати (двигун), підпалювати повторно
auto-relight	автопідпалення; автоматичний запуск (двигуна)
flame-out	зрив полум'я
sustain	підтримувати
self-sustaining	самопідтримуючий
pump	насос
power turbine	силова турбіна
direct-drive engine	двигун з прямим приводом
run	працювати (щодо двигуна)
true air speed	дійсна повітряна швидкість

Exercise 15. *Read, translate and give the gist of text 2*

Text 2. MAGOR COMPONENTS OF THE HELICOPTER ENGINE

There are two types of compressors: an axial compressor and a centrifugal compressor. The axial compressor includes two main elements, the rotor and the stator. The rotor consists of a number of blades fixed on a rotating spindle and resembles a fan. As the rotor turns, air is drawn rearwards. Stator vanes are arranged in fixed rows between the rotor blades and act as a diffuser at each stage to decrease air velocity and increase air pressure. There may be a number of rows of rotor blades and stator vanes. Each row constitutes a pressure stage. The number of stages depends on the amount of air and pressure rise required for the particular engine.

The centrifugal compressor consists of an impeller, a diffuser, and a manifold. The impeller, which is a forged disc with integral blades, rotates at a high speed to draw air in and expel it at an accelerated rate. The air then passes through the diffuser which slows the air down. When the velocity of the air is slowed, static pressure increases, resulting in compressed, high pressure air. The high pressure air then passes through the compressor manifold where it is distributed to the combustion chamber.

Unlike a piston engine, the combustion in a turbine engine is continuous. The igniter plug serves only to ignite the fuel/air mixture when starting the engine. Once the fuel/air mixture is ignited, it will continue to burn as long as the fuel/air mixture continues to be present. If there is an interruption of fuel, air, or both, combustion ceases. This is known as a "flame-out," and the engine has to be restarted or relit. Some helicopters are equipped with auto-relight, which automatically activates the igniters to start combustion if the engine flames out.

The turbine section consists of a series of turbine wheels that are used to drive the compressor section and the rotor system. The first stage, which is usually referred to as the gas producer or N1 may consist of one or more turbine wheels. This stage drives the components necessary to complete the turbine cycle making the engine self-sustaining. Common components driven by the N1 stage are the compressor, oil pump, and fuel pump. The second stage, which may also consist of one or more wheels, is

dedicated to driving the main rotor system and accessories from the engine gearbox. This is referred to as the power turbine (N2 or Nr).

If the first and second turbine stages are mechanically coupled to each other, the system is said to be a direct-drive engine or fixed turbine. These engines share a common shaft, which means the first and second stage turbines, and thus the compressor and output shaft, are connected.

On most turbine assemblies used in helicopters, the first stage and second stage turbines are not mechanically connected to each other. They are mounted on independent shafts and can turn freely with respect to each other. This is referred to as a "free turbine". When the engine is running, the combustion gases pass through the first stage to drive the compressor rotor, and then pass the independent second stage, which turns the gearbox to drive the output shaft.

Exercise 16. Give Ukrainian equivalents of the following terms.

Impeller, manifold, diffuser, rotor, stator, vane, blade, rate, velocity, fan, row, spindle, disc, plug, flame, pressure, chamber, turbine, mixture, start, interruption, restart, igniter, combustion, pump, stage, drive, gearbox, shaft, assembly, cycle, fuel, power, accessories, relight, safety, reliability, simplicity.

Exercise 17. Read and translate the following "noun + noun" collocations.

Compressor section, stator vane, rotor blade, pressure stage, pressure rise, compressor manifold, combustion chamber, igniter plug, fuel/air mixture, turbine section, rotor system, gas producer, turbine cycle, oil pump, fuel pump, engine gearbox, output shaft, combustion gases, gas turbine, pressure rate, power turbine, turbine assembly, compressor rotor, exhaust gases, Pratt & Whitney turbine engine.

Exercise 18. Translate the following verb combinations and use them in sentences of your own.

To consist of the rotor and stator, to arrange in fixed rows, to act as a diffuser, to decrease air velocity, to increase air pressure, to constitute a pressure stage, to depend on the amount of air and pressure rise, to rotate at a high speed, to draw air, to expel air at an accelerated rate, to pass through the diffuser, to result in high pressure air, to ignite the fuel/air

mixture, to start the engine, to burn the fuel/air mixture, to activate the igniters, to start combustion, to be referred to as the gas producer, to complete the turbine cycle, to make the engine self-sustaining, to be coupled to each other, to be mounted on independent shafts, to pass through the first stage, to drive the output shaft.

Exercise 19. *Work in pairs. Add question tags and answer them.*

1. The helicopter engine is used to rotate the main rotor, ...? 2. The main rotor generates both thrust and lift, ...? 3. The helicopter engine must have gearbox of a high reduction ratio, ...? 4. If the helicopter has several main rotors, they can be driven from one engine or each from a separate engine, ...? 5. The purpose of an engine on a helicopter differs from that of an engine on an airplane, ...? 6. The tail has a tendency to swing in one direction, ...? 7. A small anti-torque rotor is mounted at the tail, driven by an extension shaft from the engine transmission, ...? 8. The pitch of the tail rotor is adjusted so that at cruise speed the aircraft is trimmed to fly a straight course, ...? 9. The only helicopter Super Puma can fly in icing conditions, ...? 10. Instability, low airspeed, hovering make helicopter crew workload more difficult than in an airplane, ...?

Exercise 20. *Write out of text 2 words that can function both as verbs and nouns. There are more than 20 such words. Give their translation.*

Exercise 21. *Choose nouns among the following words. Put their first letters into the cells below in the same order. Read and translate the obtained word.*

--	--	--	--	--	--	--	--	--	--

Connect, compose, construction, cease, open, office, fixed, axial, manifold, constitute, particular, blade, simple, centrifugal, unit, usually, section, equip, complete, turbine, common, independent, some, impeller, between, require, operation, necessary, number, continuous.

Exercise 22. *Work with a partner. Ask and answer the questions.*

1. What types of compressors are there? 2. What does the axial compressor include? 3. What does the rotor consist of? 4. How are stator vanes arranged? 5. What constitutes a pressure stage? 6. What does the number of stages depend on? 7. What does the centrifugal compressor

consist of? 8. What does the igniter plug serve for? 9. What does the turbine section consist of? 10. What are turbine wheels used for? 11. What are the functions of the first and second turbine stages? 12. What is the "free turbine"?

Exercise 23. *Change the verbs from the Passive to Active form.*

1. The latest reliable and durable materials are extensively used in helicopter construction, the rotor blades, for example are made of glass plastic. 2. Engine access is used for engine maintenance. 3. The difference between dynamic air pressure and static air pressure is used for computing true air speed of the helicopter. 4. The first turbine stage is usually referred to as the gas producer or NI. 5. In the semi-rigid rotor the blades were attached rigidly to the hub. 6. Power is provided by a turbine unit mounted completely externally on the deck at the rear of the forward fuselage. 7. The standard of electrical equipment and avionics is intended for extreme reliability. 8. The high-altitude capacities of the helicopter, its reliability and safety, the simplicity of its technical servicing were appreciated by civil and military users. 9. The Ansat, a single-rotor helicopter is powered by two Pratt & Whitney PW-206C turbine engines.

Exercise 24. *Read, translate in writing and entitle text 3.*

Text 3

The engine, whether turbine or reciprocating, is connected to the blades via a transmission and drive shaft. This same engine also drives a small propeller — the 'tail rotor' — at the rear of the ship to overcome the torque generated by the main blades overhead. The pitch of the main rotor blades is controlled by two separate controls. The first, the 'collective', is located to the pilot's left. It is a rod that pivots at the back of the seat. Pulling this rod up increases the pitch of all the main blades the same amount and at the same time. This provides lift and makes the helicopter rise straight. Another stick, the 'cyclic', is located between the pilot's legs and controls the pitch of the main blades at various points around its arc.

Exercise 25. *Put key questions on the topic "Helicopter Engines".*

Exercise 26. *Speak on:*

1. Types of helicopter engines.
2. Major components of helicopter engines.

Unit III

HELICOPTER SYSTEMS

Exercise 1. Memorize the basic vocabulary to text 1.

transmission system	трансмiсія; система передачі
fuel system	паливна система
power transmission	силова передача
hydraulic system	гiдравлiчна система
stability augmentation system (SAS)	система автостабiлiзацiї/пiдвищення рiвня стiйкостi
autopilot	автопiлот
environmental system	система життєзабезпечення
anti-icing system	протиоблiднювальна система
tail rotor	рульовий/хвостовий гвинт
accessory	допомiжний агрегат
mechanical engineering	машинобудування
performance	льотно-технiчнi характеристики
sophisticated	1. складний; 2. сучасний
avionics	бортове (<i>radio</i>) електронне обладнання
malfunction	несправнiсть
emergency	аварiйна ситуацiя
machinery	машини, механiзми
flight controls	органи керування польотом
lighten	1. полегшувати 2. зменшувати (<i>вагу, навантаження</i>)
workload	(<i>фiзичне</i>) навантаження
fatigue	втома
incorporate	включати (<i>до складу чого-небудь</i>)
disturbance	порушення
sling loading	зовнiшня пiдвiска на тросах; вантаж, що пiдвищується пiд гелiкоптером
search and rescue	пошуково-рятувальнi (<i>операцiї</i>)
altitude	висота

heading hold	стабілізація курсу
heating	нагрів(ання)
cooling	охолодження
heat exchanger	теплообмінник
ram air	потік повітря, що набігає
air duct	повітропровід
contaminant	забруднююча речовина
slush	рідка грязь, сльота
coating	покриття, облицювання

Exercise 2. *Read, translate and give the gist of text 1.*

Text1. HELICOPTER SYSTEMS

There are different systems on board a helicopter to provide its proper operation. They are the transmission system, the fuel system, the electrical systems, the hydraulic system, the stability augmentation system, the autopilot system, the environmental and anti-icing systems.

The transmission system transfers power from the engine to the main rotor, tail rotor, and other accessories. In mechanical engineering, transmission or power transmission means all the mechanisms that connect the engine with what should move, as well as everything that ensures the operation of these mechanisms.

The helicopter fuel system allows the flight crew to pump, manage and deliver fuel to the engine. Fuel systems can differ greatly due to different performance characteristics of the helicopter in which they are installed.

The electrical systems, in most helicopters, reflect the increased use of sophisticated avionics and other electrical accessories. More and more operations in today's flight environment are dependent on the aircraft electrical system. However, all helicopters can be safely flown without any electrical power in the event of an electrical malfunction or emergency.

A hydraulic system uses a fluid under pressure to drive helicopter machinery or move its mechanical components. It provides an assisting force to move the respective flight controls, thus lightening the force required by the pilot. This eases the pilot's workload and fatigue.

Some helicopters incorporate a stability augmentation system (SAS) to help stabilize the helicopter in flight and in a hover. Stability augmentation systems reduce pilot's workload by improving basic aircraft control and decreasing disturbances. These systems are very useful when it is required to perform other duties, such as sling loading and search and rescue operations.

Helicopter autopilot systems are similar to stability augmentation systems, but they have additional features. An autopilot can actually fly the helicopter and perform certain functions selected by the pilot. The most common of them are altitude and heading hold.

The environmental system provides heating and cooling of the helicopter cabin. The simplest form of cooling is by ram air, which is let into the cabin through air ducts. Air conditioners or heat exchangers can be fitted to the helicopter as well.

The anti-icing system is responsible for the process of protecting strategic areas against frozen contaminant, snow, ice, or slush on a surface. Anti-icing materials or coatings are placed in strategic areas to reduce ice formation and improve performance.

Exercise 3. Give Ukrainian equivalents of the following terms and terminological word combinations.

Main rotor, tail rotor, mechanical engineering, power transmission, sophisticated avionics, electrical malfunction, performance characteristics, electrical accessories, assisting force, aircraft control, helicopter machinery, flight environment, electrical power, mechanical component, flight controls, pilot's workload, decreasing disturbances, sling loading, search and rescue operation, additional feature, altitude and heading hold, helicopter cabin, air duct, heat exchanger, strategic area, anti-icing material, ice formation, anti-icing coating, frozen contaminant.

Exercise 4. Give English equivalents of the following terms and terminological word combinations.

Система передачі, система автостабілізації, хвостовий гвинт, органи керування польотом, фізичне навантаження пілота, складна авіаційна електроніка, аварійна ситуація, теплообмінник, зовнішня підвіска на тросах, стабілізація курсу, потік повітря, що набігає, протиобліднувальне покриття, механізми гвинтокрила, нагрівання та охолодження.

Exercise 5. Make up sentences with the following word combinations.

To provide proper operation; to transfer power from the engine; to ensure the operation of mechanism; to deliver fuel to the engine; to differ greatly; to be installed in a helicopter; to be safely flown without any electrical power; in the event of malfunction; to move the respective flight controls; to lighten the force required by the pilot; to ease the pilot's workload; to incorporate a system; to help stabilize the helicopter in flight; to perform sling loading; to reduce pilot's workload; to provide heating and cooling; to be fitted to the helicopter; to protect strategic areas against frozen contaminant; to improve performance.

Exercise 6. Match the terms and their definitions.

- | | |
|-----------------|--|
| 1) transmission | a) a method of improving the navigation through the integration of external information into the calculation process |
| 2) hydraulics | b) the application of chemicals that keep atmospheric moisture from accumulating on helicopter surfaces |
| 3) augmentation | c) the electronic systems that include communications, navigation, the display and management of multiple systems fitted to aircraft or helicopter to perform individual functions |
| 4) anti-icing | d) the study and use of systems that work using hydraulic pressure on the parts of a vehicle that take power from the engine to the wheels |
| 5) hover | e) a system used to control the trajectory of an aircraft, marine craft or spacecraft without requiring constant manual control by a human operator |
| 6) avionics | f) nearly stationary flight in a helicopter |

Exercise 7. Match the names of systems in the left column with the functions they perform in the right column.

- | | |
|----------------------------------|---|
| 1) fuel system | a) provides heating and cooling of the helicopter cabin |
| 2) transmission system | b) flies the helicopter and performs certain functions selected by the pilot |
| 3) hydraulic system | c) deals with sophisticated avionics and other electrical accessories |
| 4) stability augmentation system | d) transfers power from the engine to the main rotor, tail rotor, and other accessories |
| 5) electrical system | e) pumps, manages and delivers fuel to the engine |
| 6) anti-icing system | f) uses fluid under pressure to drive helicopter machinery |
| 7) autopilot system | g) protects strategic areas against ice formation |
| 8) environmental system | h) stabilizes the helicopter in flight and in a hover |

Exercise 8. Fill in the gaps with the following terms: **helicopter machinery, pilot's workload, flight controls, electrical accessories, electrical power, disturbances, air ducts, assisting force, sophisticated avionics, ram air, performance characteristics, an electrical malfunction.** Translate the sentences.

1. Fuel systems can differ greatly due to different of the helicopter.
2. The electrical systems, in most helicopters, reflect the increased use of and other
3. All helicopters can be safely flown without any in the event of
4. Stability augmentation systems reduce by improving basic aircraft control and decreasing
5. The simplest form of cooling is by, which is let into the cabin through
6. A hydraulic system provides an to move the respective
7. A hydraulic system uses a fluid under pressure to drive

Exercise 9. Say whether the following sentences are true or false. Correct the false ones.

1. Fuel systems installed in different helicopters are mostly similar in design and functioning. 2. Helicopters are highly dependent on their electrical system and cannot fly safely without any electrical power in the event of an electrical malfunction or emergency. 3. A hydraulic system uses fluid under pressure to protect strategic areas against ice formation and improve performance. 4. An autopilot can actually fly the helicopter and perform heading hold. 5. Air conditioners and heat exchanges are a part of the environmental system. 6. Stability augmentation systems improve basic aircraft control. 7. Helicopter autopilot systems differ greatly from stability augmentation systems. 8. The most common functions of the autopilot are altitude and heading hold.

Exercise 10. Answer the questions on text 1.

1. What systems are there on board a helicopter to provide its proper operation? 2. Where does the transmission system transfer power? 3. What does power transmission mean in mechanical engineering? 4. What does the fuel system serve for? 5. Is the work of the electrical systems associated with the use of sophisticated avionics in most helicopters? 6. Can helicopters be safely flown without any electrical power in the event of an electrical malfunction or emergency? 7. What does the hydraulic system use fluid under pressure for? 8. Why do some helicopters incorporate a stability augmentation system? 9. What is the helicopter autopilot system similar to and what functions does it perform? 10. The anti-icing system provides heating and cooling of the helicopter cabin, doesn't it? 11. What is the anti-icing system responsible for? 12. Where are anti-icing materials or coatings placed and what for?

Exercise 11. Put questions on the italicized words.

1. *Helicopter rotors* allow it to take off and land vertically. 2. *A helicopter* carries loads connected to long cables or slings. 3. *Police departments* use helicopters to pursue suspects. 4. *Unsafe helicopter operation* can result in loss of control, structural damage, or loss of life. 5. *Helicopters* are used as air ambulances for emergency medical assistance in some situations. 6. *Unmanned helicopter system* is developed by company for military and surveillance duties. 7. *Transport helicopters* are used to ferry troops and supplies. 8. There are different systems on board a helicopter to provide its proper operation.

Exercise 12. Translate the following sentences into English.

1. Системи гелікоптера, що забезпечують його належну роботу – це система трансмісії, паливна система, електричні системи, гідравлічна система, система автостабілізації, система автопілота, системи життєзабезпечення та протиобледеніння
2. Паливна система гелікоптера перекачує, управляє та подає паливо до двигуна
3. Електрична система гелікоптера відображає широке використання складної авіоніки та інших електричних допоміжних агрегатів
4. Гелікоптером можна безпечно керувати за відсутності електроенергії у електромережі або в аварійній ситуації.
5. Рідина під тиском приводить в рух механізми гелікоптера і переміщує його механічні компоненти
6. Система автостабілізації використовується для стабілізації гелікоптера в польоті і зависанні
7. Робоче навантаження пілота знижується за рахунок поліпшення базового управління гелікоптером і зменшення перешкод
8. Система автопілота гелікоптера має додаткові функції, такі як утримання висоти і курсу
9. Обігрів та охолодження кабіни гелікоптера забезпечуються системою життєзабезпечення
10. Система протиобледеніння захищає стратегічні ділянки від змерзлих забруднюючих речовин, снігу, льоду або сльоти на поверхні

Exercise 13. Compose a dialogue on "Helicopter Systems". Ask about the systems used on board a helicopter, the purposes they serve for and operational situations they could be used in.

Exercise 14. Memorize the basic vocabulary to text 2.

main rotor	несний гвинт (гелікоптера)
transmission	трансмісія, передача
tail rotor drive system	система приводу хвостового ротора/кермового гвинта
clutch	муфта (зчеплення)

freewheeling unit	механізм холостого ходу (<i>несучого гвинта</i>)
lubricate	змащувати
oil supply	подача мастила
gauge	вимірювальний прилад
sight gauge	оглядовий вимірювальний прилад (<i>рівня мастила</i>)
chip detector	індикатор наявності стружки в мастилі
sump	відстійник; зливна ємність; резервуар
wire	1. дріт; 2. монтувати проводку
warning light	світловий аварійний сигналізатор (<i>лампа</i>)
instrument panel	приладова панель
burn off	спалювати
attempt	1. намагання, спроба 2. намагатися, пробувати
output	1. вихід, продуктивність; вихідна потужність 2. вихідний, на виході
r.p.m (revolutions per minute)	число оборотів за хвилину
maintain	підтримувати, зберігати
manoeuvring maneuvering (амер.)	маневрування
mount	встановлювати, монтувати
rotation	обертання
rotor shaft	вал несного гвинта
tail boom	хвостова балка
right angle	прямий кут
adjust	приспособляти; приганяти
disconnect	відключати, від'єднувати
starter	стартер; пристрій для запуску двигунів
engage	включати; з'єднувати
gradually	поступово
pick up	набирати швидкість, збільшувати обороти (<i>двигуна</i>)
load	навантаження
autorotation	авторотація, самообертання
disengage	від'єднувати; роз'єднувати

Exercise 15. *Read, translate and give the gist of text 2.*

Text 2. HELICOPTER TRANSMISSION SYSTEM

The purpose of the transmission system is to transfer power from the engine to the main rotor, tail rotor, and other accessories. The main components of the transmission system are the main rotor transmission, tail rotor drive system, clutch, and freewheeling unit.

Helicopter transmissions are normally lubricated and cooled with their own oil supply. A sight gauge is provided to check the oil level. Some transmissions have chip detectors located in the sump. These detectors are wired to warning lights located on the pilot's instrument panel that illuminate in the event of an internal problem. Some chip detectors on modern helicopters have a "burn off" capability and attempt to correct the situation without pilot action. If the problem cannot be corrected on its own, the pilot must refer to the emergency procedures for that particular helicopter.

The primary purpose of the main rotor transmission is to reduce engine output rpm to optimum rotor rpm. This reduction is different for the various helicopters. As an example, suppose the engine rpm of a specific helicopter is 2.700. A rotor speed of 450 r.p.m would require a 6:1 reduction. A 9:1 reduction would mean the rotor would turn at 300 r.p.m. Maintaining main rotor rpm is essential for adequate lift. Rpm within normal limits produces adequate lift for normal maneuvering.

In helicopters with horizontally mounted engines, another purpose of the main rotor transmission is to change the axis of rotation from the horizontal axis of the engine to the vertical axis of the rotor shaft. This differs from airplanes, which have their propellers mounted directly to the crankshaft.

The tail rotor drive system consists of a tail rotor drive shaft powered from the main transmission and a tail rotor transmission mounted at the end of the tail boom. The tail rotor transmission provides a right angle drive for the tail rotor and may also include gearing to adjust the output to optimum tail rotor r.p.m.

In a conventional airplane, the engine and propeller are permanently connected. However, in a helicopter they are not. Because of the greater weight of a rotor in relation to the power of the engine, as compared to the weight of a propeller and the power in an airplane, the rotor must be

disconnected from the engine when the starter is engaged. A clutch allows the engine to be started and then gradually pick up the load of the rotor.

The freewheeling unit allows the main rotor transmission to drive the tail rotor drive shaft during autorotation. If the engine fails, the freewheeling unit automatically disengages the engine from the main rotor when engine r.p.m. is less than main rotor r.p.m. This allows the main rotor to continue turning at normal in-flight speeds.

Exercise 16. *Translate the derivative chains.*

To lubricate-lubricated-lubrication; to detect-detected-detection; to engage-engaged-engagement; to maintain-maintained-maintenance; to transmit transmitted-transmission; to reduce-reduced-reduction; to disconnect-disconnected-disconnection; to adjust-adjusted-adjustment; to provide-provided-provision; to locate-located-location; to arrange-arranged-arrangement; to correct-corrected-correction.

Exercise 17. *Translate and memorize the words, which are used both as verbs and nouns.*

Line, manoeuvre, change, drive, level, switch, transfer, control, supply, store, feed, pump, light, drain, flow, service, reverse, start, use, pump, filter, board, condition, float, design, power, present, stop, charge, discharge, fuel, balance, check, force, function, wire.

Exercise 18. *Translate noun + noun terminological collocations.*

Rotor transmission, drive system, tail rotor, oil supply, chip detector, helicopter avionics, oil level, instrument panel, airframe design, engine weight, fluid pressure, emergency procedures, engine output, rotor speed, rotor shaft, engine power, rotor load, system failure, control unit, fuel level, power control, flight condition, fuel pump, float valve, oil quantity, propeller operation.

Exercise 19. *Use the following terminological word combinations in the sentences of your own.*

To transfer power to the main rotor; to be lubricated with own oil supply; to check oil level; to be located in the sump; to be wired to warning lights; to illuminate in the event of a problem; to be corrected on its own; to refer to the emergency procedures; to reduce engine output; to change the axis of rotation; to be mounted directly to the crankshaft; to

provide a right angle drive; to include gearing; to adjust engine output; to be permanently connected; to be disconnected from the engine; to engage the starter; to pick up the load of the rotor; to drive the tail rotor drive shaft; to disengage the engine; to continue turning; to operate at normal in-flight speeds.

Exercise 20. Match the English – Ukrainian equivalents.

- | | |
|----------------------------|---|
| 1) warning light | a) головна передача ротора |
| 2) tail rotor drive system | b) сигналізатор стружки в мастилі |
| 3) engine output | c) муфта (зчеплення) |
| 4) freewheeling unit | d) система приводу кермового гвинта |
| 5) main rotor transmission | e) вимірювальний прилад (рівня мастила) |
| 6) clutch | f) механізм вільного ходу |
| 7) chip detector | g) світловий аварійний сигналізатор |
| 8) sight gauge | h) вал несного гвинта |
| 9) rotor shaft | i) потужність двигуна |
| 10) starter | j) хвостова балка |
| 11) tail boom | k) пристрій для запуску двигунів |

Exercise 21. Give definitions of the following terms.

Transmission, transmission system, main rotor transmission, sight gauge, chip detector, engine output, tail rotor drive system, tail rotor transmission, starter, clutch, freewheeling unit, autorotation.

Exercise 22. Complete the sentences giving English equivalents of the words in brackets.

1. The main components of the transmission system are (трансмiсія несного гвинта, система приводу кермового гвинта, зчеплення та механізм вільного ходу). 2. The primary purpose of the main rotor transmission is (знизити швидкість обертання вихідного валу двигуна до оптимальної швидкості обертання ротора). 3. The purpose of the main rotor transmission is (змінити вісь обертання з горизонтальної осі двигуна на вертикальну вісь вала ротора). 4. The tail rotor drive system consists of (привідний вал кермового гвинта, що приводиться в дію від головної передачі, та трансмісія кермового гвинта, встановлена

на кінці хвостової балки). 5. The tail rotor transmission provides (привід кермового гвинта під прямим кутом). 6. A clutch allows the engine to be started and then (поступово піднімати навантаження ротора). 7. The free wheeling unit allows the main rotor transmission (приводити в дію привідний вал кермового гвинта під час авторотації). 8. Airplanes, which have their propellers (встановлені безпосередньо на колінчастому валу).

Exercise 23. *Answer the questions on text 2.*

1. What are the main components of the transmission system?
2. What are helicopter transmissions normally lubricated and cooled with?
3. Chip detectors are provided to check the oil level, aren't they?
4. When do the warning lights on the pilot's instrument panel illuminate?
5. When must the pilot refer to the emergency procedures?
6. What are the two primary purposes of the main rotor transmission?
7. What does the tail rotor drive system consist of?
8. Are the engine and propeller permanently connected on aircraft or helicopters?
9. Why must the rotor be disconnected from the engine when the starter is engaged?
10. What function does the clutch perform?
11. What unit allows the main rotor transmission to drive the tail rotor drive shaft during autorotation?
12. When does the freewheeling unit disengage the engine from the main rotor?

Exercise 24. *Ask questions on the gaps beginning with the question words given in brackets. Answer the questions.*

1. Quadcopters have ... rotors with parallel axes (How many?).
2. The reduction of engine output differs ... for various helicopters (How?).
3. The freewheeling unit automatically disengages the engine from ... when engine r.p.m. is less than main rotor r.p.m (What ... from?)
4. Some transmissions have chip detectors located ... (Where?).
5. The pedals are used to control ... (What?).
6. A sight gauge is provided to ... (What ... for?).
7. Chip detectors are wired to ... (What to?).
8. The tail rotor transmission may include gearing ... (What...for?).
9. The rotor must be disconnected from the engine ... (Why?).
10. Early helicopter designs utilized ... (What?).
11. ... revolutionized the aviation industry (What?).

Exercise 25. Put questions of different kinds on the following sentences.

1. A helicopter carries loads connected to long cables. 2. A helicopter can take off and land vertically due to its operating characteristics. 3. Helicopter uses include transportation of people and cargo, military uses, construction, firefighting, etc. 4. A helicopter is used as air ambulances for emergency medical assistance. 5. Unmanned aerial systems vary in sizes and missions they perform. 6. Helicopters are used in the logging industry to lift trees out of terrain. 7. Helicopters are often equipped with lighting and heat-sensing equipment for night operation.

Exercise 26. Translate the following sentences into English.

1. Система трансмісії слугує для передачі потужності від двигуна до несного гвинта, кермового гвинта та інших допоміжних пристроїв
2. Основними компонентами системи трансмісії є трансмісія несного гвинта, система приводу кермового гвинта, зчеплення та механізм вільного ходу
3. Трансмісії гвинтокрилів зазвичай змащуються та охолоджуються власною системою подачі масла
4. Для перевірки рівня масла використовується оглядовий вимірювальний прилад
5. Детектори стружки підключені до світлових аварійних сигналізаторів, розташованих на приладовій панелі пілота
6. Трансмісія несного гвинта зніжує швидкість обертів двигуна на виході до оптимальної швидкості обертів ротора
7. Зчеплення дозволяє запускати двигун, а потім поступово піднімати навантаження ротора
8. У звичайному літаку двигун і гвинт постійно з'єднані
9. Механізм вільного ходу автоматично відключає двигун від несного гвинта, якщо двигун виходить з ладу
10. Якщо проблему не вдається усунути самостійно, пілот повинен перейти до аварійних заходів

Exercise 27. Memorize the basic vocabulary to text 3.

single-engine piston helicopter	одномоторний поршневий гвинтокрил
multi-engine helicopter	багатомоторний гелікоптер
fuel supply system	система подачі палива
engine fuel control system	система регулювання подачі палива до двигуна
fuel tank	паливний бак
airframe	корпус
vent	вентиляційний отвір
fuel quantity gauge	паливомір, датчик кількості палива
shut-off valve	перекривний/відсічний клапан
fuel filter	паливний фільтр
fuel line	паливний трубопровід/лінія/магістраль
primer	заливний насос
fuel pump	паливний насос
negligible	незначний
center of gravity	центр тяжіння
drain	1. зливання; 2. зливати
sediment	осад, відстій
overflow	1. надлишок; 2. переливати через край
expand	збільшувати (<i>розмір, обсяг</i>), розширювати
rupture	проривати, розривати
sensing unit	сенсорний датчик
capacity	ємність, літраж
gallon	галон (<i>міра рідких і сипучих тіл</i>)
carburetor	карбюратор
fuel injection system	система впорскування палива
pound	фунт (<i>одиниця ваги</i>)
full authority digital electronic engine control (FADEC)	цифрове електронне керування режимами роботи двигуна
analog electronic engine control (EEC)	аналогове електронне керування двигуном

overriding	заміщування
control unit	блок керування
emergency mode	аварійний режим
accomplish	1. виконувати 2. завершувати, доводити до кінця

Exercise 28. *Read, translate and give the gist of text 3.*

Text 3. HELICOPTER FUEL SYSTEM

The purpose of the helicopter fuel system is to deliver an adequate supply of clean fuel to the engine at the proper pressure and temperature under all flight conditions. Fuel systems can be different according to the performance characteristics of the helicopter. A single-engine piston helicopter will have a very simple fuel system, while a multi-engine helicopter will have a far more complex system. A helicopter fuel system will vary as to what kind of engine or engines are being used, and what are the performance characteristics of the helicopter as to speed, altitude, etc.

The fuel system in a helicopter is made up of two groups of components: the fuel supply system and the engine fuel control system.

The supply system consists of a fuel tank or tanks, fuel quantity gauges, a shut-off valve, fuel filter, a fuel line to the engine, and possibly a primer and fuel pumps.

The fuel tanks are usually mounted to the airframe as close as possible to the center of gravity. This way, as fuel is burned off, there is a negligible effect on the center of gravity. A drain valve located on the bottom of the fuel tank allows the pilot to drain water and sediment that may have collected in the tank. A fuel vent prevents the formation of a vacuum in the tank, and an overflow drain allows for fuel to expand without rupturing the tank. A fuel quantity gauge located on the pilot's instrument panel shows the amount of fuel measured by a sensing unit inside the tank. Some gauges show tank capacity in both gallons and pounds. The fuel travels from the fuel tank through a shut-off valve, which provides a means to completely stop fuel.

The purpose of the fuel control system is to bring outside air into the engine, mix it with fuel in the proper proportion, and deliver it to the combustion chamber. Fuel is delivered to the cylinders by either a carburetor or fuel injection system.

Two types of fuel control system that are used today by most modern turbine helicopters are the full authority digital electronic engine control (FADEC) and analog electronic engine control (EEC). FADECs have no form of manual overriding available, giving the computer full authority over the operating parameters of the engine. If a total FADEC failure occurs, the engine fails. If the engine is controlled digitally and electronically but allows for manual operation, it is considered an EEC or electronic control unit. It allows the pilot to continue to operate the engine while in emergency mode (manual mode).

With fuel being so important to the operation of the engines, anything that can hurt the fuel system can have a negative impact on engine performance, which can prevent the helicopter from accomplishing its mission.

Exercise 29. Translate the terms and verb combinations from text 3.

a) adequate supply of clean fuel; proper pressure; performance characteristics; multi-engine helicopter; single-engine piston helicopter; complex system; engine fuel control system; fuel quantity gauge; center of gravity; negligible effect; fuel injection; operating parameters; emergency mode; manual operation;

b) to deliver under all flight conditions; to be mounted to the airframe; to burn off fuel; to drain water and sediment; to collect in the tank; to prevent formation of a vacuum; to expand without rupturing the tank; to be measured by a sensing unit; to show tank capacity; to bring outside air into the engine; to be controlled digitally; to operate in emergency mode; to prevent from accomplishing mission.

Exercise 30. Match the English – Ukrainian equivalents.

- | | |
|-------------------------------|---|
| 1) fuel quantity gauge | a) система регулювання подачі палива до двигуна |
| 2) fuel supply system | b) цифрове електронне керування режимами роботи двигуна |
| 3) shut-off valve | c) система подачі палива |
| 4) engine fuel control system | d) паливомір |
| 5) electronic control unit | e) перекривний клапан |

6) full authority digital electronic engine control	f) електронний блок керування
7) emergency mode	g) аналогове електронне управління двигуном
8) fuel injection system	h) датчик
9) analog electronic engine control	i) аварійний режим
10) sensing unit	j) система впорскування палива

Exercise 31. Fill in the gaps with the following terms: a shut-off valve, the fuel supply system, tank capacity, the engine fuel control system, electronic control unit, a drain valve, a fuel quantity gauge, a sensing unit, emergency mode, fuel tank.

1. The fuel system in a helicopter is made up of two groups of components: ... and ... 2. ... located on the bottom of the ... allows the pilot to drain water and sediment. 3. ... located on the pilot's instrument panel shows the amount of fuel measured by ... 4. Some gauges show ... in both gallons and pounds. 5. The fuel travels from the fuel tank through ..., which provides a means to completely stop fuel. 6. ... allows the pilot to continue to operate the engine while in ... or manual mode.

Exercise 32. Answer the questions on text 3.

1. What is the purpose of the helicopter fuel system? 2. What systems do single-engine piston helicopters and multi-engine helicopters use? 3. What components is the fuel system made up of? 4. The fuel tanks are mounted to the airframe as far as possible from the center of gravity, aren't they? Why? 5. What system consists of a fuel tank, fuel quantity gauges, a shut-off valve, fuel filter, a fuel line to the engine and pumps? 6. The purpose of the engine control system is to bring outside air into the engine, mix it with fuel in the proper proportion, and deliver it to the combustion chamber, isn't it? 7. What two types of fuel control system are used today by most modern turbine helicopters? 8. What is the difference between the full authority digital engine control (FADEC) and analog electronic engine control (EEC)? 9. Which of these systems allows to operate the engine in emergency mode? 10. Why is the fuel system so important to the operation of the helicopter?

Exercise 33. *Put questions on the italicized words.*

1. *The fuel system is complex because fuel is stored in some interconnected tanks.* 2. *Severe changes in temperature and pressure occur as the helicopter maneuvers.* 3. *Fuel systems for helicopter engines vary widely with the engine type and performance characteristics of the helicopter.* 4. *Anything that can hurt the fuel system can have a negative impact on engine performance.* 5. *Any system must be designed to satisfy particular requirements of a helicopter.*

Exercise 34. *Write out of text 3 Passive verb forms and analyze their structure.*

Exercise 35. *Open the brackets using the verb in the Present Indefinite Active or Passive.*

1. Some helicopter-type vehicles (to use) electric motors. 2. Fuels other than gasoline (to use) on radio-controlled helicopters, which (to operate) on piston engines. 3. Some turbine engines (to use) commonly in helicopters and can (to work) on biodiesel instead of jet fuel. 4. The fuel (to travel) from the fuel tank through a shut-off valve, which (to provide) a means to completely stop fuel. 5. The fuel system in a helicopter (to make up) of two groups of components. 6. The fuel tank (to mount) to the airframe as close as possible to the center of gravity. 7. The fuel control system (to bring) outside air into the engine and (to mix) it with fuel in the proper proportion. 8. Then fuel (to deliver) the combustion chamber. 9. The engine can (to control) digitally and electronically but also (to allow) manual operation. 10. Fuel systems can (to be) different according to the performance characteristics of the helicopter. 11. A drain valve (to locate) on the bottom of the fuel tank. 12. Drain valves (to allow) the pilot to drain water that (to collect) in the tank.

Exercise 36. *Change sentences from Active to Passive.*

1. Manufactures provide many subsystems to ensure safe and reliable operation. 2. The engine driven pump supplies fuel to the engine. 3. Fuel nozzles atomize fuel. 4. The main fuel pump provides continuous fuel flow. 5. Switches in the cockpit control the electrical pumps. 6. A vent prevents vacuum formation. 7. A fuel filter removes any remaining moisture and sediment from the fuel. 8. A fuel quantity gauge shows the amount of fuel measured by a sensing unit. 9. The electrical pumps maintain positive fuel pressure. 10. The airplanes with present-day engines use complex fuel systems.

Exercise 37. Translate the following sentences into English.

1. Паливна система забезпечує достатню подачу чистого палива до двигуна при належному тиску і температурі за будь-яких умов польоту
2. Паливна система гвинтокрила складається з системи подачі палива та системи регулювання подачі палива до двигуна
3. Паливні баки зазвичай кріпляться до корпусу якомога ближче до центру тяжіння
4. Зливний клапан, розташований на дні паливного бака, дозволяє пілотові зливати воду і відстій
5. Паливомір, розташований на приладовій панелі пілота, показує кількість палива у баці
6. Система регулювання подачі палива до двигуна подає зовнішнє повітря до двигуна, змішує його з паливом у потрібній пропорції та подає у камеру згоряння
7. Сьогодні на більшості сучасних вертольотів з турбінним двигуном використовуються два типи систем контролю палива: цифрове управління двигуном (FADEC) і аналогове електронне управління двигуном (ЕЕС)
8. Все, що може пошкодити паливну систему, може негативно вплинути на роботу двигуна
9. Одномоторні поршневі гвинтокрили мають дуже просту паливну систему, у порівнянні з багатомоторними гвинтокрилами, які мають набагато більш складну систему
10. Паливні системи розрізняються залежно від льотно-технічних характеристик гвинтокрилів

Exercise 38. Compose a dialogue on "Helicopter Fuel System".

- Ask about 1) the purpose of the fuel system; 2) its main components; 3) the principles of functioning; 4) two types of fuel supply control; 5) general importance of fuel system to helicopter operation.

Exercise 39. Memorize the basic vocabulary to text 4.

battery	батарея, акумулятор
starting vibrator	пусковий вібратор
alternator	генератор змінного струму
circuit breaker	автомат захисту електромережі
switch	вимикач; перемикач
direct current	постійний струм
alternating current	змінний струм
generator	генератор, джерело енергії
turn over	1. обертати; 2. перевертати
standby	резервний, запасний; аварійний
emergency electrical power	аварійна система енергопостачання
ammeter	амперметр
loadmeter	вимірювач навантаження
fuse	плавкий запобіжник
overload	перевантаження
pop out	(тут) спрацьовувати
loss of power	втрата енергопостачання
charge	1. заряд; 2. заряджати

Exercise 40. Read, translate and give the gist of text 4.

Text 4. HELICOPTER ELECTRICAL SYSTEMS

The electrical systems in most helicopters deal with avionics and other electrical accessories. Their various components include battery, starting vibrator, starter, alternator, all circuit breakers and switches.

Helicopters have either a 14- or 28-volt, direct-current electrical system.

Turbine powered helicopters use a starter/generator system. The starter/generator is permanently connected to the engine. When starting the engine, electrical power from the battery is supplied to the starter/generator, which turns the engine over. Once the engine is running, the starter/generator is driven by the engine and is then used as a generator.

An alternator is an electrical generator that converts mechanical energy to electrical energy in the form of alternating current.

A battery is mainly used for starting the engine. In addition, it permits limited operation of electrical components, such as radios and lights, without the engine running. The battery is also a valuable source of standby or emergency electrical power in the event of alternator or generator failure. An ammeter or loadmeter is used to monitor the electrical current within the system. The ammeter reflects current flowing to and from the battery.

Electrical switches are used to select electrical components. Circuit breakers or fuses are used to protect various electrical components from overload. A circuit breaker pops out when its respective component is overloaded. Caution lights on the instrument panel may be installed to show the malfunction of an electrical component.

Flight is still possible during a total loss of electrical power, and students should be taught to remain calm and safely land the helicopter. The engine continues to operate normally without electrical power. The battery, if fully charged, provides a limited time of power for items such as radios.

Exercise 41. Form nouns from the following verbs by adding the following suffixes: -t(-ion), -ancel-ence, -ment, -or/er and translate them.

Arrange, develop, direct, differ, resist, transform, measure, generate, connect, depend, attach, create, attract, activate, perform, operate, indicate, react, equip, require, locate, move, assist, express.

Exercise 42. Form adjectives from the following verbs by adding the following suffixes: -able\ible, -ful, -ive, -ous, -al and translate them.

Adjust, access, change, consider, act, harm, attract, construct, form, operate, structure, move, correct, create, rely, effect, express, interchange, value, comprehend, understand, reverse, continue, use.

Exercise 43. Form adverbs from the following adjectives by adding the suffix -ly and translate them.

Clear, easy, equal, definite, complete, exact, frequent, gradual, immediate, obvious, proper, recent, slow, sudden, natural, dangerous, comfortable.

Exercise 44. Match the synonyms in the left and right columns.

1. warning light	a) reserve
2. malfunction	b) feed
3. stand-by	c) fuse
4. running	d) failure
5. supply	e) caution light
6. circuit breaker	f) rotate
7. turn over	g) operating

Exercise 45. Give Ukrainian equivalents of the following terms and terminological word combinations.

Battery, starting vibrator, starter, alternator, circuit breaker, switch, direct-current, generator, alternating current, warning light, emergency electrical power, standby power, alternator, ammeter, loadmeter, fuse, overload, malfunction, loss of power, caution light, instrument panel.

Exercise 46. Make up sentences with the following verb combinations.

To be supplied to the starter or generator; to turn the engine over; to be driven by the engine; to convert mechanical energy into electrical energy; to be used for starting the engine; to permit limited operation; to use standby or emergency electrical power; to monitor electrical current; to protect various electrical components from overload; to pop up to show malfunction; to indicate loss of electrical power; to operate normally without electrical power; to be fully charged.

Exercise 47. Paraphrase the sentences according to the model.

Model: A battery starts the engine.

a) A battery *serves for* starting the engine.

b) A battery *is used to* start the engine.

c) *The function of* a battery is to start the engine.

1. An alternator converts mechanical energy to electrical energy.
2. A generator turns the engine over. 3. Circuit breakers protect various electrical components from overload. 4. An ammeter monitors the electrical current within the system. 5. Electrical switches select electrical components. 6. The ammeter reflects current flowing to and from the battery.

Exercise 48. *Fill in the blanks with proper prepositions' to, in, on, for, of, from, with, through, within, into. Translate the sentences.*

1. Maintaining main rotor rpm is essential ... adequate lift. 2. Rpm ... normal limits produces adequate lift ... normal maneuvering. 3. The fuel travels ... the fuel tank ... a shut-off valve. 4. The purpose ... the fuel control system is to bring outside air ...the engine, mix it ... fuel ... the proper proportion, and deliver it ... the combustion chamber. 5. The starter/generator is permanently connected ... the engine. 6. An alternator is an electrical generator that converts mechanical energy ... electrical energy ... the form ... alternating current. 7. The ammeter reflects current flowing ... and ... the battery. 8. Circuit breakers or fuses are used to protect various electrical components ... overload. 9. Caution lights ... the instrument panel are installed to show the malfunction ... an electrical component.

Exercise 49. *Write out of text 4 a) Passive verb forms; b) Gerund forms; c) Participles I and II forms.*

Exercise 50. *Put key questions on text 4.*

Exercise 51. *Ask questions on the missing information. Complete the following statements.*

1. The electrical systems in most helicopters deal with... .
2. Various components of the electrical systems include
3. Helicopters have either a 14- or 28-volt, electrical system.
4. The starter/generator is permanently connected to
5. An alternator is an electrical generator that converts 6. A battery is mainly used for 7. The battery is also a valuable source of electrical power in the event of 8. Electrical switches are used to
9. Caution lights on the instrument panel may be installed to show
10. A circuit breaker pops out when

Exercise 52. *Compose a summary of text 4.*

Exercise 53. *Speak on:*

1. Helicopter systems.
2. Transmission system.
3. Fuel system.
4. Electrical system.

Unit IV

HELICOPTER FLIGHT CONTROLS

Exercise 1. *Memorize the basic vocabulary to text 1.*

manipulate	1. майстерно здійснювати ручне управління 2. вміло поводитися
flight controls	органи управління літальним апаратом
collective pitch control	управління спільним кроком (<i>несного гвинта</i>)
throttle	дросель, важіль управління двигуном
throttle control	управління тягою
cyclic pitch control	автомат-перекіс; управління циклічним кроком (<i>лопатеї несучого гвинта</i>)
lever	важіль
pitch lever	важіль кроку (<i>лопатеї, гвинта</i>)
pitch angle	1. кут нажиму (<i>лопатеї</i>) 2. кут тангажу
twist outboard\ inboard	крутити (<i>дросель</i>) назовні/всередину
pitch change mechanism	механізм зміни кроку
angle of attack	кут атаки
reverse	реверс; зворотна дія
conjunction	зчеплення, з'єднання
tall rotor gearbox	редуктор хвостового//кермового гвинта
offset	компенсувати, врівноважувати
pedal	педаля
stick-type control	керування за допомогою важеля
tip	нахиляти; відхиляти
plane of rotation	площина обертання
sequential	1. послідовний 2. наступний

Exercise 2. Read, translate and give the gist of text 1.

Text 1. BASIC CONTROLS OF HELICOPTER

A helicopter pilot manipulates the helicopter flight controls to achieve and maintain controlled aerodynamic flight. A helicopter has four controls: the collective pitch control, the throttle control, the antitorque control, and the cyclic pitch control.

The collective pitch control is usually found at the pilot's left hand. It is a lever that moves up and down to change the pitch angle of the main rotor blades. Raising or lowering the pitch control increases or decreases the pitch angle on all blades by the same amount. An increase in the pitch angle will increase the angle of attack, causing both lift and drag to increase and causing the rpm of the rotor and the engine to decrease. The reverse happens with a decrease in pitch angle.

Because it is necessary to keep rotor rpm as constant as possible, the collective pitch control is linked to the throttle to automatically increase power when the pitch lever is raised and decrease it when the pitch lever is lowered. The collective pitch control thus acts as the primary control both for altitude and for power.

The function of the throttle is to regulate engine r.m.p. The throttle control is used in conjunction with the collective pitch control and is an integral part of its assembly. The throttle control is twisted outboard to increase rotor rpm and inboard to decrease rpm.

The antitorque controls are pedals linked to operate a pitch change mechanism in the tail rotor gearbox. A change in pedal position changes the pitch angle of the tail rotor to offset torque. As torque varies with every change of flight condition, the pilot is required to change pedal position accordingly. The antitorque control does not control the direction of flight.

It was stated above that the lift/thrust force is always perpendicular to the plane of rotation of the rotor. The cyclic pitch control, a stick-type control found to the pilot's right, controls the direction of flight by tipping the plane of rotation in the desired direction. The term cyclic derives from the sequential way each blade's pitch is changed so that it takes the flight path necessary to effect the change in direction.

Exercise 3. *Form antonymous adjectives from the following words by adding negative prefixes: -in, -ir, -dis, -im, -un, -il and translate them.*

Active, able, capable, relevant, formal, dependent, direct, legal, safe, necessary, logical, possible, efficient, visible, practical, measurable, secure, regular, predictable, usual, responsible, probable, reliable.

Exercise 4. *Translate the derivative chains.*

Accomplish — accomplished-accomplishment; accuracy — accurate — accurately; achieve-achievement — achievable; combine — combination — combined; compare — comparison — comparative — comparatively; define-definition — definite — definitely; fail — failure; harm — harmful-harmfully; innovate — innovator — innovation — innovative; limit-limitation — limited; period — periodical — periodically; save — safe — safety-(un)safe — safely; separate — separation — separately; use — user — useful — usefully.

Exercise 5. *Find English equivalents in text 1.*

Органи управління; кут нахилу лопатей; кут атаки; зворотна дія; лопаті несного гвинта; механізм зміни кроку; редуктор хвостового гвинта; керування за допомогою важеля; важіль загального кроку.

Exercise 6. *Translate the verb combinations from text 1.*

To change pitch angle; to lower pitch control; to be linked to the throttle; to automatically increase power; to act as the primary control; to regulate engine r.m.p.; to be used in conjunction with; to be an integral part of the assembly; to operate a pitch change mechanism; to offset torque; to change pedal position; to tip the plane of rotation; to control the direction of flight; in the desired direction; to take the flight path to effect the change in direction.

Exercise 7. *Complete the following statements based on text 1.*

1. A helicopter pilot manipulates the helicopter flight controls to achieve and maintain 2. The collective pitch control is usually found at 3. Raising or lowering the pitch control increases or decreases on all blades by the same amount. 4. An increase in the pitch angle will increase , causing both lift and drag to ... and causing the rpm of the rotor and the engine to 5. The collective pitch control acts as

both for altitude and for 6. The function of the throttle is to 7. The throttle control is used in conjunction with 8. The antitorque controls are pedals linked to operate in the tail rotor gearbox. 9. The lift/thrust force is always perpendicular to 10. The cyclic pitch control controls the direction of flight by tipping

Exercise 8. *Ask questions about missing information in exercise 7.*

Exercise 9. *Answer the questions on text 2.*

1. What does a pilot use the helicopter flight controls for? 2. What controls does a helicopter have? 3. Where is the collective pitch control usually located? 4. How does a lever of the collective pitch control move? 5. Does raising the pitch control increase or decrease the pitch angle on all blades by the same amount? 6. How are the pitch angle and the angle of attack interrelated? 7. How important is the collective pitch control in controlling the flight? 8. What is the collective pitch control linked to? 9. What is the function of the throttle? 10. Is the throttle control twisted outboard to increase or decrease rotor rpm? 11. What are the antitorque control pedals linked to? 12. What controls the direction of flight by tipping the plane of rotation in the desired direction? 13. What does the term cyclic derive from?

Exercise 10. *Give definitions of the following terms.*

Flight controls, collective pitch control, throttle control, antitorque control, cyclic pitch control, pitch angle, angle of attack, pitch lever.

Exercise 11. *Fill in the blanks with proper prepositions: to, at, up, into, with, in, of, by, above, down, downward. Translate the sentences.*

1. The collective pitch control is usually found ... the pilot's left hand. 2. The collective pitch control is a lever that moves ... and ... to change the pitch angle ... the main rotor blades. 3. The reverse happens ... a decrease ... pitch angle. 4. The collective pitch control is linked ... the throttle to automatically increase and decrease power. 5. The throttle control is used ... conjunction ... the collective pitch control and is an integral part ... its assembly. 6. A change ... pedal position changes the pitch angle ... the tail rotor to offset torque. 7. The lift/thrust force is

always perpendicular ... the plane of rotation ... the rotor. 8. The cyclic pitch control controls the direction ... flight ... tipping the plane of rotation ... the desired direction. 9. In normal powered helicopter flight, air is drawn ... the main rotor system from ... and exhausted

Exercise 12. *Memorize the basic vocabulary to text 2.*

forward flight	прямолінійний/горизонтальний політ
deviation	відхилення (<i>від курсу, маршруту</i>)
attitude	положення літака в повітрі
cyclic	ручка керування (<i>гвинтокрилом</i>)
drift	(бічне) знесення
heading	курс
fixed-wing aircraft	літальний апарат з нерухомим крилом
pitch down/up	опускатися/підніматися
climb	1. набір висоти, підйом 2. набирати висоту, підніматися
induce	викликати; призводити (<i>до чогось</i>)
descend	знижуватися
rotary-wing aircraft	гвинтокрилий літальний апарат
autogyro	автожир
exhaust	1. випуск, вихлоп 2. випускати
relative wind	відносний потік, набігаючий потік
engine failure	відмова двигуна
single-engine helicopter	одномоторний гвинтокрил
means	засіб
type certificate	сертифікат типу

Exercise 13. *Read, translate and give the gist of text 2.*

Text 2. HELICOPTER BASIC FLIGHT CONDITIONS

There are three basic flight conditions for a helicopter: hover, forward flight and autorotation.

Hover. Some pilots consider hovering the most challenging aspect of helicopter flight. This is because helicopters are generally dynamically unstable, meaning that deviations from a given attitude are not corrected without pilot input. Thus, frequent control inputs and corrections must be made by the pilot to keep the helicopter at a desired location and altitude. The pilot's use of control inputs in a hover is as follows: the cyclic is used to eliminate drift in the horizontal plane collective is used to maintain desired altitude; and the tail rotor or anti-torque system pedals are used to control nose direction or heading.

Forward flight. In forward flight, a helicopter's flight controls behave more like those in a fixed-wing aircraft. Moving the cyclic forward makes the nose pitch down, thus losing altitude and increasing airspeed. Moving the cyclic back makes the nose pitch up, slowing the helicopter and making it climb. Increasing collective (power) while maintaining a constant airspeed induces a climb, while decreasing collective (power) makes the helicopter descend. Coordinating these two inputs causes airspeed changes while maintaining a constant altitude. The pedals serve the same function in both a helicopter and an airplane, to maintain balanced flight. This is done by applying a pedal input in the necessary direction.

Autorotation is a state of flight in which the main rotor system of a helicopter or other rotary-wing aircraft turns by the action of air moving up through the rotor, as with an autogyro, rather than engine power driving the rotor. The most common use of autorotation in helicopters is to safely land the aircraft in the event of an engine failure or tail-rotor failure. It is a common emergency procedure taught to helicopter pilots as part of their training.

In normal powered helicopter flight, air is drawn into the main rotor system from above and exhausted downward, but during autorotation, air moves up into the rotor system from below as the helicopter descends. Autorotation is permitted mechanically because of both a freewheeling unit, which allows the main rotor to continue turning even if the engine is

not running, as well as aerodynamic forces of relative wind maintaining rotor speed. It is the means by which a helicopter can land safely in the event of complete engine failure. Consequently, all single-engine helicopters must demonstrate this capability to obtain a type certificate.

Exercise 14. *Translate the following terms and word combinations.*

Flight conditions, hover, forward flight, autorotation, control input, cyclic, plane, anti-torque system, nose direction, heading, fixed-wing aircraft, climb, descent, rotary-wing aircraft, main rotor system, autogyro, single-engine helicopter, aerodynamic force, freewheeling unit, engine failure, collective power, pedal input, balanced flight.

Exercise 15. *Find English equivalents to the following terms and word combinations in text 2.*

Умова польоту; положення літака в повітрі; літальний апарат з нерухомим крилом; (бічне) знесення; гвинтокрилий літальний апарат; сертифікат типу; прямолінійний політ.

Exercise 16. *Give definitions of the following terms.*

Flight conditions, hover, forward flight, autorotation, climb, descend, heading.

Exercise 17. *Distribute the information below in the columns to describe three basic flight conditions.*

Hover	Forward Flight	Autorotation

The tail rotor or anti-torque system pedals are used to control nose direction or heading; moving the cyclic forward makes the nose pitch down; increasing collective power while maintaining a constant airspeed induces a climb; the main rotor system of a helicopter turns by the action of air moving up through the rotor; to safely land the aircraft in the event of an engine failure or tail-rotor failure; the cyclic is used to eliminate drift in the horizontal plane; decreasing collective power makes the helicopter descend; moving the cyclic back makes the nose pitch up;

a freewheeling unit allows the main rotor to continue turning even if the engine is not running; aerodynamic forces of relative wind keeps maintaining rotor speed; the most challenging aspect of helicopter flight.

Exercise 18. *Say whether the following sentences are true or false. Correct the false ones.*

1. Some pilots consider hovering the most challenging aspect of helicopter flight, because helicopters are generally dynamically unstable. 2. In hovering deviations from a given attitude are corrected only by pilot input. 3. The cyclic is used to eliminate drift in the horizontal plane. 4. Collective pitch control is used to control nose direction or heading. 5. In forward flight, a helicopter's flight controls behave differently from those in a fixed-wing aircraft. 6. The pedals serve the same function in both a helicopter and an airplane, to maintain balanced flight. 7. The most common use of autorotation in helicopters is to safely land the aircraft in the event of an engine failure. 8. In normal powered helicopter flight, air moves up into the rotor system from below as the helicopter descends, but during autorotation air is drawn into the main rotor system from above and exhausted downward. 9. A freewheeling unit allows the main rotor to continue turning only if the engine is running.

Exercise 19. *Put key questions on text 2.*

Exercise 20. *Open the brackets using the verb in the Present Indefinite Active or Passive.*

1. A helicopter pilot (to manipulate) the helicopter flight controls to achieve and maintain controlled aerodynamic flight. 2. The cyclic (to use) to control the main rotor in order to change the helicopter's direction of movement. 3. The anti-torque pedals (to locate) in the same place as the rudder pedals in an airplane, and (to serve) a similar purpose. 4. Applying the pedal in a given direction (to change) the tail rotor blade pitch. 5. Helicopter rotors (to design) to operate at a specific rotational speed. 6. The throttle (to control) the power of the engine, which (to connect) to the rotor by a transmission. 7. Some pilots (to consider) hovering the most challenging aspect of helicopter flight. 8. Frequent control corrections must (to make) by the pilot to keep the helicopter at a desired location and altitude. 9. In forward flight, a

helicopter's flight controls (to behave) more like those in a fixed-wing aircraft. 10. The pedals (to serve) the same function in both a helicopter and an airplane, to maintain balanced flight.

Exercise 21. Translate the following sentences into English.

1. Пілот гвинтокрила керує системами управління польотом для досягнення та підтримання контрольованого аеродинамічного польоту. 2. Управління спільним кроком — це важіль, який рухається вгору і вниз для зміни кута нахилу лопатей головного ротора. 3. Управління спільним кроком пов'язане з дроселем для автоматичного збільшення потужності при піднятті важеля висоти. 4. Функція дроселя — регулювати пробіг двигуна. 5. Управління тягою використовується спільно з управлінням спільним кроком, і є невід'ємною частиною його конструкції. 6. Управління циклічним кроком керує напрямком польоту, відхиляючи площину обертання в потрібному напрямку. 7. Існують три основні режими польоту для вертольота: прямолінійний політ, зависання і авторотація. 8. Ручка управління гвинтокрилом використовується для усунення дрейфу в горизонтальній площині. 9. Важіль лопатей несного гвинта використовується для підтримання бажаної висоти. 10. Педалі хвостового ротора або системи протиобертового моменту використовуються для управління носовим напрямком або курсом.

Exercise 22. Compose a dialogue on the basis of text 2. Speak about three basic flight conditions for a helicopter: hover, forward flight and autorotation and the way they are achieved and maintained.

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Навчальне видання

**PROFESSIONAL ENGLISH
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OF HELICOPTER DESIGN**

**ПРАКТИКУМ
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