

МИНИСТЕРСТВО ОБРАЗОВАНИЯ И НАУКИ РОССИЙСКОЙ ФЕДЕРАЦИИ
ФЕДЕРАЛЬНОЕ ГОСУДАРСТВЕННОЕ АВТОНОМНОЕ
ОБРАЗОВАТЕЛЬНОЕ УЧРЕЖДЕНИЕ ВЫСШЕГО ОБРАЗОВАНИЯ
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АНГЛИЙСКИЙ ЯЗЫК ДЛЯ СТУДЕНТОВ АЭРОКОСМИЧЕСКОГО ПРОФИЛЯ

под общей редакцией Л.П. МЕРКУЛОВОЙ

Рекомендовано редакционно-издательским советом федерального государственного автономного образовательного учреждения высшего образования «Самарский национальный исследовательский университет имени академика С.П. Королева» в качестве учебника для студентов, обучающихся по основным образовательным программам высшего образования по направлениям подготовки 15.03.04 Автоматизация технологических процессов и производств, 24.03.04 Авиастроение, 25.04.01 Техническая эксплуатация летательных аппаратов и двигателей

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Соответствует Федеральному государственному образовательному стандарту высшего профессионального образования третьего поколения.

Для студентов и аспирантов авиационных и аэрокосмических вузов и факультетов, инженеров-практиков, а также всех желающих овладеть навыками общения на английском языке в области авиации и космонавтики.

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Part I. AIRCRAFT ENGINEERING

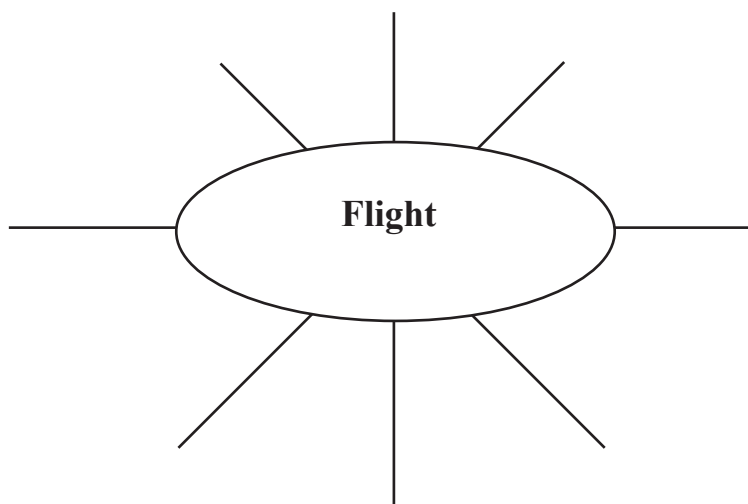
Section 1. AIRCRAFT STRUCTURE

UNIT 1

A Short History of Flying

Lead in

1. a) Brainstorm the words which come to your mind when you think of flight.



b) Choose those ones that may be related to the human flight and explain why you have chosen them.

2. Before you read the text try to answer the following questions. Share your answers.

1) Why can airplanes fly? Is there any difference between flight of birds and airplanes?

2) What are the main forces acting on the aircraft in flight?

3) What types of the aircraft do you know?

3. Scan the text and try to guess the meaning of underlined words from the content of the text.

Reading

1. Read the text and highlight the key ideas of each paragraph.

A Short History of Flying

A. The desire to fly was one of the oldest desires of man. But in old times people knew little about air and its nature.

B. The Greek philosopher Aristotle believed that air had weight and pressed on bodies which were in the air. One of the most famous Greek legends is the legend of Daedalus and Icarus who made wings and fastened them on with wax. Daedalus landed in safety. Icarus was not so careful as his father and he flew closer and closer to the sun. The closer he was the hotter it became. The wax melted, his wings came off and he fell into the sea.

C. Later scientists like Galileo, Roger Bacon and Pascal came to conclusion that air was gas and that the higher you went the less its pressure was.

D. People who like to read books on aviation development may take interest in the book “On the Flight of Birds” by Leonardo da Vinci. That human flight is possible is the fundamental idea of the book. In the book the famous Italian artist and scientist recorded the first scientific principles of human flight. He found that the faster the flow of the air the greater the lift was. As a result of these studies he designed a flying device. In his device the pilot had to operate movable wings with the help of his arms and feet. But the machine did not fly.

E. In the course of many centuries scientists tried to make a flying device. But the development of a practical flying device on a really scientific basis began later. The first flying machine man could control in the air appeared only in the 19-th century.

F. And this first in the history of civilization plane was the one designed by Alexander Mozhaisky. It went up in the summer of 1832.

G. There are many glorious chapters in the history of flying in our country. There were the famous flights by the crews of V. Chkalov and M. Gromov, who flew their planes from the Soviet Union to the United States via the North Pole and will forever be considered models of courage and skill.

H. Devoted courage was displayed by our pilots in the Great Patriotic War. More than 2000 Soviet pilots won the title of Hero of the Soviet Union, and 69 won this award twice. Alexander Pokryshkin and Ivan Kozhedub, the famous fighter aces, became triple Heroes of the Soviet Union.

I. Following the glorious traditions of the Soviet aviation our pilots are establishing new world records for altitude, range and speed. In our days air forces are undergoing a qualitative reequipping. New supersonic jet planes have replaced the piston-engined aircraft. Air force equipment and armaments are being improved continually. Aviation has given birth to astronautics, it has provided the theoretical and practical bases for the conquest of outer space. The time is not far away when passengers aircraft will be doing regular service on space lines.

Comprehension Check

1. The text has 9 paragraphs. Which paragraph mentions the first controlled flying machine?
2. Which of the following sentences summarize the main idea of the paragraph *D*?
 - a) Human flight is possible due to moving wings.
 - b) Flight principle was known from the ancient Greeks.
 - c) Scientific principle of the human flight was recorded by Leonardo da Vinci.
 - d) Leonardo da Vinci predicted conquest of outer space.
3. In the text find the definition of the main scientific principle of human flight.
4. Look at the text again and answer the questions.
 1. Who believed that air had weight?
 2. Who wrote the book “On the Flight of Birds”?
 3. What is the fundamental idea of the book “On the Flight of Birds”?
 4. What did Leonardo da Vinci record in his book “On the Flight of Birds”?
 5. When is the lift of the aircraft greater?
 6. When did the first flying machine appear?
 7. Who designed the first plane?

Language Focus

1. Work in pairs. Give the definitions of the following words and expressions.

Famous person, gas, lifting force, airplane, world record, range, passenger, supersonic plane.

2. a) In the text find the antonyms for the words in the box.

danger	lose	slower	the newest
impossible	irregular	moveless	impractical

b) Make up sentences with the words from the box.

3. Complete the sentences below with suitable words from the text.

1. Later men of science came to conclusion that the higher you went air pressure was.

- a) the higher b) the more c) the little d) the less

2. Leonardo da Vinci discovered that the flow of the air the lift was.

- a) the faster, the less b) the faster, the greater c) the greater, the less

3. Supersonic jet planes have replaced

- a) helicopters b) piston-engined aircraft c) subsonic aircraft

4. Air force equipment and armaments are being continually.

- a) considered b) improved c) displayed d) controlled

Speaking

1. What are the facts you have learnt from the text? Share ideas with your partner.
2. Work in pairs. Imagine that one of you is a visitor of a museum of aviation and the other is a museum guide. Make up a dialog. You may need some more information. Conduct an investigation to find out some interesting facts.

Use the following expressions:

Excuse me, do you know ...

I could hardly imagine that

I didn't expect that ...

That's a very interesting question ...

UNIT 2

Types of Aircraft

Lead in

1. Look through the pictures carefully. Do you know the names of each flying device? Name them and describe them. How does each of these move? Try to group them according to their principle of flying.

A.



B.



C.



D.



E.



F.



G.



H.



I.



2. Match the keywords with their translations.

- | | |
|-----------------|------------------------------|
| 1. seaplane | a. воздушный винт |
| 2. glider | b. амфибия |
| 3. airplane | c. реактивный снаряд, ракета |
| 4. helicopter | d. гидросамолёт |
| 5. autogiro | e. силовая установка |
| 6. missile | f. планер |
| 7. airscrew | g. автожир |
| 8. float | h. вертолёт |
| 9. amphibian | i. поплавок |
| 10. power plant | j. самолёт |

Reading

1. Read the text and check whether your predictions in ex. 2 were correct.
2. Name the vehicles described in the text which were not mentioned at the beginning of the unit.
3. Read the text again and write out the words and word combinations you don't know, try to guess their meaning from the context. Compare your notes with your partners.

Types of Aircraft

A. Modern heavier-than-air aircraft are divided into two main classes according to the principle of flying: 1) aircraft flying due to aerodynamical action and 2) aircraft performing ballistic flight.

B. Aircraft of the first class are gliders, airplanes, helicopters, autogiros and winged missiles. Ballistic rockets belong to the second class.

C. Gliders have no power plant and are supported in the air by up and down airstreams or airflows encountering the wing. The glider is lighter than the airplane and covers long distances with little loss of height. Now the gliders serve mostly for sport and training.

D. Airplanes are controllable machines and have engines which give power for forward motion. The lifting force of airplanes is created by the wing itself while they are propelled by the thrust produced by the airscrew or by a jet engine. The arrangement and number of the wings subdivide the airplanes into the classification as follows:

- 1) the biplane which is a two wing plane with an upper and lower of wings;
- 2) the monoplane which is an airplane with wings in one level.

These are divided into four general types according to the wing position:

- a) the mid wing monoplane with the wing secured midway between the top and bottom of the fuselage;
- b) the high wing monoplane having the wing attached to the top of the fuselage;
- c) the low wing monoplane with the wing attached to the bottom of the fuselage;
- d) the parasol wing monoplane having its wing placed a short distance above the fuselage and attached to it by struts and braces.

E. Many airplanes are equipped to take off water and land on water. Such airplanes are called flying boats if the boat hull replaces the airplane fuselage or seaplanes if floats take the place of wheels on a conventional land plane. If flying boats and seaplanes are also equipped with wheels for landing on the ground they are called amphibians.

F. At present VTOL and STOL aircraft are becoming popular but. For vertical take-off it is necessary to produce the lift force exceeding the aircraft weight. The source of the lift is the energy developed by the propulsion system. The following methods of vertical take-off are suggested now:

- a) the direct application of power plant thrust,
- b) the application of lifting properties of airfoil.

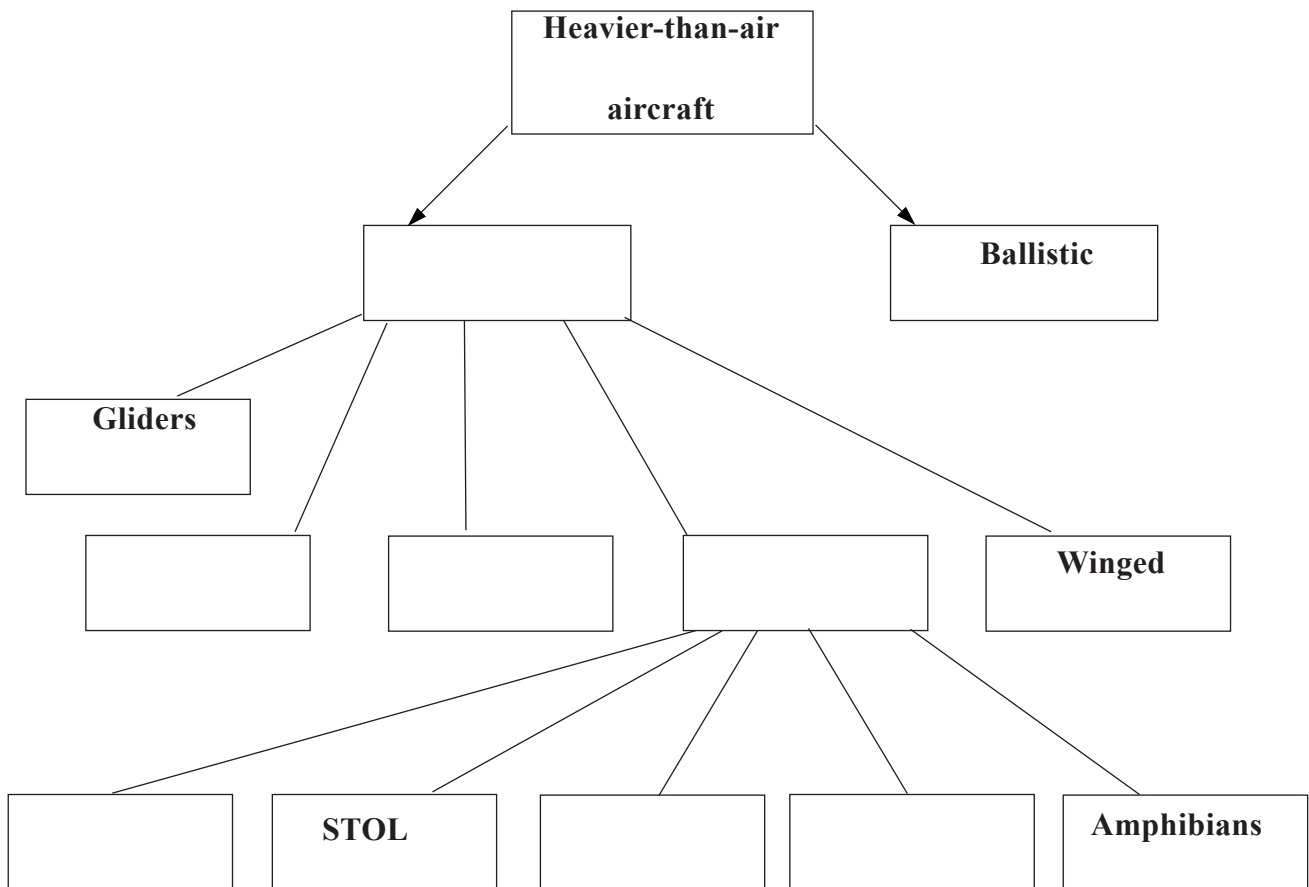
G. The helicopter largely differs from the airplane. The main thing that distinguishes a helicopter from an airplane is that the necessary lift force for helicopter is produced by a rotor instead of wings. The helicopter has a fuselage but there is no conventional propeller in the nose. Instead it has rotor blades on the top. The engine drives them. The power of a helicopter engine is transmitted to the rotor which produces the thrust for vertical take-off, hovering and forward propulsion. The helicopter is able to rise straight off the ground, fly forward, backward, sideward and descend vertically to the ground. Yet it has a few disadvantages. One of them is its inability to fly at high speed.

H. The autogiro is flying on the same principles, but the difference is that in addition to a rotor the autogiro has also a tractor airscrew. The power developed by the autogiro engine is transmitted to the airscrew while the rotor is freely revolving under the action of airflow, thus creating the lifting force.

I. Ballistic rockets (missiles) belong to the second class of aircraft. They do not require any lifting force produced by means of a wing. The rocket engine is to impart them the necessary energy for propulsion. The rocket engines are mostly operated on liquid or solid fuels.

Comprehension Check

1. Fill in the diagram with missing information from the text.



2. The text has 9 paragraphs. Which paragraph mentions **a)** different landing devices; **b)** vehicle flying due to up and down air streams; **c)** vehicle able to hover in the air?

3. Read the text again and decide if these statements are true or false. Correct the false ones.

1. Modern heavier-than-air aircraft are classified into two classes according to their flying principle.
2. Airplanes fly due to up and down air stream.
3. Gliders are equipped with airscrew and power plant.
4. Airplanes can be fitted with floats to take off and land on water.
5. In helicopters lifting force is produced by the wing itself.
6. The helicopters can take off and land vertically.
7. The autogiros and ballistic rockets fly on the same principles.
8. Ballistic rockets do not produce lifting force by means of a wing.

4. Ask your partner ten questions about types of aircraft.
5. Explain the difference between:
 - a) airplanes and ballistic rockets
 - b) helicopters and autogiros
 - c) seaplanes and amphibians
 - d) helicopters and airplanes

Language Focus

1. Match the synonyms.

<i>A</i>	<i>B</i>
advance	wing
produce	mount
subdivide	vehicle
propel	progress
airfoil	move
attach	create
aircraft	classify

2. Make up all possible combinations with the verbs.

To divide, to support, to produce, to propel, to attach, to place, to create, to equip, to differ, to require.

3. Make up 5 sentences with the word combinations from ex. 2.

4. Work in pairs. Give the definitions of the following words and expressions.

Fuselage, glider, biplane, helicopter, amphibian aircraft, ballistic rocket, high wing monoplane.

5. Fill in the gaps with the words and expressions from the box.

the	wing position	engines	the autogiro
	the parasol wing	flying boat	seaplanes
	the wing itself		a rotor
	ballistic rockets	up and down airstreams	

1. Gliders are supported in the air by _____.
2. The lifting force of the wing is created by _____ when it moves through the air.
3. The monoplanes are divided into four types according to _____.
4. _____ monoplane has its wing placed a short distance above the fuselage.
5. In _____ the boat hull replaces the airplane fuselage.
6. _____ are equipped with floats to take off water and land on water.
7. The helicopters produce lifting force by _____.
8. _____ is equipped with a tractor airscrew and a rotor.
9. The rocket engine provides energy for propulsion for _____.
10. In airplanes _____ supply power for forward motion.

6. Give the English equivalents to the words in the brackets.

1. Modern (летательные аппараты тяжелее воздуха) are divided into two classes according to the principle of flying.
2. The (планер) is lighter than the airplane.
3. Many airplanes are equipped (взлетать) from water and (садиться) on water.
4. At present (ЛА с вертикальным взлётом-посадкой) and (ЛА с укороченным взлётом-посадкой) aircraft are becoming popular.
5. The helicopter has a (фюзеляж) but there is no (обычный винт).
6. Helicopters have a few (недостатки).
7. Ballistic rockets do not require any lifting force produced (при помощи) a wing.
8. The power developed by the autogiro (двигатель) is (передать) to the (воздушный винт).

Speaking

1. If you were a traveler and had at your disposal any passenger-carrying apparatus, by which one would you prefer to travel? Provide reasoning.
2. Watch the video from <http://www.youtube.com/watch?v=KmX39xcA1SA> “To infinity and beyond” and write down as much information from the video as you can.
3. Prepare a 7-minute presentation on types of aircraft (heavier– or lighter– than -air) for a seminar.

Writing

1. Translate the text in a written form.

The airplane can rise into the air and remain in the air because of the forces acting on it. In flight the airplane is acted upon by four forces – lift, drag, thrust and gravity.

When flying, the aircraft produces an upward force which is called lifting force and acts at right angle to the direction of the air stream. Part of air moves rapidly over the wing and part of it moves under the wing, and both parts are joined behind the wing. The air flowing above the top of the wing develops a reduced pressure on the upper surface. The air flowing along the bottom of the wing is compressed and develops increased pressure. The higher air pressure under the wing flows to the lower pressure on top, resulting in lifting force of the entire wing.

To produce lifting force the airplane wing is to move through the air at high speed developed by a force of thrust acting in the direction of the airplane motion.

Drag is the resistance an airplane faces in moving through the air. The faster the airplane moves the greater the drag will be.

Gravity is the force of attraction that tends to move bodies towards the Earth.

Lift opposes weight and thrust opposes drag. To overcome the forces of nature engines producing high thrust and wing developing lift are used. They both assist to overcome forces of nature – drag and gravity.

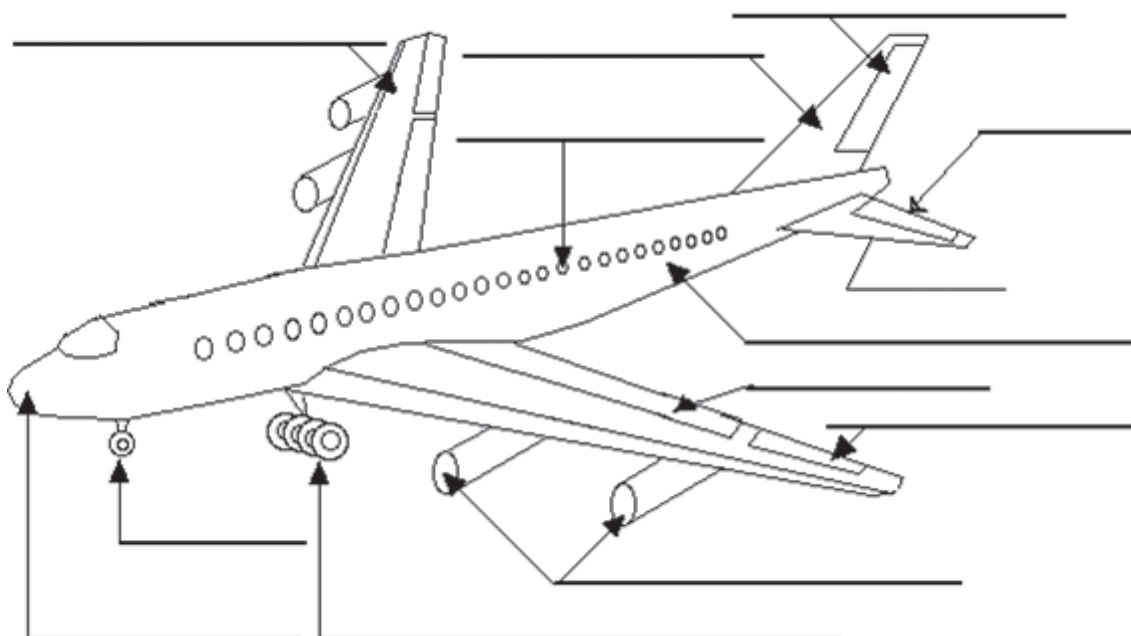
In straight-and-level uniform flight lift equals weight and thrust equals drag. Any inequality between lift and weight results in an airplane climb or descent. Any inequality between thrust and drag results in acceleration or deceleration until the two forces become balanced.

UNIT 3

Airplane Components

Lead in

1. Airplanes have many applications in a variety of fields. Brainstorm as many uses of the airplane as possible.
2. Look at the picture of an airplane. Name the airplane components you know, share the terms with your partner.



Reading

1. Read the text and try to guess the meaning of underlined words from the content of the text.

Airplane Components

A. The airplane consists of six principal structural units, namely, the power plant, the fuselage, the wing, the tail unit (or empennage), flight controls and the landing gear (undercarriage).

B. The power plant is a source of power. It provides power and propels the airplane. Nowadays there are many types of aircraft engines. These engines have one thing in common. The energy is derived from a chemical reaction which takes place inside the engine itself. Nacelles are compartments housing the power plant or engine and its accessories. The engine is really the heart of the airplane.

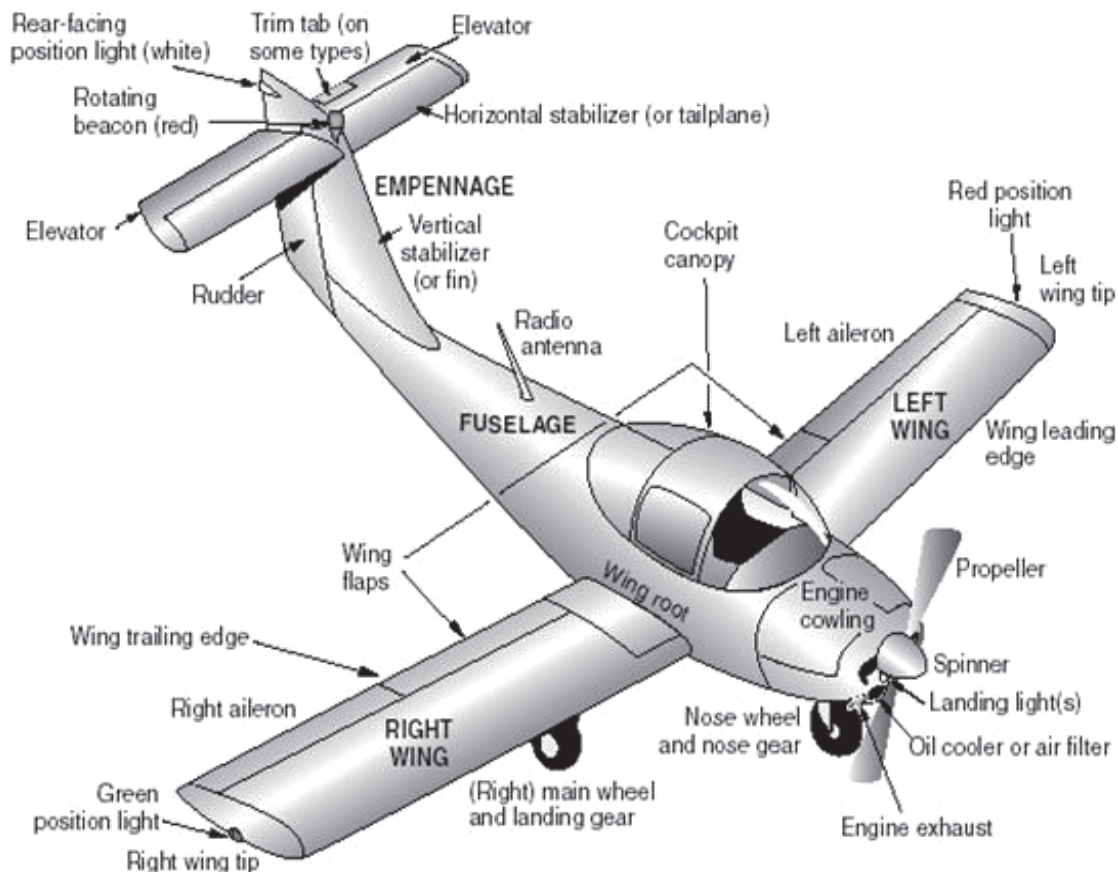
C. The fuselage is the main body of the airplane which is divided into some cabins (compartments). A nose cabin is a pilot's cabin (cockpit). The cockpit houses the crew, the flight controls and flight instrument panels. The next section of the fuselage is a wing centre-section. Passenger compartments are situated there. The rear part of the fuselage is designed for cargo rooms and for mounting a tail unit on it.

D. The wing is the main lifting surface of sweptback shape. Its function is to support the aircraft in flight producing lifting force. There may be different arrangement, shapes and number of the wings. At the trailing edge of the wing there are movable parts which are called ailerons, flaps and trimmer tabs (trimmers).

E. The tail unit (empennage) provides the necessary stability and consists of vertical and horizontal control surfaces. The vertical plane is called a fin. It has a movable part – a rudder. The horizontal plane is a stabilizer. The movable part at the trailing edge of the stabilizer is an elevator.

F. Three basic flight control surfaces are the ailerons, the elevators, and the rudder. They are hinged so to move and thus to deflect the air stream passing over there. The ailerons are located at the trailing edge and near the tips of the wings. They control the motion of the plane about the longitudinal axis. The elevators are hinged to the horizontal stabilizers and control the airplane's movement up and down about the lateral axis. The rudder is hinged to the vertical stabilizer (fin), and it controls the movement of the airplane around the vertical axis.

G. The landing gear (undercarriage) carries the wheels on which the aircraft moves on the ground. Struts attach it to the fuselage. Two different arrangements of landing wheels are in use today. They are conventional tricycle gears and the landing gear with a skid. The landing gear may be retractable and non-retractable.



Comprehension Check

1. You have read the text. Fill in the picture with missing terms from the text.
2. Complete the table according to the content of the text.

Component	Function
	to develop the necessary supporting force
Fuselage	
	to change the attitude and direction of flight
Power plant	
Aileron	
	to control the airplane's movement up and down about the lateral axis
Cockpit	
	to house luggage and cargo
	to control the movement of the airplane around the vertical axis
Nacelle	
Landing gear	
	to provide stability of flight

3. Read the sentences and decide if they are true (T) or false (F). Correct the false ones.

1. Power plant produces lifting force.
2. The rear part of the fuselage is designed for the cockpit.
3. The landing gear is designed to assist the airplane maneuvering on the ground.
4. Ailerons, flaps and trimmers are located at the trailing edge of the wing.
5. Flight controls produce additional lifting force.
6. Empennage is mounted on the wing centre-section.

4. Answer the following questions:

1. What units does the airplane consist of?
2. The power plant is a source of power, isn't it?
3. What does the cockpit house?
4. Is the function of the wing to support the aircraft in flight?
5. Where are movable parts of the wing? Name them.
6. Does the tail unit consist of a vertical stabilizer and rudder and horizontal stabilizer and elevators?
7. What components are responsible for airplane motion? Where are they located?
8. What is the function of the landing gear?

Language Focus

1. Match the words from *A* and *B*. Make as many combinations as possible.

<i>A</i>	<i>B</i>
Horizontal	Edge
Lifting	Compartment
Passenger	Surface
Sweptback	Unit
Trailing	Shape
Movable	Plant
Structural	Part
Power	Stabilizer

2. Find the words in the text that mean:

air flow (F); engine (B); surface (E); to locate (C); to hinge (J); energy (B); usual (J); to manage (F); form (D); compartment (C); wing (D).

3. Translate the words in brackets:

a) into Russian:

1. Силовая установка (provides) энергией.
2. (Nacelles) – это отсеки, вмещающие двигатель и его вспомогательные элементы.
3. Фюзеляж (contains) кабину пилота, пассажирский и багажный отсеки.
4. На задней кромке крыла располагаются (ailerons, flaps) и триммеры.

b) into English:

1. (Руль направления) is hinged to the vertical stabilizer.
2. The main landing gear (прикрепляются) by struts to the fuselage.
3. The wings are the main (подъёмные плоскости).
4. There are conventional (трёхопорное шасси) and the landing gear with a (хвостовой опорой).

Speaking

1. You know that the history of aircraft designing was very long and designers constructed amazing flying machines. Prepare a presentation (a talk) about one of them to your group mates.

2. Watch the video “Airplane assembly” at <http://www.youtube.com/watch?v=wLk6b3SIzDY> and describe the main stages of airplane A340 assembling.

Example: 1. Main components of the airplane are delivered to the assembly plant.

Writing

1. Translate the text in a written form.

The structure of the airplane is designed under the safe-life philosophy with damage tolerance features to provide a long and economic service life with high standards of safety and integrity. This is achieved by minimizing stress concentrations, the use of low working stress levels, the duplication of primary structural components and crack arrest detail design.

The materials used for the primary structure are chosen to maximize fatigue resistance and damage tolerance. Assembly of the structure includes the use of conventional fasteners and adhesive bonding to eliminate stress concentrations and reduce weight. Anti-corrosion treatment is applied to the whole structure. This measure provides the ability to keep the airframe free of corrosion after long service experience in hostile climatic conditions. All internal and external surfaces are given a coat of epoxy primer. Additionally the nose and rear equipment bays, undercarriage bay and lower fuselage are given a coat of polyurethane enamel paint, fast-dried, to provide a hard damage resistant finish.

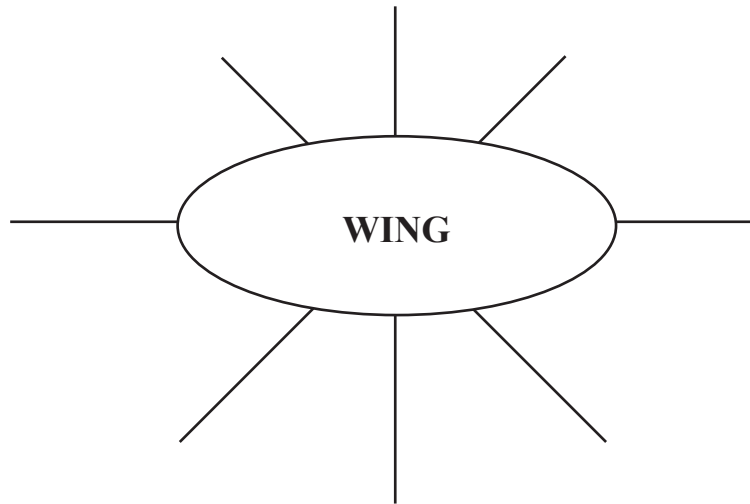
The test airframe is submerged in a water tank to allow flight loads and maximum cabin differential pressure to be applied simultaneously in adverse combination. The test “flight” takes into account all the loads imposed during a 45 minute sector, including those loads associated with fuelling, passenger boarding, flap and undercarriage cycling and atmospheric turbulence.

UNIT 4

The Wing

Lead in

1. Brainstorm all possible terms related to the topic.



2. Before you read the text name the main functions of the wing, try to describe wing structure. Share your ideas with your group mates.

Reading

1. Read the text and write a brief heading for each paragraph.
2. Read the text and write out the underlined words. Try to guess their meaning from the context. Compare your notes with your partners.

The Wing

A. The main lifting surfaces of every airplane are wings. The wings are light structures which extend out on each side of the body. Their function is to push downward on the air as the machine moves through it. This push or lift of the wings is the secret of the support of the airplane in the air.

B. The wing is divided into three sections: a wing root, an inter-mediate section and a wing tip. The front edge of the wing is called the leading edge and the rear one is called the trailing edge. There are some movable parts on the trailing edge of the wing. These are ailerons, flaps and trimmer tabs.

C. The primary function of the wing is to produce lift (lifting force) for flying. The secondary function is to house many vital parts of the aircraft, such as fuel tanks, control mechanism and very often the engines and landing gear bay are arranged in the wing structure.

D. The distance from the wing tip on one side to the wing tip on the other side is called the span and the distance from the leading edge of the wing to the trailing edge is the chord.

E. The shape of the wing is of great importance for an aircraft. There are different configurations of the wing. There are rectangular and elliptical wings, wings of trapezoidal form, straight, sweptback and sweptforward wings. There is also a delta wing form.

F. The wing structure consists of longitudinal structural members – spars, stringers and beams and of transverse elements – ribs. The wing structure is covered with skin (or covering). According to the position in which the wing of a monoplane is fixed in relation to the fuselage the aircraft is called a low-wing monoplane, a mid-wing monoplane and a high-wing monoplane.

G. The aerodynamic loads on the wing produce bending, shear and torsion. A typical construction of a wing must resist these loads and usually consists of a thin sheet metal shell of airfoil shape, reinforced within by spanwise stiffeners and transverse ribs. Every component of an airplane must be so designed that it could carry its intended function.

H. Light weight is very important in an airplane structure because every pound of structural weight replaces a pound of payload. The wing structure is no exception in this respect. The stressed skin type of construction was adopted because it can be made light.

Comprehension Check

1. Define the main idea of paragraph H. Find the supporting details that help to develop the main idea.

2. Complete the sentences with the best options.

1. There are some movable parts on the _____ of the wing.

- a) leading edge b) trailing edge c) centre-section

2. The _____ structural members of the wing are spars, stringers and beams.

- a) transverse b) covering c) longitudinal

3. The _____ the wing produce bending, shear and torsion.

- a) weight of b) aerodynamic loads on c) structure of

4. Every pound of wing structural weight replaces a pound of _____ .

- a) payload b) power c) lifting force

5. The distance between wing tips is called the _____.

- a) chord b) beam c) span

3. Match the terms with their definitions.

1. In this type of construction the skin of the aircraft carries structural loads.

a. span

2. This component of the airplane produces lifting force for flying.

b. skin

3. They are the longitudinal members of the wing structure.

c. stressed skin

4. The distance between the wing tips.

d. chord

5. It covers the wing structure. e. wing

6. It is a transverse element of the wing structure.

f. spar, stringer and beam

7. Distance from the leading to the trailing edge of the wing.

g. rib

4. Read the text again and decide if these statements are true or false.
1. There are two main functions of the wing – to produce lift and to house many vital parts of the aircraft.
 2. Movable parts of the wing are located on the leading edge.
 3. Span – it is a distance between the wing tips.
 4. Light weight is of no importance in an airplane structure.
 5. Ribs are longitudinal members of the wing structure.
 6. Spars, stringers and beams are spanwise stiffeners of the wing structure.
 7. Skin is the covering of the wing structure and it can carry structural loads.
5. These are the answers. What are the questions?
1. – the wings.
 2. – a wing root, an intermediate section and the wing tip.
 3. – on the trailing edge.
 4. – chord.
 5. – longitudinal and transverse elements.

Language Focus

1. Match the synonyms.

<i>A</i>	<i>B</i>
wing	rear edge
front edge	bay
shape	engine
covering	airfoil
section	form
trailing edge	skin
power plant	leading edge

2. Match the antonyms.

<i>A</i>	<i>B</i>
leading	secondary
take off	fixed
primary	weaken
root	trailing
different	landing
reinforce	tip
transverse	similar
movable	longitudinal

3. Give the English equivalents to the words in the brackets.

1. Rib is a (поперечный) element of an airplane structure.
2. The main longitudinal structural members of the wing structure are – (лонжероны, стрингеры и балки).
3. A typical construction of the wing must resist (изгибу, сдвигу и кручению).
4. (Топливные баки), control mechanisms and very often (двигатели) and landing gear (отсеки) are arranged in the wing structure.

4. Translate into English the following words and word combinations.

Работающая обшивка, гондола шасси, низкоплан, среднеплан, высокоплан, изгибающая нагрузка, корневая часть крыла, закрылок, отсек шасси, механизм управления, продольный элемент жёсткости, форма крыла, напряжение.

5. Use the prepositions in the box to complete the sentences.

from	with	into	in	of	on	to
------	------	------	----	----	----	----

1. The wing is divided _____ three sections
2. There are some movable parts _____ the trailing edge of the wing.
3. Fuel tanks, control mechanisms and very often engines and landing gear bays are arranged _____ the wing structure.
4. The distance _____ the leading edge of the wing _____ the trailing edge is the chord.
5. The wing structure is covered _____ skin.
6. The wing structure consists _____ longitudinal and transverse elements.

Speaking



1. Look at the picture and predict what kind of aircraft it is. Explain why you think so. Discuss its advantages and disadvantages.

2. Watch the video “Flying wing returns to flight” at <http://www.youtube.com/watch?v=B0gqSHv> and describe this aircraft. Pay attention to flight controls, fuselage, engines etc.

3. Analyze conventional wing and flying wing. Compare them. Highlight their similarities and differences. Make a report to your group mates. The following expressions might be helpful:

- The object of this report is ...
- First of all I would like to
- It should be stressed ...
- In comparison with
- Summing up, I would like to ...

Writing

1. Translate the text in a written form.

The wing consists of front, main and rear spars together with transverse ribs and incorporates an integral fuel tank. The wing skin is chemically-etched and reinforced with bonded span wise stringers.

Double-slotted flaps extend from the fuselage side to approximately two thirds of the semi-span. They are designed to move in an arc actuated by the forward section of a double-acting jack. The flaps are hydraulically operated.

Ailerons, which extend from the end of the flap to the wing tip, are both mass and aerodynamically balanced. They provide good positive response and ensure excellent handling characteristics throughout the flight.

Wingtip devices improve aircraft handling characteristics and enhance safety. They increase the effective aspect ratio of a wing, with less added wingspan.

UNIT 5

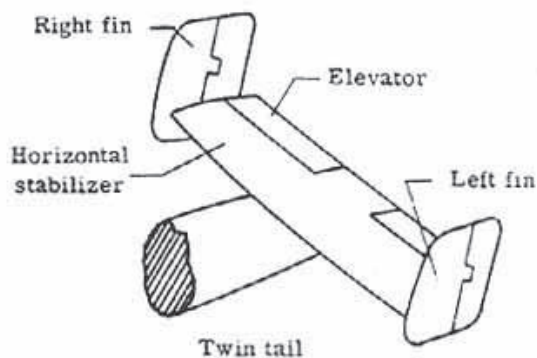
The Tail Group

Lead in

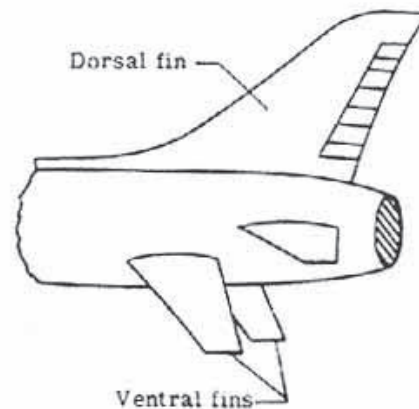
1. Look at these pictures. These are the types of tail group. Try to predict what types of aircraft they belong to. Share your ideas with your partners.



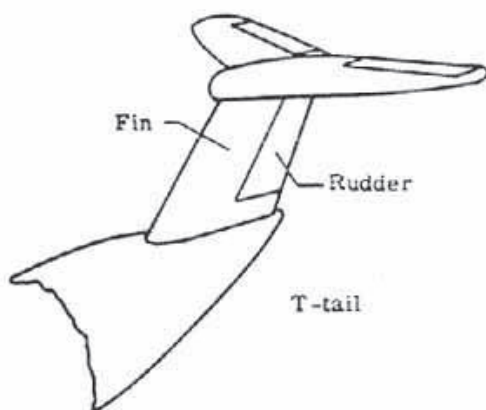
Standard tail



Twin tail



Ventral fins



T-tail



V-butterfly-tail

2. Before you read the text answer the following questions:
 1. What are the movable parts of the tail unit intended for?
 2. Is there any difference between the tail groups of civil and military aircraft?

Reading

1. Read the text and match the English words with their Russian counterparts.

- | | |
|-----------------|-------------------------------|
| 1. elevator | a. руль направления |
| 2. fin | b. площадь компенсатора |
| 3. rudder | c. руль высоты |
| 4. tail plane | d. форкиль |
| 5. attitude | e. киль |
| 6. dorsal fin | f. пространственное положение |
| 7. precaution | g. стабилизатор |
| 8. balance area | h. предосторожность |

The Tail Group

A. In order to provide the necessary stability airplanes are fitted with a tail unit (a tail group, empennage) which usually consists of the horizontal tail surfaces – stabilizer and elevator and the vertical surfaces – fin and rudder. The stabilizer and the fin are fixed portions, the elevator and the rudder movable.

B. A movable control surface called an elevator is hinged to the rear of the tail plane. It is intended to control the altitude of the aircraft in flight. It can be deflected upwards or downwards. Moving up the elevator reduces its angle of attack and creates a down load on the tail which raises the nose of the aircraft.

C. In order to secure directional stability the fin is used which is the vertical fixed control surface at the rear of the fuselage. The action of the vertical surface is quite clear. Since it has a great lever arm from the airplane's centre of gravity the vertical surface is able to stabilize the directional motion of the plane. Directional control of the airplane is achieved by means of the rudder, which is a movable vertical surface hinged to the rear of the fin. It can be moved to right or left or retained in the neutral position in line with the fin.

D. When the pilot needs to change his flight direction towards the right (or starboard) he moves the rudder to the right. The reaction of the stream on the surface produces a couple about the centre of gravity and the nose of the aircraft is turned to starboard. If it is necessary for the pilot to control the attitude of the aircraft and cause the nose to rise or fall this is done by means of the elevator.

E. In addition to the principal control surfaces there are some auxiliary ones such as trimming tabs (trimmers) which represent small adjustable areas arranged near the trailing edges of the movable surfaces. They are used to produce constant control deflections to hold the airplane in a certain attitude of flight. They are adjustable from the cockpit.

F. There is also a dorsal fin placed along the upper side of the aft portion of the fuselage body.

G. On large fast airplanes it is usually necessary to provide the movable surfaces with some area called balance area. It reduces the hinge moment needed to deflect the surface. This is often required because the hinge moment increases with size and speed. This dynamic balancing is one of the precautions taken to avoid flutter, a violent vibration of a wing or control surface.

H. The structure of the tail plane as well as that of a wing consists of longitudinal and transverse structural elements called spars and ribs.

Comprehension Check

1. Match the given titles with the corresponding paragraphs. Watch out! There is an extra title.

1. balance area
2. tail unit arrangement
3. tail unit function
4. tail plane structure
5. elevator
6. dorsal fin
7. rudder
8. fin
9. trimmers

2. Which of the following sentences summarize the main idea of the paragraph *E* most accurately?

1. Trimmers are arranged near the trailing edges of the movable surfaces and adjustable from the cockpit.
2. Trimming tabs are necessary to produce constant control deflections to keep the airplane in a given attitude of flight.
3. Auxiliary surfaces are adjustable from the cockpit and produce additional lifting force.

3. Guess what it is:

- 1) This component of the aircraft provides the necessary stability.
- 2) The structure of the tail plane consists of these members.
- 3) It is used in the tail group to avoid flutter and violent vibration.
- 4) They are arranged near the trailing edges of the movable surfaces.
- 5) When the pilot needs to change the flight direction he moves it to the right or left.
- 6) It is a vertical fixed surface of the tail unit.
- 7) It is used to produce constant control deflections.
- 8) This part of the tail group is to stabilize the directional motion of the airplane.
- 9) It is a horizontal movable plane. It can be deflected upwards and downwards.
- 10) This part of the tail group is placed along the upper side of the aft portion of the fuselage body.
- 11) These portions are used when the pilot is to cause the nose to rise or to fall.
- 12) This is used to reduce the hinge moment which is increases with size and speed.

4. In the text find the definition of *flutter*.

	rudder	hinged	dorsal fin
altitude		auxiliary	stability
		rear	trailing edges

1. Tail unit provides the necessary _____ of an airplane.
2. An elevator is _____ to the _____ of the tail plane.
3. Elevators control the _____ of the aircraft in flight.
4. _____ can be deflected to the right or to the left.
5. Trimmers are _____ surfaces arranged near the _____ of the movable surfaces.
6. To avoid flutter _____ is used.

5. Work in pairs. Make up 5 "False" and 5 "True" statements and tell them your partner. "False" statements should be corrected.
6. Ask your group mates ten questions concerning the tail unit.

Language Focus

1. a) Check if you know the meaning of the following verbs.
To provide, to consist, to intend, to arrange, to hold, to control, to deflect, to reduce, to secure, to fit.
- b) Find these words in the text and write out the words collocate with.
- c) Think of other nouns they can go with.
- d) Give synonyms of the verbs from a).
2. In the text find the antonyms of the following words and make up your own word combinations with them.
Fixed, to increase, main, to promote, irregular, weak.
3. Translate from English into Russian.
Оснащать хвостовым оперением, отклонять вверх или вниз, достигается посредством руля высоты, вспомогательная плоскость, шарнирный момент, избегать флаттера, правый борт ЛА, положение самолёта в воздухе.
4. Use the prepositions in the box to complete the sentences.

along	of	at	from	in	of	with
-------	----	----	------	----	----	------

1. Trimmers are used to produce constant control deflections to hold the airplane _____ a certain attitude _____ flight.
2. The dorsal fin is placed _____ the upper side _____ the fuselage body.
3. In order to provide the necessary stability airplanes are fitted _____ a tail unit.
4. Fin is a vertical control surface _____ the rear of the fuselage.
5. Trimmers are adjustable _____ the cockpit.

5. Translate the following word combinations into Russian:

1. rocket launch
2. aircraft maintenance
3. communication satellite
4. communication satellite launch
5. weather radar antenna
6. robot manipulator arm
7. combustion chamber pressure
8. landing gear bay
9. fixed oxygen system reservoir
10. extensive fatigue test programme

Speaking

1. Prepare a presentation about different types of tail units to your group mates. Compare tail unit designs of fighters, cargo airplanes and passenger liners.

Writing

1. Translate the text in a written form.

The flying controls are designed to ensure high control and maneuverability.

The primary flying controls are manually operated by a system of cables and rods. They are aerodynamically and mass-balanced.

The ailerons provide good response and ensure excellent handling characteristics throughout the flight modes. The ailerons and elevators are fitted with trim tabs and the rudder has a spring tab.

The rudder pedals are adjustable for leg length. A spring strut is fitted to interconnect the rudder and the aileron system so that each control will respond to the movement of the other.

The double-slotted flaps are designed to move in an arc. They are actuated by the forward section of a double-acting jack, to 35° extension for landings. The intermediate selections are 10° take-off and 20° for approach.

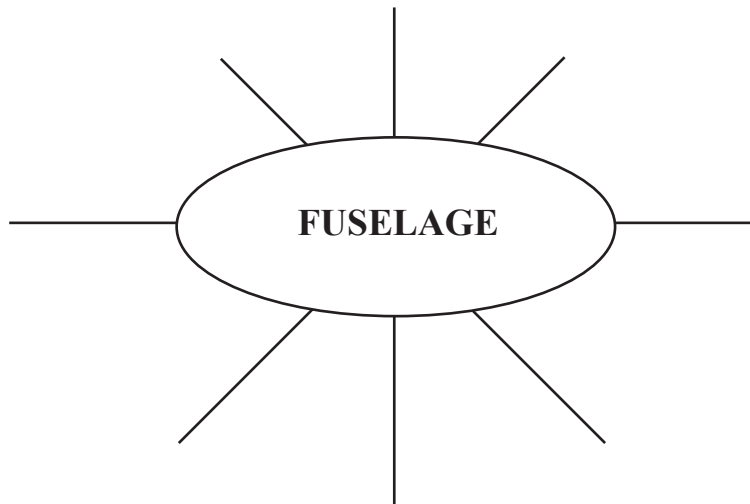
The flaps are hydraulically operated, they provide low approach speed.

UNIT 6

The Fuselage Structure

Lead in

1. Brainstorm all possible terms related to the topic.



2. Before you read the text, read the statements and agree or disagree with them and explain your viewpoint.
 1. The fuselage is designed for housing passengers, equipment and cargo.
 2. Fuselage structure is a monolithic structure made of aluminium alloy.
 3. Composite materials are widely used in modern aircraft.

Reading

1. Read the text and make a list of unfamiliar words. Compare them with your partner. In pairs try to guess the meaning of these words.

The Fuselage Structure

A. The fuselage is the main body of the aircraft. It usually serves the purposes of housing the crew, passengers and payload and of connecting the wing and the tail group. It may also carry fuel and support the engines and the landing gear. Its structure is called upon to carry bending, shear and torsion loads due to all these functions.

B. The usual constructions of a fuselage consist of longitudinal members (longerons), transverse rings (frames) and covering skin. The designer's problem is complicated by the presence of doors, windows, wheel wells, bomb bays, etc.

C. A fuselage construction may be broken down into two main classes: the truss type consisting of a welded tubular structure covered with skin and a girder type. The latter is divided into the monocoque type consisting of a strong outer skin from which the fuselage primarily derives its strength, and the semi-monocoque type – the combination of a single shell structure with longerons and stringers to reinforce the skin.

D. A very common type of a fuselage is the monocoque type of construction. It is called so because it uses of a single shell which is sufficient to provide the necessary structural strength. Monocoque construction aims at concentrating the structural material towards the outer surfaces and the success of stressed-skin fuselage depends upon the stiffness of the skin.

E. The semi-monocoque type is the most popular fuselage construction. It presents the same outside appearance but instead of relying entirely on the skin for strength incorporates longerons or stringers usually riveted to the skin and carrying the main portion of the load. Thus it may be said that the longerons and the skin mutually reinforce each other.

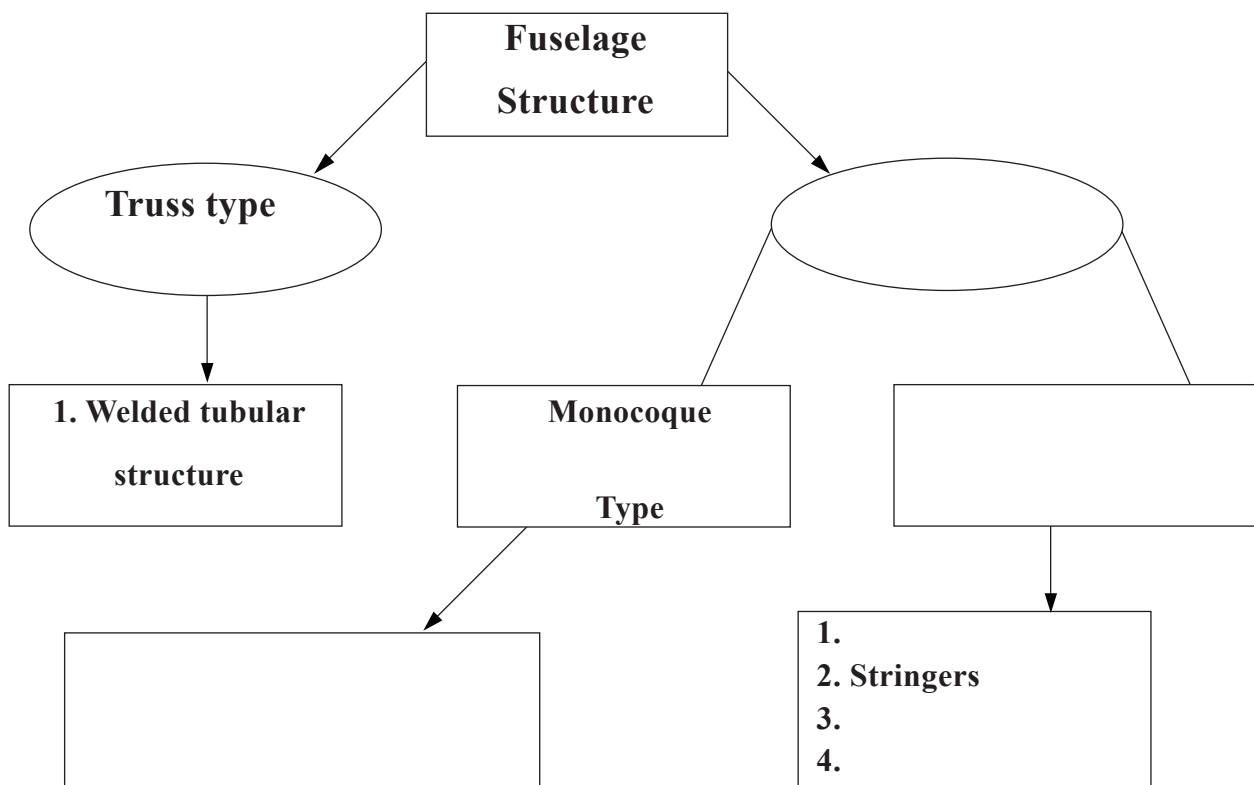
F. The main longitudinal members, longerons, provide the basis of the necessary strength to resist bending together with transverse frames which are of a very light gauge metal. The transverse frames are rolled in channel or similar shape and spaced at intervals along the fuselage. The whole structure is covered with a very light gauge skin riveted in position. The longitudinal members in a semi-monocoque fuselage are held apart by bulkheads, which give the fuselage its shape. Bulkheads are solid or semisolid frames placed where the greater stresses are to occur or at any point in the fuselage that requires special strength.

G. The skin is put on in long strips (or panels) riveted to each other and to the stringers and bulkheads. Both the monocoque and semi-monocoque type structures are referred to as stressed-skin construction.

H. The fuselage is generally built in three sections or assemblies: the nose, the centre section and the aft section. When the assemblies are completed they are joined to form the entire fuselage.

Comprehension Check

1. Divide the text into logical parts. Think of the subtitle to each part.
2. Explain the difference between:
 - a) longerons and bulkheads;
 - b) monocoque and semi-monocoque fuselage.
3. Define the main idea of paragraph *F*. Find the supporting details that help to develop the main idea.
4. Fill in the diagram with missing information from the text.



5. Look at the text again and answer the questions.
 1. What can be housed inside the fuselage structure?
 2. What loads act on the fuselage in flight?
 3. What are the main members of the fuselage structure?
 4. How is the skin joined to the stringers and formers?
 5. What purpose are the bulkheads used for?
 6. What is the best material for the airplane fuselage?

6. Read and memorize the following definitions.

Longeron – a main longitudinal member of the fuselage

Rivet – a metal pin that is inserted into holes in larger parts to be joined, and then compressed to produce a permanent fastening

Skin – a material which covers the structure of an airplane

Airframe – the basis structure of a plane, including fuselage, wings and so on

Bulkhead – an upright partition that serves to divide the airplane into compartments and to provide structural strength.

Stringer – a longitudinal member that shapes and strengthens the skin.

Language Focus

1. Give your own definitions for the words from the text.

Crew, fuel, payload, wheel well, assembly, to rivet, aerodynamic load.

2. a) Check if you know the meaning of the following verbs.

To space, to resist, to reinforce, to rely, to depend, to divide, to cover, to derive.

b) Think of other nouns they can go with. Make up your own sentences with the verbs from a).

3. Match the synonyms. Watch out! There is an extra word in the column *B*.

<i>A</i>	<i>B</i>
cover	pressure
derive	strengthen
divide	contain
reinforce	split
resist	frame
bulkhead	shield
bay	withstand
assembly	obtain
stress	compartment
house	basis
	unit

4. In the text, find the words with the meaning opposite to these words.
Started; flexible; different; broken; insufficient; weak; simplify; inner.

5. Choose the best alternative to fill the gaps in these sentences.

1. The main _____ members, longerons, provide the basis of the fuselage strength.

- a) transverse b) longitudinal c) solid

2. Both the monocoque and semimonocoque fuselage structures are referred to as _____ construction.

- a) monolithic b) welded c) stressed-skin

3. The designer's task is _____ by the presence doors, windows, wheel wells, etc.

- a) complicated b) improved c) simplified

4. The _____ type fuselage consists of a welded tubular structure covered with skin.

- a) monocoque b) girder c) truss

5. _____ are solid or semisolid members placed where greater stresses occur.

- a) stringers b) bulkheads c) longerons

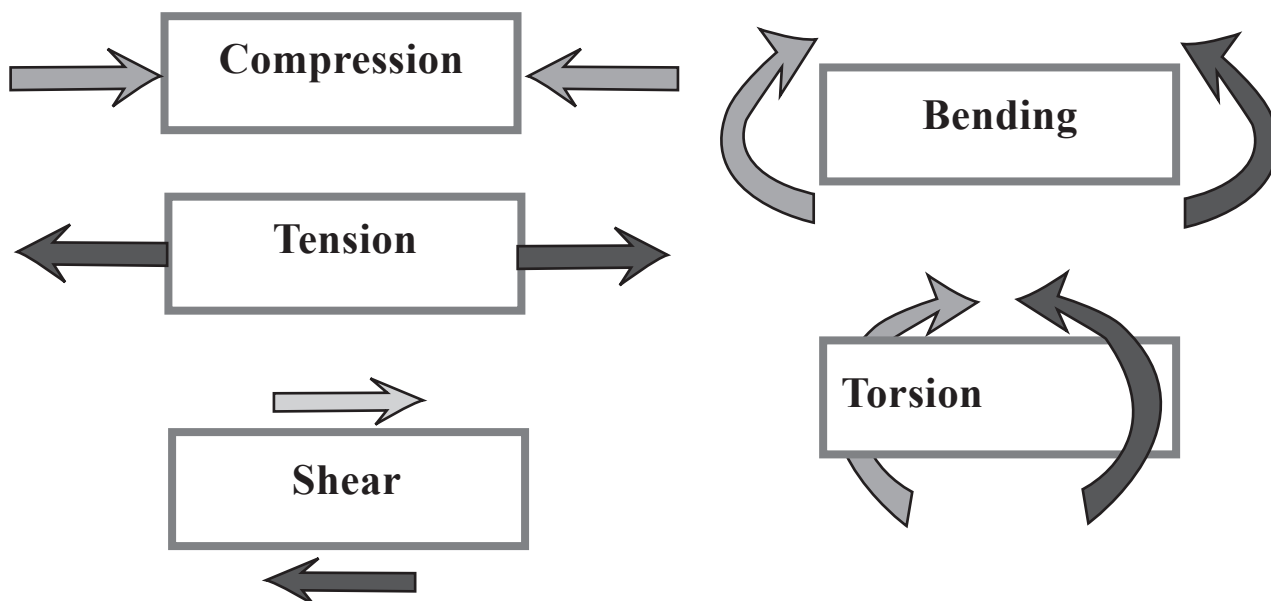
6. Longerons and stringers are _____ to the skin and they carry the main portion of the load.

- a) welded b) bolted c) riveted

6. Translate the following word combinations into Russian:

1. flight data recorder
2. cockpit voice recorder
3. front pressure bulkhead
4. ice-protection measures
5. automatic system malfunction
6. emergency brake accumulator
7. audio warning system
8. extensive fatigue test programme
9. intensive multi-cycle airplane operation
10. fiber-reinforced rubber sheeting

7. The stresses an airplane has to withstand in flight can be classified into five types. Match the pictures with the definitions.



- a) this type of stress is a result of two opposite longitudinal forces
- b) this type of stress is a result of two opposite twisting forces
- c) this type of stress is the opposite compression
- d) twisting of a part by application of equal and opposite torques at either end
- e) movement that causes the formation of a curve

Speaking

1. Work in group. Imagine that your team is to design a new business airplane for 10 passengers. What type of fuselage suits this purpose best of all? Give your reasons. Compare different types of fuselage structure and give pros and cons of using your choice.

Writing

1. Translate the text in a written form.

The semi-monocoque fuselage comprises a pressurize cabin and flight deck with unpressurised nose and tail sections. Stringers, longerons and frames are made of aluminium alloy. Front and rear pressure bulkheads comprise flat webs reinforced with horizontal stiffeners providing high degree of damage tolerance.

The passenger entry door has its own integral steps and is locked by six fail-safe bolts. Failure to lock by any of the bolts is signalled on the flight deck and the position of the bolts can be checked visually. Two overwing emergency exits are incorporated, one on each side of the cabin. Each exit is fitted with a quick release mechanism and can be opened from either inside or outside.

The nose equipment bay forward of the front pressure bulkhead houses avionics equipment, batteries and inverters and is accessed through two large hinged doors. The nose cone, housing the weather radar antenna, is removable and made of glass-reinforced plastic.

The rear equipment bay, aft of the rear pressure bulkhead, is accessed from the fuselage underside. This area accommodates the fixed oxygen system reservoir, cockpit voice recorder, flight data recorder, water tank and emergency locator transmitter.

UNIT 7

The Landing Gear

Lead in

1. Give a definition to the term “landing gear”. Try to predict what performances the landing gear must have.
2. Match the keywords with their translations.

1. undercarriage	a. каркас
2. take-off	b. шина
3. landing	c. хвостовая опора
4. oleo unit	d. масляный агрегат
5. tyre	e. посадка
6. nose over	f. шасси
7. skid	g. капотировать
8. framework	h. взлёт

Reading

1. Read the text and write a brief heading for each paragraph.

The Landing Gear

A. The landing gear (or undercarriage) is intended to support the airplane in proper location for take-off and landing and to provide the shock absorption. The shock is usually absorbed by a sort of pneumatic tyres and shock-absorbing struts. The landing gear usually consists of a pair of wheels carried either from the fuselage or from the wings by a framework of hollow tubes called struts. In addition to these main wheels a support is needed at the rear of a machine. This is a tail wheel (or skid) carried on a swiveling mounting.

B. Two different arrangements of landing wheels are in use today. They are conventional tricycle gears and the landing gear with a skid.

C. The first, the tricycle type, has the main wheels mounted slightly aft of the centre of gravity and the third wheel (the nose wheel) in front. The second type comprises two main wheels located slightly forward of the airplane's centre of gravity and a tail skid at the rear.

D. The tricycle landing gear of the aircraft consists of one nose leg and two main legs. The nose leg is mounted under the nose section of the fuselage. The main legs are installed under the wing or the fuselage symmetrically with respect to its centre line. Tricycle gear has many advantages. It simplifies landing, eliminates the danger of nosing over and carries the airplane in normal take-off position. It permits an airplane to land and come to rest within a shorter distance.

E. Consequently, it is the rule today to employ retractable landing gear which can be drawn up (or retracted) in flight into the wing or fuselage structure. Most high-speed airplanes have retractable landing gears. The retracting mechanism may be either mechanical, powered by electric motors, or hydraulic. Various linkages are employed to perform the retraction of wheels and struts into the fuselage, wing or nacelles.

F. After take-off the nose leg is retracted into the well provided in the fuselage and the main legs are retracted into the well of special nacelles. The landing gear legs have oleo-pneumatic shock absorbers. The shock strut is the major assembly of the wheels. It consists of a shock absorber and other elements. The shock absorber comprises an outer steel tube with a welded top head which attaches a plunger.

G. The landing wheels are fitted with large diameter low-pressure tyres which allow the airplane to taxi over rough ground and also assist in absorbing the shock of landing. The landing gear is designed to withstand the loads imposed by rough landings and fast taxiing. It must also carry the braking loads in a fully braked landing.

H. The design of the tail wheel is similar to that of the main legs and usually consists of a single oleo unit. The tail wheel may be of the conductor type. When it is resting on the ground it provides an electrical earth contact and so prevents the aircraft and crew from damage through static electrical charges.

Comprehension Check

1. Complete the table according to the content of the text.

UNIT	FUNCTION
Landing gear	
Pneumatic tyres	
Shock-absorbing struts	
Tail skid	
Wheel well	

2. Define the main idea of paragraphs *D* and *H*.

3. Complete the sentences below with suitable words from the box.

main legs	oleo unit	to support	to provide
skid	nacelles	nose leg	

- The landing gear is designed _____ the airplane on the ground and _____ the shock absorption.
- Tricycle landing gear consists of one _____ and two _____.
- After take-off main legs are retracted into special _____.
- The tail wheel consists of a single _____.
- The rear part of some airplanes is supported by the _____.

4. Ask questions to which the following sentences are answers. Remember to use “*wh-*” words: *why, what, where, when*.

- tricycle landing gears and the landing gear with a skid.
- it simplifies landing and prevents nosing over.
- after take-off.
- into the well of special nacelles.
- large diameter low-pressure tyres.
- to protect the aircraft and crew from damage through static electrical charge.
- by a framework of hollow tubes called struts.

5. Give your own definitions for the words from the text.

Tail skid, low-pressure tyre, aircraft centre line, landing gear well, framework, retractable landing gear.

Language Focus

1. Match the word in column *A* with the word in column *B* having a similar meaning. Be careful! There are some extra words in column *B*.

<i>A</i>	<i>B</i>
fit	linkage
strut	skid
rear	design
landing gear	maintain
intend	equip
support	back
tail wheel	leg
conventional	usual
	undercarriage
	provide

2. Find in the text antonyms of the following words.

Fixed (A); similar (B); add, complicate (D); straight (G); different, result in, repair (H).

3. a) Check if you know the meaning of the following words.

To intend, to carry, to mount, to install, to employ, to perform, to attach, to withstand, to impose, to prevent.

b) Make up your own word combinations using these verbs.

4. Complete the missing part of the table.

Verb	Noun	Adjective (Participle)
		simple
absorb		
		arranged
	retraction	
mount		
	addition	
		conductive

Speaking

1. You are a guide of the museum of aviation. Tell a group of the first-year students about different types of landing gears. The presentation is welcomed to support your excursion.

Writing

1. Match the beginnings and the endings of the sentences.

1. The shock is usually absorbed by ...	a) eliminates danger of nosing over.
2. Landing gear with a skid comprises two main wheels located	b) prevents the aircraft and crew from damage through static electrical charges.
3. Tricycle landing gear simplifies landing and ...	c) pneumatic tyres and shock absorbing struts.
4. The landing wheels are fitted with...	d) slightly forward of the airplane's centre of gravity and a tail skid at the rear.
5. The tail wheel provides electrical contact and so ...	e) large diameter low-pressure tyres.

2. Translate the text in a written form.

This airplane has hydraulically operated retractable tricycle landing gear with nosewheel steering. The port and starboard main gear assemblies each consists of a single with an oleo-pneumatic shock absorber and a stub axle carrying a single wheel and tyre. Each leg is attached to the wing spars and retracts inwards into a landing gear bay in the wing. A door is hinged to the wing outboard of each leg and covers the outer portion of the gear bay when the gear is retracted.

The nose gear leg consists of an oleo-pneumatic shock absorber attached to the forward pressure bulkhead, with two wheels mounted on a live axle. Mechanical linkage ensures that the nosewheel bay doors are in closed position except during gear travel.

The brakes on each main wheel consist of cintered iron plates operated hydraulically by a multi-piston arrangement. Anti-skid units and automatic wear adjusters are fitted to ensure maximum braking efficiency under all conditions.

Extension of the landing gear in the event of hydraulic failure is achieved by using emergency system operated by a hand pump from the flight deck.

Section 2. AIRCRAFT ENGINE

UNIT 8

Engine Designing



Lead in

1. Discuss the following questions with your partner.

- a) What does the aviation success mostly result from?
- b) What are the stages of engine developing?

2. Choose from the list below the most important factors engineers should take into account in the process of engine designing. Explain your choice.

- weight
- speed
- complexity
- reliability
- life
- materials the engine is made of
- if it is environmentally friendly
- cost of production

3. Think about adjectives for the items you have just spoken about and their antonyms.

<i>Item</i>	<i>adjective</i>	<i>antonym</i>
weight	light	heavy
speed		
complexity	complex	simple
power		
reliability		
beauty		
price		
strength		

Reading

- a) Scan the text and mark the factors not mentioned before.
 b) Read the text again. While reading match the keywords with their Russian counterparts.

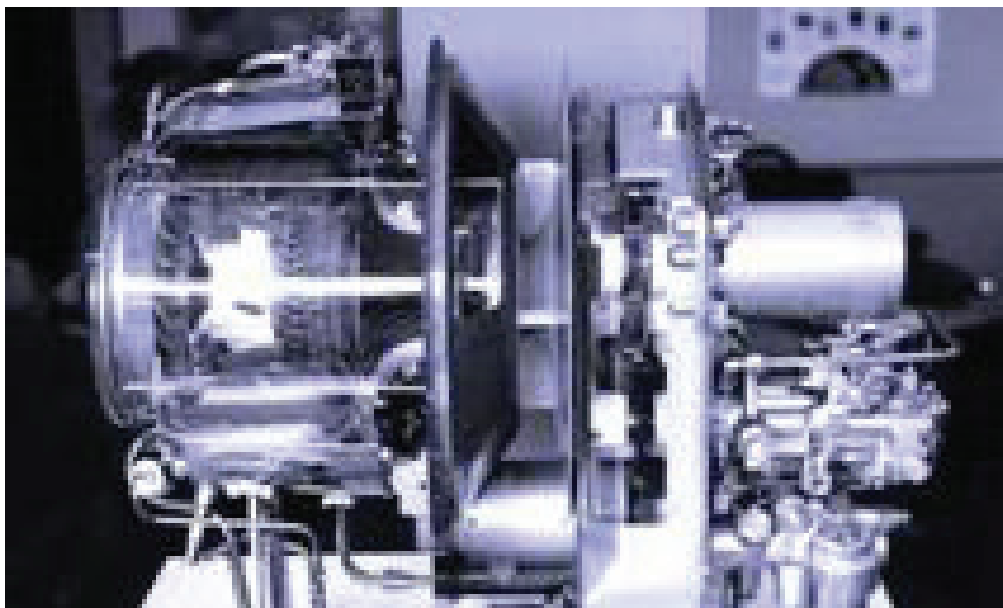
- | | |
|--------------------|-------------------------------|
| 1) performance | a) совершать, выполнять |
| 2) payload | b) режим работы двигателя |
| 3) drag | c) загрязнять |
| 4) to create | d) оказывать влияние |
| 5) power output | e) летные характеристики |
| 6) to accomplish | f) лобовое сопротивление |
| 7) strength | g) выходная мощность |
| 8) loss | h) вспомогательные средства |
| 9) facilities | i) цель |
| 10) to influence | j) достигать |
| 11) goal | k) грузоподъемность; нагрузка |
| 12) power setting | l) создавать |
| 13) to reduce | m) прочность |
| 14) to achieve | n) снижать |
| 15) to contaminate | o) потери |

Engine Designing

A. To move and fly any aircraft demands power. A machine that produces mechanical power necessary for propulsion of a vehicle is called an engine. It is constant engine evolution that decidedly influences the aircraft performance.

B. The process of developing an engine is one of compromises. Therefore creating engines begins with solving very complex and contradictory problems - determination of the most optimum parameters permitted by modern science in the engine operating process. Then the designers work at developing such engine constructions that could accomplish this process without unnecessary loss and would have the long life and the high strength. Engineers design specific attributes into engines to achieve specific goals. Aircraft are one of the most demanding applications for an engine, presenting multiple design requirements. An aircraft engine must be:

- *reliable* - aircraft engines must perform reliably at high pressure, all temperatures and speeds;
- *lightweight* - a heavy engine increases the empty weight of the aircraft and reduces its payload;
- *powerful* – to overcome the weight and drag of the aircraft;
- *small and easily streamlined* - large engines with the substantial surface area, when installed , create too much drag, wasting fuel and reducing power output;
- *repairable* - to keep the cost of replacement down;
- *fuel efficient* - to give the aircraft the range the design requires.



C. The design of aircraft engines tends to favor reliability over performance. Long engine operation times and high power settings, combined with the requirement for high reliability, means that engines must be constructed so they could support this type of operation with ease. Aircraft spend the vast majority of their time travelling at high speed. This allows an aircraft engine to be air cooled, as opposed to having a radiator. The amount of air flow an engine receives is usually designed according to expected speed and altitude of the aircraft in order to maintain the engine at the optimal temperature.

D. Besides engine designers, experts in the field of automatic control, measuring and information systems also take part in developing engines. They make every effort to get units that could meet all modern requirements.

E. Today we speak about the necessity to create nuclear, plasma, ion and other exotic engines. Besides, it is quite necessary to have “clean” aircraft power plants, that is, aviation engines which do not contaminate the environment due to usage of hydrogen as the main fuel. Aircraft-engine building is a fast developing branch of industry. The engine complexity doubles every 15 years. Aircraft engine designers must be well educated and able to solve the most difficult problems by using all modern knowledge, techniques and facilities.

Comprehension Check

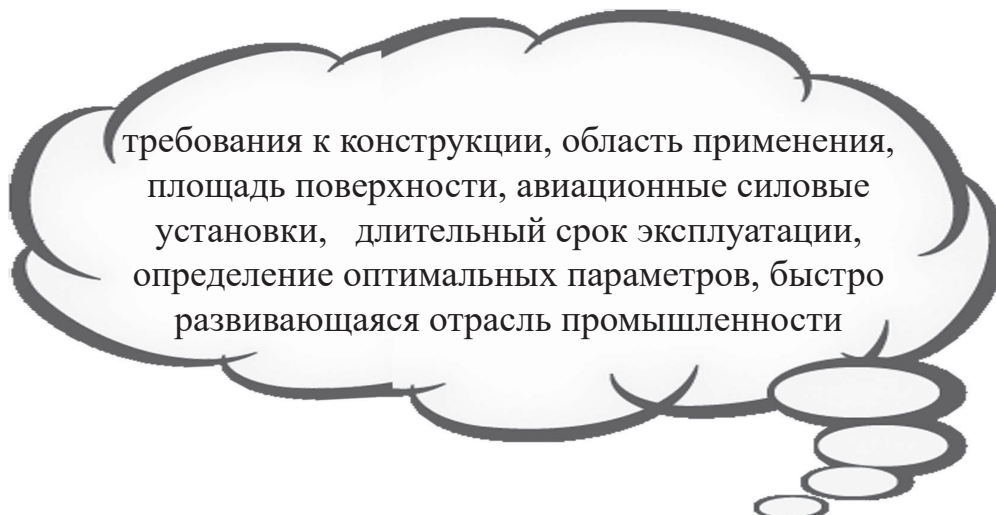
1. Match the headings below and parts of the text **A-E**.

1. Basic things for engine design
2. Innovations in engine design
3. A machine for generating mechanical power
4. Experts involved in the process of engine construction
5. Factors, providing good engine operation and its reliability

2. Answer the questions.

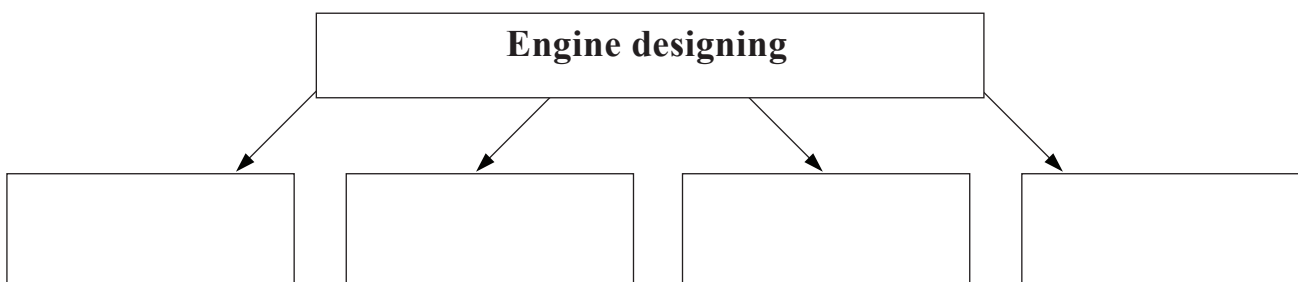
1. What kind of machine is an engine?
2. What is the primary task of any engine?
3. What other specialists (except engine designers) are involved in the construction of aviation engines?
4. What qualities should aircraft engine designers possess to meet modern requirements?
5. What are the new tendencies in the field of aircraft engine design?

3. a) Find in the text the English equivalents to the word combinations:



b) Speak about the context in which they are used.

4. a) Fill in the diagram according to the content of the text.



b) Share information with your partner. Speak on the topic, using the diagram above.

Language Focus

1. a) Match the nouns with their definitions:

- | | |
|----------------|---|
| 1. aircraft | a. something successfully finished |
| 2. advancement | b. the use of physical strength or power of the mind |
| 3. achievement | c. a method of doing something that needs skill |
| 4. effort | d. improvement, development or movement to a higher rank facility |
| 5. facility | e. a system that makes a particular activity possible |
| 6. loss | f. inability to keep something |
| 7. techniques | g. a flying machine of any type, with or without an engine |

b) Now, it is your turn to define the words:

- | | | |
|----|-------------|----|
| 1. | movement | a. |
| 2. | performance | b. |
| 3. | requirement | c. |
| 4. | strength | d. |
| 5. | specialist | e. |

2. Fill in the table according to the example, using either comparative or superlative form.

a)	<i>high</i>	<i>higher</i>	<i>the highest</i>
	small great simple cheap strong		
b)	<i>modern</i>	<i>more modern</i>	<i>the most modern</i>
	efficient lightweight attractive popular significant		

3. Which of the words below are adjectives in a comparative form?

- | | | | |
|---------|---------|-------|---------|
| larger | lighter | other | glider |
| wider | colder | more | easier |
| winter | spider | over | pointer |
| heavier | driver | lower | further |

4. Use the proper form for the adjectives in brackets.

1. Most airplane materials are now made out of composite materials that are (strong) and (lightweight) than most metals.
2. Modern turboprop engines are equipped with propellers that have a (small) diameter but a (large) number of blades for efficient operation at much (high) flight.
3. It became readily apparent that a (good) job has to be done in supporting the F-100 engine fleet.
4. The problem of aircraft noise is one of the (bothersome) problems.
5. The rocket equation states the intuitive fact that the (fast) you throw propellant out from a spacecraft, the (little) you need to execute a rocket-born maneuver.
6. Air transport can and will make (far) progress.
7. Airplane can fly at (high) speed than helicopter.
8. The (great) advantage that many digital instruments have is that they don't have any moving parts.

5. Translate from Russian into English.

1. Благодаря своим характеристикам, данный тип двигателя способен конкурировать с самыми лучшими мировыми двигателями этого класса.
2. Эта конструкция является более эффективной, но она и более дорогая.
3. Более холодный воздух смешивается с горячим воздухом на входе в двигатель.
4. Фронтальная область турбины намного меньше, чем фронтальная область компрессора и камеры сгорания.
5. Результатом увеличения объёма является более высокая скорость.
6. Двигатель F100 – это самый безопасный и самый надёжный двигатель, выпускаемый для самолётов-бомбардировщиков.
7. Поскольку двигатель J73 снабжен входными направляющими лопатками с изменяемым углом, он может разгоняться гораздо быстрее, чем раньше.
8. Последнее время самолеты-перевозчики стали пользоваться большим спросом особенно у азиатских компаний, выполняющих грузоперевозки.
9. Чем больше энергии вырабатывает турбина, тем меньше становится скорость выхлопных газов турбовентиляторного двигателя.
10. В некоторых случаях самолёты не так эффективны, как вертолёты.

6. a) Put the words below into the correct column of the table.

steam	fix	invent
exhaust	heat	change
demand	blade	export
influence	result	degree
performance	burn	melt
combustion	power	process

<i>verb</i>	<i>noun</i>	<i>both verb and noun</i>

b) Mark the stress of all the words in a) according to the part of speech they belong to. Practise their pronunciation aloud.

7. Rearrange the words to get true sentences. Mind, the very first word is the beginning of the sentence.

- a) Any / propulsion / unit / a / engine / be / called / can.
- b) The / were/ first / units / plants / steam / power.
- c) Turbojet / the / speeds / suitable / high / engine / for / most / forward /is.
- d) The /stages / engine / various / of /compressor / with / in / axial / number / design / an.
- e) Fuel / chamber / in / be / combustion / must / the / burnt.
- f) There / thrust / for / engine / methods / are / of/ turbojet / a / increasing / some / the.
- g) Thrust/ force/ an/ tending/is/ applied/ a/ produce/ in/motion/ to / body/.

Speaking

a) Look at the three engines below. What kind of engines are they? Why do you think so?



Fig. 1

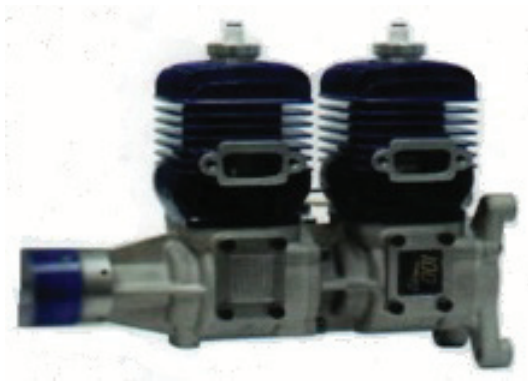


Fig. 2



Fig. 3

b) Work in pairs. In the two columns below there are some advantages and disadvantages of these engines. Match them with the engines.

Advantages

powerful
streamlined arrangement
runs well
good shape
small drag
reliable
lightweight

Disadvantages

not very powerful
expensive
complicated
needs more spare parts
too large
fuel inefficient
heavy enough

c) Work with another pair of students and compare your ideas. Give some reasons to support your point of view. The following phrases may help you to start and successfully continue your conversation.

Starting a conversation

First of all I'd like to...

As far as I know...

The subject I'm going to speak about is...

I want to begin with...

Agreeing

Yes, you are definitely right.

I agree that...

Maybe you are right.

That's true.

Asking for opinions

What do you think?

Do you agree (with that)?

What's your opinion on...?

What about (you/these factors etc)?

Disagreeing

I don't think so.

I'm not sure about that.

No, definitely not.

I'm afraid, I can't agree.

d) Look at the three engines below. What kind of engines are they? Why do you think so?

Writing

1. These are two other types of engines: a horizontally opposed twin cylinder engine and a twin engine. Do a research to compare them on the items used in Exercise 3 of the “Lead-in”. Write a short report on the work done. Use about 80-100 words.



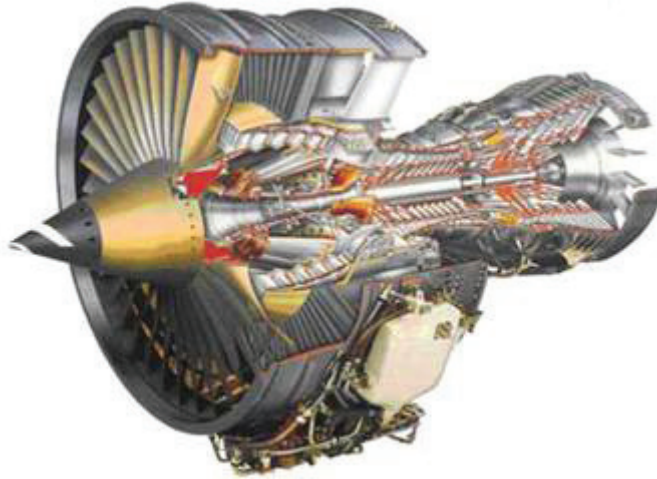
Fig. 4
Horizontally opposed
twin cylinder



Fig. 5
V twin

UNIT 9

Jet Engine

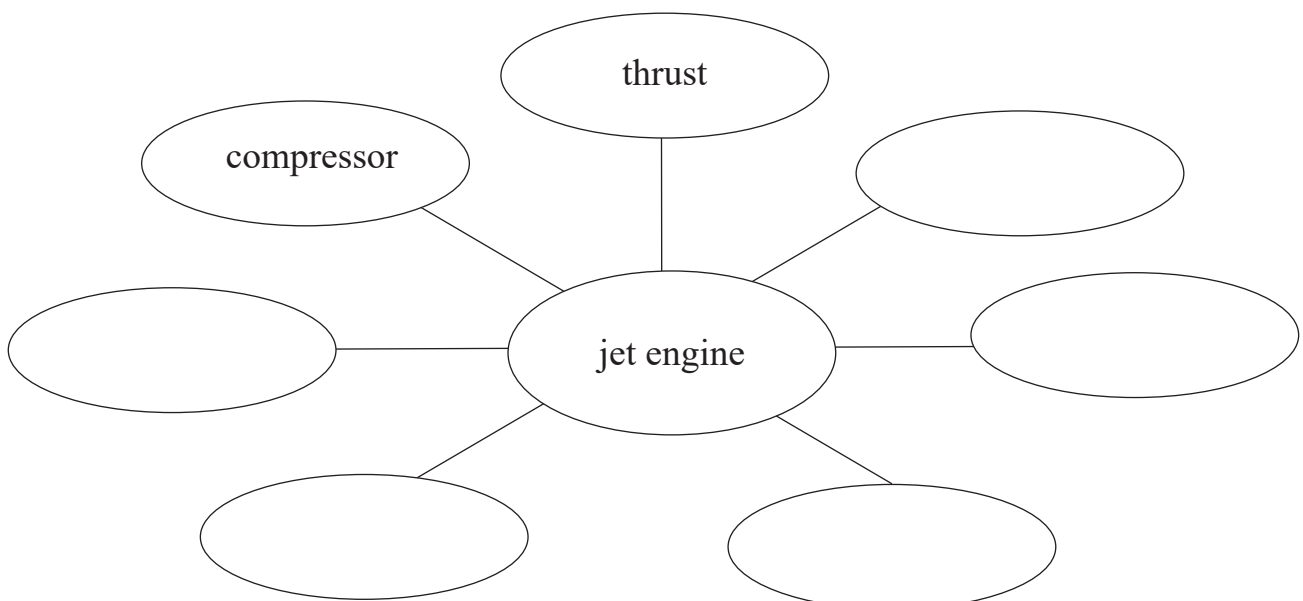


Lead in

1. Discuss the following questions with your partner.

- a) What is a jet engine?
- b) What types of a jet engine do you know?
- c) Where are jet engines applied?

2. Brainstorm all possible terms related to the topic.



Reading

While reading the text match the keywords with their Russian counterparts:

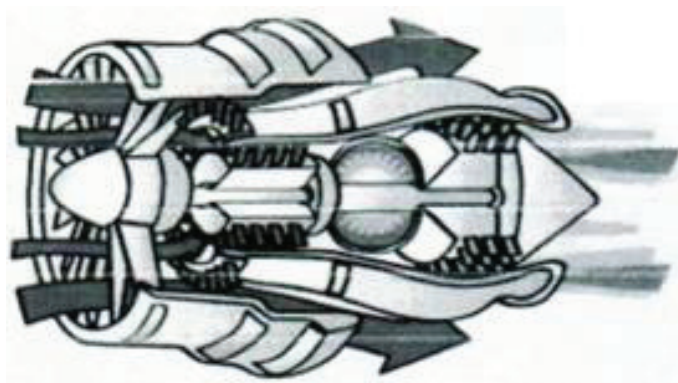
- | | |
|---------------------------|------------------------------|
| 1. jet | a. надежность |
| 2. combustion | b. тяга |
| 3. reliability | c. всасывать |
| 4. to burn (burnt, burnt) | d. обеспечивать |
| 5. to suck | e. выбрасывать, извергать |
| 6. to utilize | f. реактивный; струя |
| 7. propulsion | g. устанавливать |
| 8. to mount | h. движение вперед |
| 9. to produce | i. вырабатывать, производить |
| 10. to eject | j. горение |
| 11. to supply | к. использовать |
| 12. thrust | l. сжигать, гореть |

Jet Engines

A jet engine is a reaction engine that discharges a fast moving jet of fluid to generate thrust. This broad definition of jet engines includes turbojets, turbofans, rockets, ramjets, pulse and pump-jets. In general, most jet engines are internal combustion engines but non-combusting forms also exist.

The term “jet engines” refers to any jet propulsion device which utilizes air from the atmosphere together with the combustion of a fuel and produces the jet for propulsion purposes.

The basic idea of a jet engine is to produce the high pressure and high temperature gas jet. The jet is ejected rearwards with great force named thrust. The thrust is the reaction of the jet of hot gases ejected from the rear. The jet is produced by combustion of the fuel in the compressed air. The latter is supplied by the atmospheric air that enters through the front opening where a compressor is mounted. It must provide the combustion chamber with the required air. Air is sucked, compressed and then used to burn the fuel. The image below shows how the air flows through the engine.



The air goes through the core of the engine as well as around the core. This causes some of the air to be very hot and some to be cooler. The cooler air then mixes with the hot air at the engine exit area.

Jet engines find extensive use. The application of jet power plants to aircraft has made flying faster than the speed of sound, which was once considered impossible.

Jet engines, involving the most advanced science and technology, are widely utilized for not only aircraft but also industrial systems and equipment. In addition to the capacity to produce larger power with comparatively compact size and light weight, the high reliability and easy maintenance of jet engine will provide extreme advantage in view of automation and power economy.

Comprehension Check

1. Say if the statements are true or false. Correct the false ones.
 1. There are several types of jet engines.
 2. Being ejected rearwards the jet produces thrust.
 3. The speed of a jet aircraft is less than that of sound.
 4. A fast moving jet that is discharged by the engine produces thrust.
 5. All jet engines are called internal combustion engines.
2. Complete the sentences using the ideas from the text.
 1. Jet engines include such types as...
 2. The primary purpose of a jet engine is to...
 3. The term “jet engine” means...
 4. The thrust is...
 5. Jet engines are used today for not only aircraft but ...

3. Find the words in the text which mean the following:

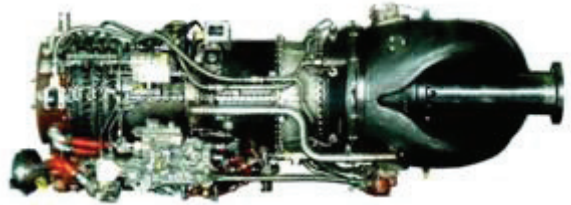
- a piece of equipment
- to manufacture
- the force pushing an airplane
- a fast narrow stream of gas
- to provide with
- the process of burning
- to think about; to believe

4. The pictures of engines, aircraft and advertisements have been mixed up. Match engines (A-D) and advertisements. Which aircraft (a-d) may these engines be installed on?

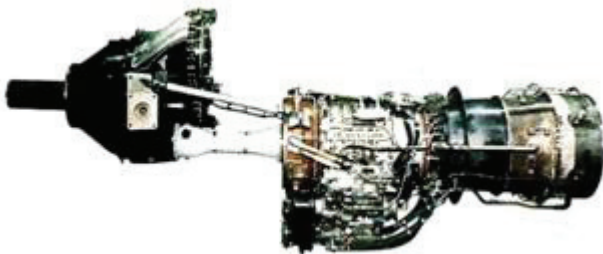
A.



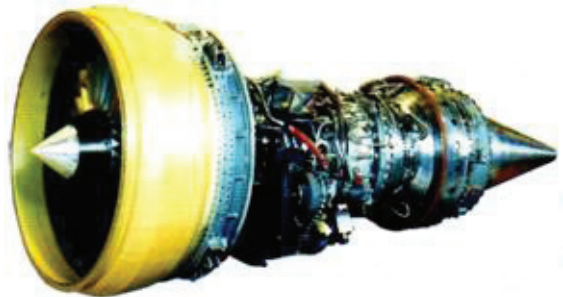
B.



C.



D.



1. J79 Turbojet Engines

J79 is capable of producing speeds up to Mach 2 and widely adopted throughout the world, which IHI serially produced for the F-104J star fighter and the F-4E Phantom under a license agreement with GE.

2. T64 Turboprop Engines

T64 is a turboprop engine serially produced by IHI to power the P-2J anti-sub-marine patrol plane and the UA-1A rescue flying boat under a license agreement with GE. This engine also powers the ECM/ELINT YS-11E plane.

3. CF34 Turbofan Engines

Developed and manufactured jointly for 70-90 seats class regional jet planes under Risk and Revenue Sharing Program, in which IHI plays major role as GE's partner. This engine is installed on Canadian Regional Jet CRJ 700/900, Brazilian Regional Jet EMBRAER 170/190 and Chinese Regional Jet ARJ21.

4. T58 Turboshaft Engines

T58 is produced by IHI under a license agreement with GE which is widely adopted to power helicopters. This engine is installed on the various kinds of helicopters such as V-107, HSS-2 and S-61.



a.



b.



c.



d.

Language Focus

1. Find pairs of synonyms among the words:

- | | |
|---------------|----------------|
| 1. to provide | a. power plant |
| 2. to mount | b. to utilize |
| 3. rearwards | c. to install |
| 4. to use | d. backwards |
| 5. engine | e. to supply |

2. Find pairs of antonyms among the words:

- | | |
|-------------|---------------|
| 1. easy | a. latter |
| 2. to suck | b. rear |
| 3. former | c. impossible |
| 4. front | d. to eject |
| 5. possible | e. heavy |

3. a) Work on your own. Choose any three words from Ex. 1 and any three words from Ex. 2. Make up sentences to show their use.

b) Work in pairs. Exchange your sentences, check them and correct mistake if there are any.

4. a) Explain the following phrases in English. If necessary refer to an English-English dictionary.

b) Give their Russian equivalents.

engine exit area	reaction principle	easy maintenance	the speed of sound
high temperature gas jet	extreme advantage	compressed air	atmospheric air
front opening	extensive use	the speed of sound	jet propulsion device

5. Define the tense-form and the voice of the predicate:

- | | |
|-----------------------|-----------------------|
| 1. is being discussed | 6. has been provided |
| 2. will be increased | 7. had equipped |
| 3. has had | 8. was subjected to |
| 4. am working | 9. left |
| 5. have | 10. had been overcome |

6. Match the predicates in column A with their Russian equivalents in column B:

<i>A</i>	<i>B</i>
1. will be designed were designed are being designed	a) проектируются b) будут проектироваться c) спроектированы
2. were being created had been created will be created	a) будет создан b) был создан c) создавались
3. was changed is being changed has been changed	a) изменена b) была изменена c) изменяется
4. is achieved were achieved will be achieved	a) будет достигнут b) достигнут c) были достигнуты
5. will be discussed has been discussed was discussed	a) обсудили b) будут обсуждать c) обсуждали

7. Complete the sentences by filling in the gaps using the prepositions from the oval and the table below as the reference material.

<i>English verbs</i>	<i>Russian verbs</i>
1. insist on	настаивать на
2. refer to	ссылаться на
3. to rely on/upon	полагаться на
4. to send for	послать за
5. to speak of	говорить о
6. to work at	работать над
7. to meet with	сталкиваться с

of, at, with, for
upon, by, to, on

1. The problem of space exploration have just been spoken
2. The results were affected ... the presence of magnetic field.
3. This reference book have been often referred
4. Such difficulties are met ... in engine production.
5. This type of vehicle may be certainly relied
6. The problem of aircraft noise reduction is still being worked
7. The workers have been sent ... some instruments.

8. Translate the sentences into English.

- 1) Докладчиков слушали с большим интересом.
- 2) На решение многих вопросов повлияли практические требования и ограничения, предъявляемые современные рынком.
- 3) Меня никогда не спрашивали об этом.
- 4) После доклада вам будут задавать вопросы.
- 5) На эти данные уже ссылались.
- 6) Оборудование уже устанавливают? Как вы думаете, его установят к полудню?
- 7) Над проектом этой установки работали 2 года.
- 8) Трудности были преодолены благодаря более тщательному анализу проблем, связанных с вибрацией.
- 9) Работа будет завершена вовремя.
- 10) Новый тип форсунки был разработан совсем недавно группой инженеров.

Writing and Speaking

1. In the text it is mentioned about several types of jet engines. Choose one of them, research information on the Internet and write down all the facts and details necessary to cover the following items:

- * jet engine invention background
- * design of early jet engines and their drawbacks
- * modern jet engines: a) design, b) technologies used, c) characteristics

2. Work in a group of four. Use your notes to tell your partners about the engine you were researching. The phrases below may help you to start and support your conversation.

Starting a conversation

- The subject of my research is...
- Let me begin (with)...
- What I'm/was interested in is/was...
- Let's start with...
- Why don't we...?

Asking for more details

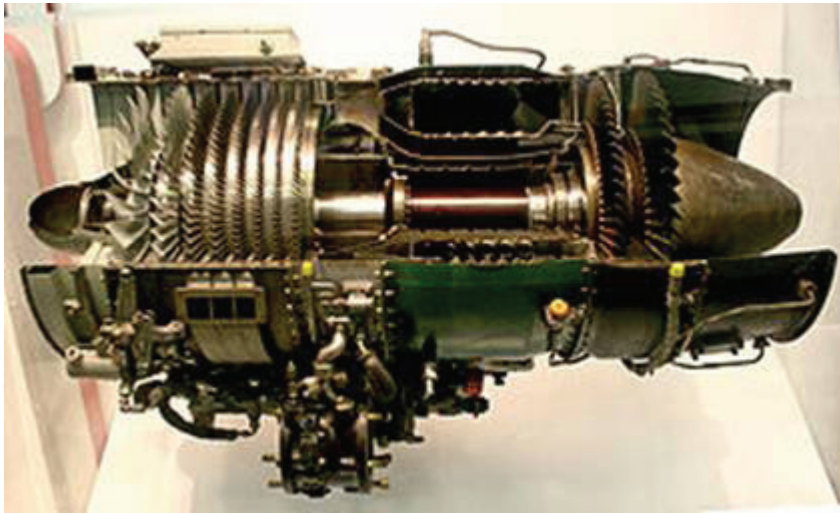
- Could you be more specific about...?
- Could you give some more details on...?
- Have you come across ...?
- Could you tell us how it operates?

Provoking a response

- Don't you think that...?
- I can't understand your point...
- You mean that..., don't you?
- I have doubts about...

UNIT 10

Power Plant

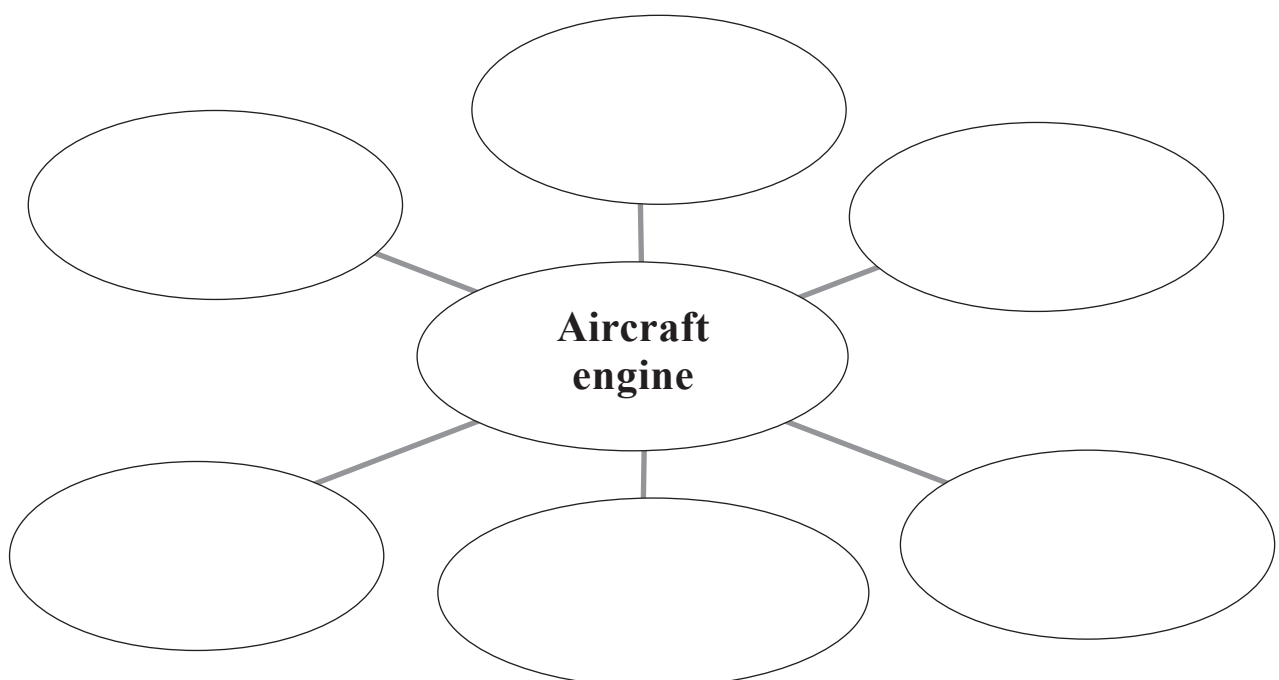


Lead in

1. Discuss the following questions with your partner.

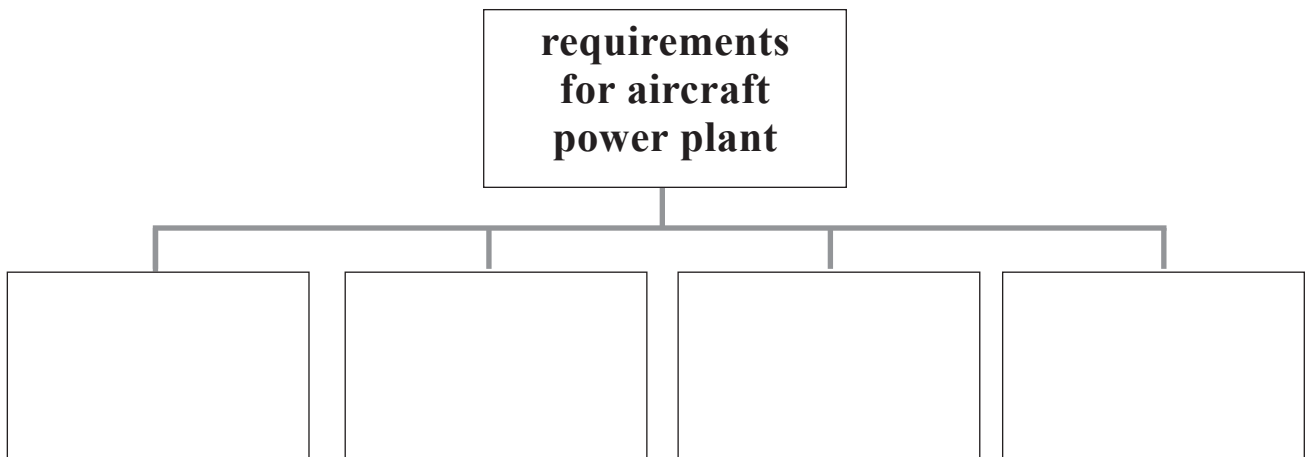
- What is the propulsion system in an aircraft for?
- What attributes should engineers design into engines to achieve specific goals?
- What should an aircraft engine be?

2. Brainstorm all possible ideas related to the topic.



Reading

- Read the text quickly and find out if your predictions are correct.
- Read the text for the second time. While reading fill in the diagram according to its contents.



Power Plant

Any kind of vehicle must move. The ability to move demands power. A machine that produces mechanical power or energy is called an engine or a power plant. Every engine must meet a number of requirements. First of all engines must have the maximum power (or thrust) for minimum weight. Therefore every engine is to have the reduced weight per horse power of the engine. The weight in pounds per horse power output may be defined as weight/ power ratio.

Then the fuel consumption must be as low as possible. And on the contrary the amount of power produced from consumed fuel for a given period of time must be as high as possible.

Another demand is proper engine flexibility. Flexibility is the ability to run smoothly and perform properly at all speeds and through all variations of atmospheric conditions.

One more important requirement is the engine reliability. The engine is to have a long life with maximum of time between overhaul periods.

Besides, any engine must be started easily and carry its full load in a few minutes.

The necessity of carrying away excess heat developed by the engine has always been a problem of first importance too.

As mentioned before the power plant is a means of propulsion. Nowadays there exist many types of engines used for various purposes. There are gasoline engines, diesel engines, gas turbines, jet engines and rocket engines. Each of them has certain advantages and disadvantages over other forms of power plant.

Comprehension Check

1. a) Give English equivalents for the following Russian words and word combinations.

силовая установка аппарат для движения величина способность
требование двигатель вес коэффициент определять выход
цель топливо потребление существовать надежность излишек
ремонт манёвренность приспособляемость

- b) Now say in your own words what context they are used in. If necessary refer to the text again.

2. Match the phrases in the left-hand columns and the phrases in the right-hand columns.

- | | |
|--|--|
| 1. All engines must have | a) may be defined as weight/ power ratio. |
| 2. Every engine is to have | b) be as low as possible. |
| 3. The weight in pounds per horse power output | c) with maximum of time between overhaul periods. |
| 4. The fuel consumption must | d) the maximum power (or thrust) for minimum weight. |
| 5. The engine is to have a long life | e) the reduced weight per horse power of the engine. |

3. Answer the questions.

1. What machine produces thrust?
2. What must the weight of any engine be?
3. What is the engine flexibility?
4. What must the period between engine overhauls be?
5. What necessity arises due to excess heat of the power plant?
6. How can you characterize the aviation power plant?
7. What types of engines do there exist nowadays?

Language Focus

1. Find the correct definitions of the terms on the left:

- | | |
|----------------|---|
| 1. engine | a) a measure of the rate of doing work expressed as the work done per unit time |
| 2. requirement | b) the amount produced, as in a given period |
| 3. power | c) necessary changes to run smoothly and perform properly at all conditions |
| 4. output | d) going beyond permitted limits |
| 5. flexibility | e) a machine that produces mechanical power or energy |
| 6. overhaul | f) examination of details or machines and if necessary to make their repairs |
| 7. excess | g) a demand |

2. Fill in the gaps, using the terms above.

- The turbine provides the _____ to drive the compressor and accessories.
- The steam engine could not fully meet all the _____ and it lead to the design of a new type.
- The conventional piston engines are not suitable for speeds in _____ of 500 miles per hour because of propeller limitations.
- The turbojet _____ is most suitable for high forward speeds.
- Different engines have different power _____ .
- The _____ and repair of all accessories constituting the fuel, oil and air are carried out by our company.
- One of the most important demands in the process of engine designing is its _____

3. a) Make meaningful collocations. Translate them into Russian.

- | | |
|----------------|----------------|
| 1. mechanical | a. consumption |
| 2. reduced | b. conditions |
| 3. fuel | c. requirement |
| 4. engine | d. weight |
| 5. atmospheric | e. period |
| 6. important | f. power |
| 7. overhaul | g. flexibility |

b) Make up sentences of your own to illustrate their use.

4. The phrases in brackets below contain modal verbs. Substitute the phrases in Russian for their English counterparts.

1. Different types of engines (должно быть, имеют) advantages and disadvantages over other forms of power plants.
2. Most small airplanes (должны были быть разработаны) with reciprocating engines.
3. The majority of reciprocating engines (возможно, являются) air cooled.
4. This kind of power plant (мог использоваться) in this engine much earlier.
5. We (следует проверить) the results once again.

5. Translate the sentences into English.

1. Силовая установка – важная часть самолета.
2. Поршневые и турбовинтовые типы двигателей состоят из двух основных частей: двигателя и винта.
3. Двигатель в самолете обеспечивает средство для передвижения.
4. Если в самолете несколько двигателей, то они размещаются в гондолах.
5. Обычно воздушный винт находится на валу двигателя.

Speaking

1. Work in pairs. Go back to the section Reading. Take turns to speak about the requirements any aircraft power plant must meet.
2. In the text it was spoken about some forms of the power plant. Do a research with your partner and find information on one of these forms. Cover the following items:
 - *history
 - *design
 - *performance
 - *application
3. Work with another pair of students and share the information on the work done.

Writing

Rearrange the words to make a meaningful sentence and write them down. Mind, the first word is the beginning of the sentence.

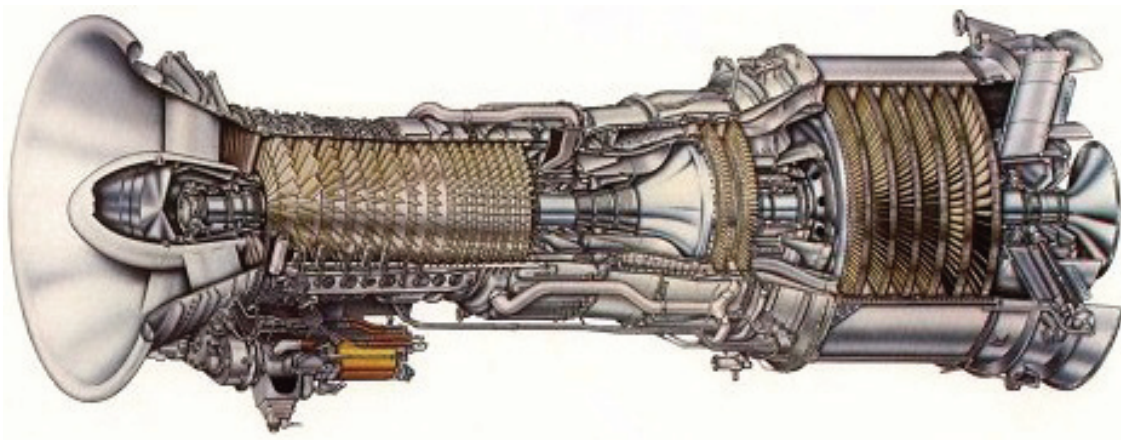
1. The / engine / power/ produces/ machine/ called/ is/ that/an.
2. A/ propulsion/ means/ a/ power/ is /plant/ of.
3. The/ consumption/ to/ designers/ solve/ fuel/ want/ problem/ of/ the.
4. Airplanes/ turbofan/ powered/ today's/ are/ engines/ by/ modern/.
5. Do/ the/ was/ engine/ you/ know/ what/ like/ first?

UNIT 11

Gas Turbine Engine Components

Lead in

1. a) This is a gas-turbine engine. Try to identify its main parts.



b) Read the text and check if your predictions were correct.

Reading

Gas Turbine Engine Components

The gas turbine engine consists of a rotary air compressor with an air intake, one or more combustion chambers, a turbine and an exhaust outlet.

There are two basic types of rotary air compressors: a centrifugal flow compressor and an axial flow one.

The centrifugal flow compressor is a single or two-stage unit which has an impeller to accelerate the air and a diffuser to produce the required pressure rise. The axial flow compressor is a multi-stage unit with alternate rows of rotating and stationary blades to accelerate and diffuse the air until the required pressure rise is obtained.

The combustion chamber has the difficult task that is to expand the air passing through the engine by burning fuel in the air stream. Although all combustion chambers work on the same principles, they may be installed in the engine in some different ways. The multiple combustion chamber layout is often used with engines having centrifugal compressors. Annular combustion chambers are used with engines having axial compressors.

The turbine provides the power to drive the compressor and accessories. It extracts energy from the hot gases released from the combustion system and expands them to a lower pressure and temperature. The turbine may consist of several stages, each using one row of stationary guide-vanes and row of moving blades.

The exhaust system passes the turbine discharge gases to atmosphere at a velocity, and in the required direction, to provide the resultant thrust.

Comprehension Check

1. a) Find Russian equivalents for the following English words and word combinations.

роторный компрессор	воздухозаборник компрессора	
выходное отверстие	центробежный компрессор	
осевой компрессор	рабочее колесо	диффузор
переменные ряды	результатирующая тяга	кольцевая
камера сгорания	вспомогательные агрегаты двигателя	
выхлопные газы	трубчатая конструкция камеры сгорания	

Make up sentences using these words.

- b) Now say in your own words what context they are used in. If necessary refer to the text again.

2. Present the information from the text in the form of a table, marking the parts of the gas turbine engine and their functions.

Part	Function

3. a) Answer the questions according to the text.

1. What components does a gas turbine engine consist of?
2. How many basic types of rotary air compressor do you know?
3. What is the function of the diffuser?
4. What types of blades are there in the axial flow compressor?
5. Where is the fuel burnt?

b) Make up 3 more questions to the text.

Language Focus

1. a) Match the verbs with their definitions.

- | | |
|------------------|--|
| 1. to accelerate | a) to gain possession of; acquire; get |
| 2. to diffuse | b) to make or become greater in extent, volume, size, or scope; increase |
| 3. to obtain | c) to free (something) from (one's grip); let go or fall |
| 4. to expand | d) to withdraw, pull out, or uproot by force |
| 5. to provide | e) to increase the velocity |
| 6. to extract | f) to put at the disposal of; furnish or supply |
| 7. to release | g) to spread in all directions |

b) Write down some sentences, leaving a gap in each sentence for your partner to fill it in. He / she should use one of the verbs above. Exchange your sentences, fill them in, check the results.

2. Read the text. Substitute the underlined words for the words from the box below.

powerful; geometry; appropriate; power; components

The gas turbine engine takes air from the atmosphere and, after compressing and heating, it uses some of its energy to drive the turbine. The mechanical arrangement of the gas turbine engine is simple. It consists of two main rotating parts, a compressor, a turbine and a combustion chamber. The turbojet engine is most suitable for high forward speeds. At aircraft speeds below 450 miles per hour the jet engine is less efficient than a propeller-type engine.

3. Translate from Russian into English.

1. Этот двигатель, возможно, будет установлен на новый самолёт.
2. Следует рассмотреть предложения этой конструкторской группы.
3. Нужно провести тщательный осмотр компрессора данной силовой установки.
4. Кроме того, следует проверить и показатели работы этой установки.
5. Нас заверили, что отчёт будет завершён в срок.

Writing

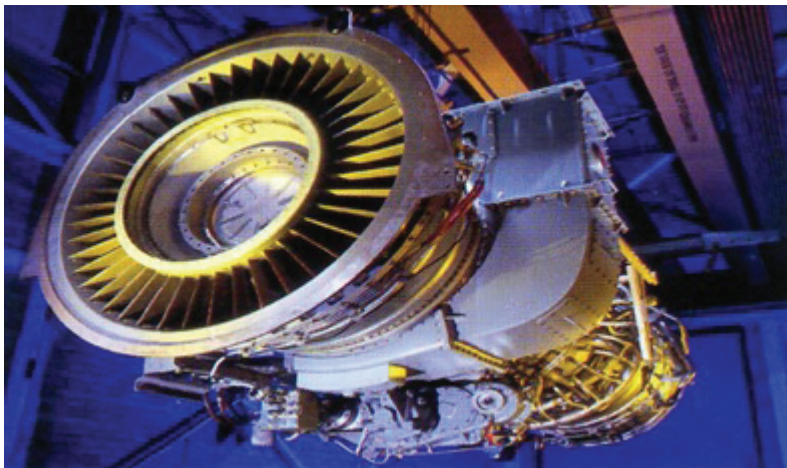
Write a short description of the gas turbine engine using ideas from the text. Use the following phrases:

- The engine consists of ...
- The main parts are ...
- The principle of operation is ...
- The function of this part is ...
- The geometry of this device is ...

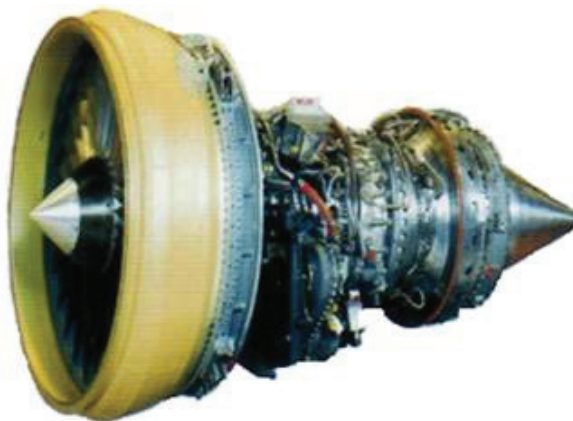
Speaking

- a) Have a look at the pictures below. What do they show? What branches of industry are these units intended for? Why?

A.



B.



C.

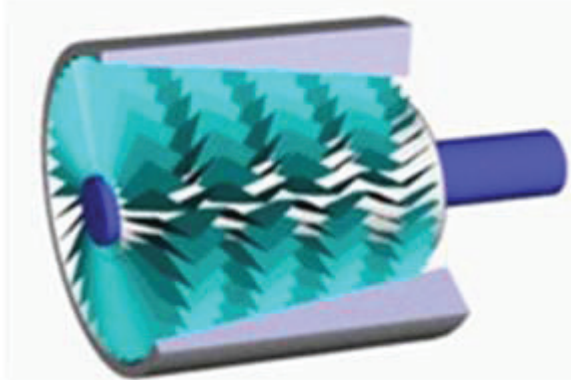


b) Search the Internet to get more information.

c) Discuss the results of your search in a group of four.

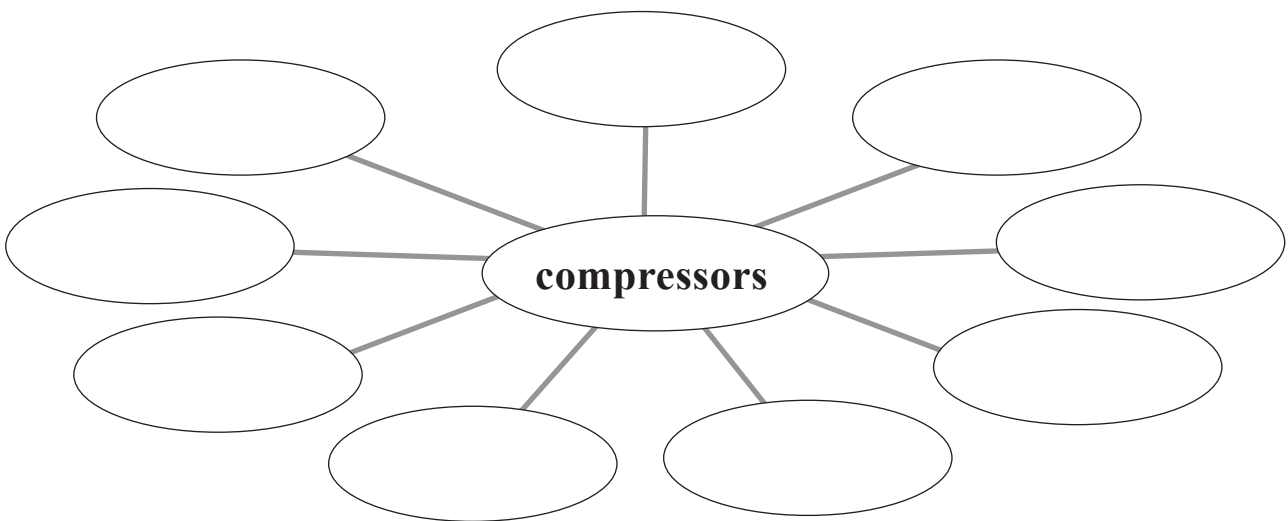
UNIT 12

Compressors



Lead in

1. Can you suggest a definition for the word compressor? What sphere of application do you think it may concern?
2. Brainstorm all possible terms related to the topic.



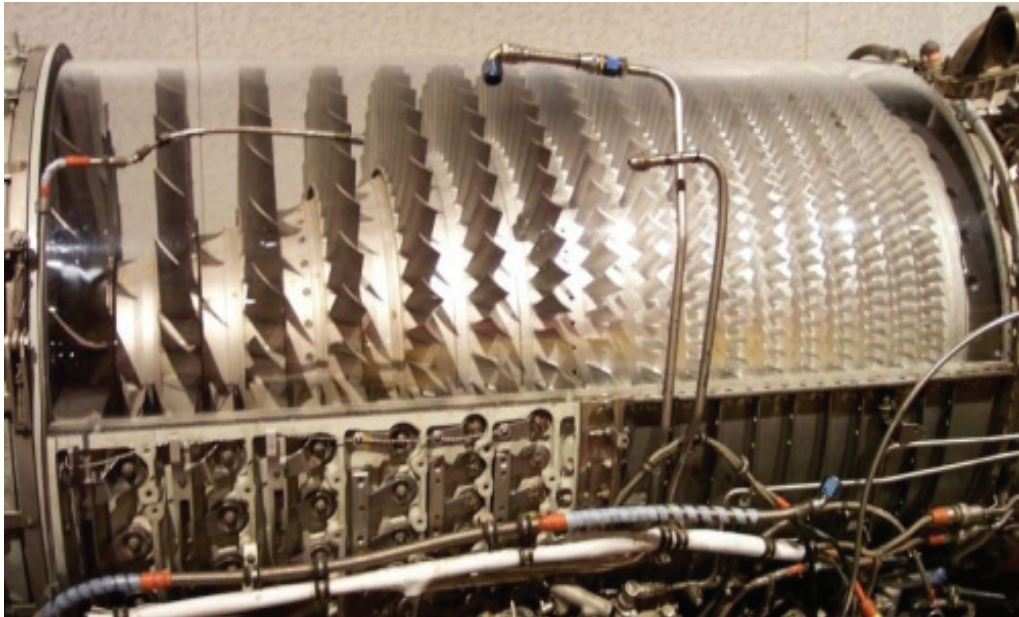
Reading

1. Quickly look through the text and find definitions of:
 - compressor efficiency
 - axial flow compressor
 - stage
 - rotor blades
 - stator vanes

2. Read the text for the second time and write out the words and word combinations you don't know. Try to guess their meaning from the context. Compare your notes with your partners.

Compressors

I.



A. The role of the compressor in a gas turbine engine is to provide a maximum of high-pressure air which can be heated in the limited volume of the combustion chamber and then **expanded** through the turbine. The energy that can be released in the combustion chamber is proportional to the mass of air **consumed**; therefore the compressor is one of the most important components of the gas turbine engine since its efficient operation (maximum compression with minimum temperature rise) is the key to high **overall** engine performance. The compressor efficiency will determine the power necessary to create the pressure rise of a given airflow and will **affect** the temperature change which can take place in the combustion chamber. Present-day compressors have compression ratios **approaching** 15:1, efficiencies near 90 percent, and airflows up to **approximately** 350 lb/s. (158.8 kg/s).

B. With the addition of a fan, total pressure ratio of 25:1 and mass airflows of over 1000 lb/s (453.6 kg/s) have been achieved.

C. All gas turbine engines use one of the following forms of compressors:

1. axial flow.
2. centrifugal flow.

The centrifugal-axial-flow compressor is a combination of the two, with operating characteristics of both.

Axial-flow Compressor

II.

D. The axial-flow compressor is made up of a **series** of **rotating** airfoils called rotor blades and a **stationary** set of airfoils called stator vanes. As its name implies, the air is being compressed in a direction parallel to the axis of the engine. A row of rotating and stationary blades is called a stage. The **entire** compressor is made up of a series of alternating rotor and stator vane stages. Some axial-flow designs have two or more compressors or spools which are driven by **separate** turbines and are **therefore** free to rotate at different speeds.

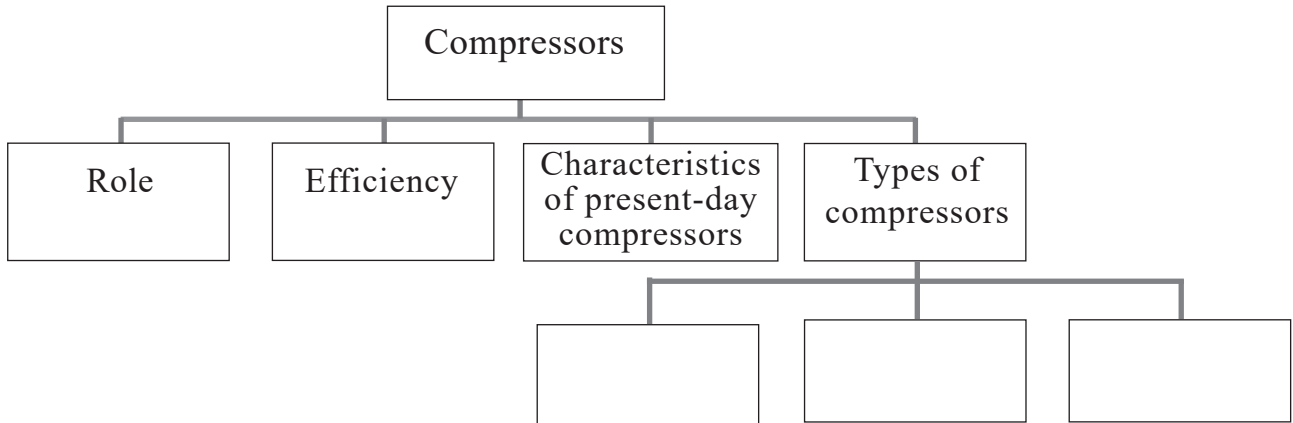
E. Axial compressors have the advantage of being **capable** to very high compression ratios with relatively high efficiencies.

F. In addition, the small frontal area created by this type of compressor **lends** itself to installation in high-speed aircraft. Unfortunately the **delicate** blading, especially toward the rear, makes this type of air pump especially **susceptible** to foreign object **damage**. Furthermore, the number of compressor blades and stator vanes (which can **exceed** 1000 in a large jet engine), the **close fits** required for efficient air **pumping**, and the much narrower range of possible operating conditions, make this type of compressor very complex and very expensive to manufacture. Modern manufacturing techniques are **bringing down** the cost for small axial-flow compressors. For these reasons the axial-flow design finds its greatest application where the demands of efficiency and output **predominate** considerations of cost, simplicity, **flexibility** of operation, etc. Most manufacturers utilize several **dodges** to increase flexibility and to improve the operating characteristics of the axial-flow compressor.

Comprehension Check

1. Work in pairs.

a) Fill in the diagram according to the first part of the text. Compare the results.



b) Make up a diagram for the second part of the text and fill it in. Share information with another pair.

2. a) Find the English equivalents to the following words and word combinations in the text:

степень сжатия	осевой компрессор	центробежный компрессор
аэродинамическая	поверхность	лопасть комплект лопаток
насос	каскад (компрессора)	фронтальная поверхность
ступень	нагнетание	повреждение диапазон
приспособляемость	плотная посадка	деталей

b) Reproduce the context in which they are used.

3. Complete the following sentences using the ideas from the text.

1. The main function of the compressor in a gas turbine engine is to ...
2. It is compressor efficiency that determines ...
3. The air in the axial-flow compressor is compressed in a direction ...
4. The axial-flow compressor is made up of ...
5. Spools of the axial-flow compressor are free to rotate at different speeds because ...
6. The advantage of axial compressors is
7. One of its drawbacks is the delicate blading, which results in ...
8. Axial-flow designs are mostly used where ...

4. Work in pairs. Translate the following sentences into English and answer them according to the text. Join another pair and compare the answers.

1. Почему компрессор является одним из наиболее важных компонентов газотурбинных двигателей?
2. Что определяет КПД компрессора?
3. Что называется ступенью компрессора?
4. Из чего состоит компрессор?
5. Какими преимуществами и недостатками обладает осевой компрессор?
6. Что делает осевой компрессор сложным и дорогостоящим в изготовлении?
7. Где осевой компрессор находит наибольшее применение?

Language Focus

1. Match the English and Russian equivalents.

- | | |
|-------------------|-------------------|
| 1. since | a. влиять |
| 2. key | b. приблизительно |
| 3. affect | c. весь |
| 4. approximately | d. особенно |
| 5. addition | e. чередующийся |
| 6. entire | f. сравнительно |
| 7. alternating | g. конструкция |
| 8. design | h. поэтому |
| 9. therefore | i. преимущество |
| 10. advantage | j. сожалению |
| 11. relatively | k. добавление |
| 12. unfortunately | l. ключ |
| 13. especially | m. поскольку |
| 14. furthermore | n. более того |

2. a) Find pairs of synonyms among the words:

- | | |
|-------------|----------------|
| to set free | overall |
| to use | to consume |
| whole | to release |
| modern | in addition to |
| besides | present-day |

b) Explain them in English. If necessary refer to an English-English dictionary.

3. Use the prepositions in the box to complete the sentences in the text. Translate the text with the help of a dictionary in written.

of, for, in, with

Axial-flow compressors are dynamic rotating compressors that use arrays ... fan-like airfoils to progressively compress the working fluid. They are used where there is a requirement ... a high flows or a compact design. The arrays ... airfoils are set ... rows, usually as pairs: one rotating and one stationary. The rotating airfoils, also known as blades or rotors, accelerate the fluid. The stationary airfoils, also known as a stators or vanes, turn and decelerate the fluid; preparing and redirecting the flow ... the rotor blades ... the next stage. Axial compressors are almost always multistage, ... the cross-sectional area ... the gas passage diminishing along the compressor to maintain an optimum axial Mach number. Beyond about 5 stages or a 4:1 design pressure ratio, variable geometry is normally used to improve operation.

4. a) Find pairs of antonyms among the words:

- | | |
|---------------|----------------|
| 1. maximum | a. narrow |
| 2. under | b. minimum |
| 3. expansion | c. output |
| 4. rotating | d. over |
| 5. front | e. simplicity |
| 6. wide | f. compression |
| 7. input | g. stationary |
| 8. complexity | h. rear |

b) Mark the stress of all the words. Practise their pronunciation aloud.

5. Fill in the gaps with the suitable derivative of the word given in brackets, use the suffixes in the box. Translate the text, define the main idea of it in one phrase.

-ing; -ly; -ed; -al; -able

Axial compressors rely on _____ (to spin) blades that have aerofoil sections, similar to airplane wings. As with airplane wings in some conditions the blades can stall. If this happens, the airflow around the _____ (to stall) compressor can reverse direction _____ (violent). Each design of a compressor has an _____ (to associate) operating map of airflow versus _____ (to rotate) speed for characteristics peculiar to that type.

At a given throttle condition, the compressor operates somewhere along the steady state running line. Unfortunately, this _____ (to operate) line is displaced during transients. Many compressors are fitted with anti-stall systems in the form of bleed bands or _____ (to vary) geometry stators to decrease the likelihood of surge. Another method is to split the compressor into two or more units, operating on separate concentric shafts.

6. a) Match the English and Russian equivalents.

b) Choose 7-10 words and use them to make up sentences of your own:

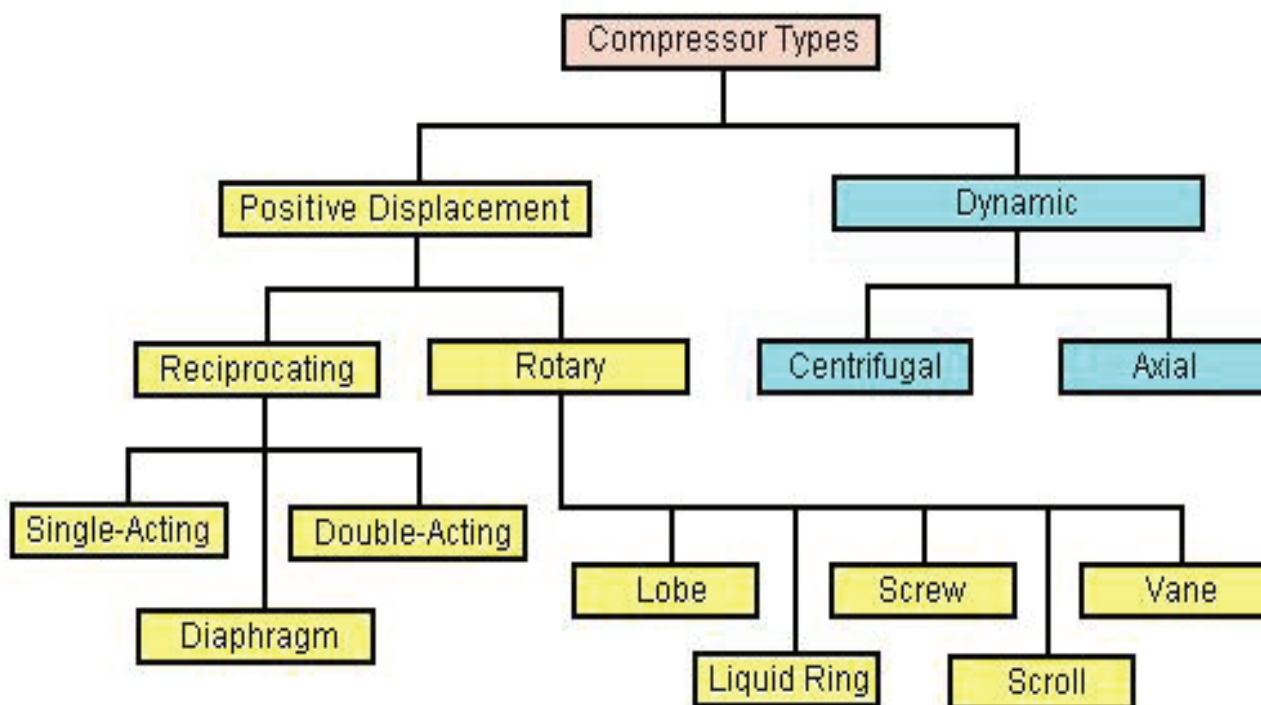
<i>A</i>	<i>B</i>
1. limited	a. to become larger in size and filling more space
2. to determine	b. to use a supply of smth such as time, energy, or fuel
3. efficiency	c. not together
4. to expand	d. all or every part of smth
5. to release	e. able to do smth
6. to consume	f. the process of putting a new system or piece of equipment in its place and making it ready for use
7. set	g. the ability to make changes or to deal with a situation that is changing
8. separate	h. to have more power, influence, or importance than other things
9. to rotate	i. not allowed to go above a particular number, amount, or level
10. entire	j. smth that can be easily damaged or broken
11. capable	k. easily influenced or affected by smth
12. installation	l. the ability to work well and produce good results
13. flexibility	m. adjustment
14. delicate	n. making a gas or liquid move into or out of smth
15. fit	o. to control or to officially decide smth
16. pumping	p. a dishonest or clever way to avoid doing smth unpleasant
17. to predominate	q. to move in a circle around a fixed central point
18. susceptible	r. a group of things
19. dodge	s. to let smth leave a place where they have been kept

7. Translate the following sentences. Pay special attention to the marked words. Give your own explanation of them.

1. Another design **consideration** in axial-flow compressor manufacturing is the average stage loading.
2. This can be kept at a **sensible** level either by increasing the number of compression stages (more weight/cost) or the mean blade speed (more blade/**disc stress**).
3. Although large flow compressors are usually all-axial, the rear stages on smaller units are too small **to be robust**.
4. **Consequently**, these stages are often replaced by a single centrifugal unit.
5. Very small flow compressors often employ two centrifugal compressors, connected **in series**.
6. Although in **isolation** centrifugal compressors are capable of running at quite high pressure ratios (e.g. 10:1), impeller stress considerations limit the pressure ratio that can **be employed** in high overall pressure ratio engine cycles.

Speaking

Below is a diagram illustrating the main types of gas compressors. Choose one type, do a research and make a short report so that other students could compare the performances and spheres of compressors application.



Writing

Summarize the information from the text “Compressors”.

Use the following phrases.

As the title implies the article describes...

The article deals with...

The text is of interest to...

It is spoken in detail about...

It should be stressed that...

A mention should be made that...

The text is of great help to...

The difference between the terms ... and...

should be stressed.

It is discussed...

UNIT 13

Centrifugal-Flow Compressor

Lead in

1. Distribute these words into the correct group.

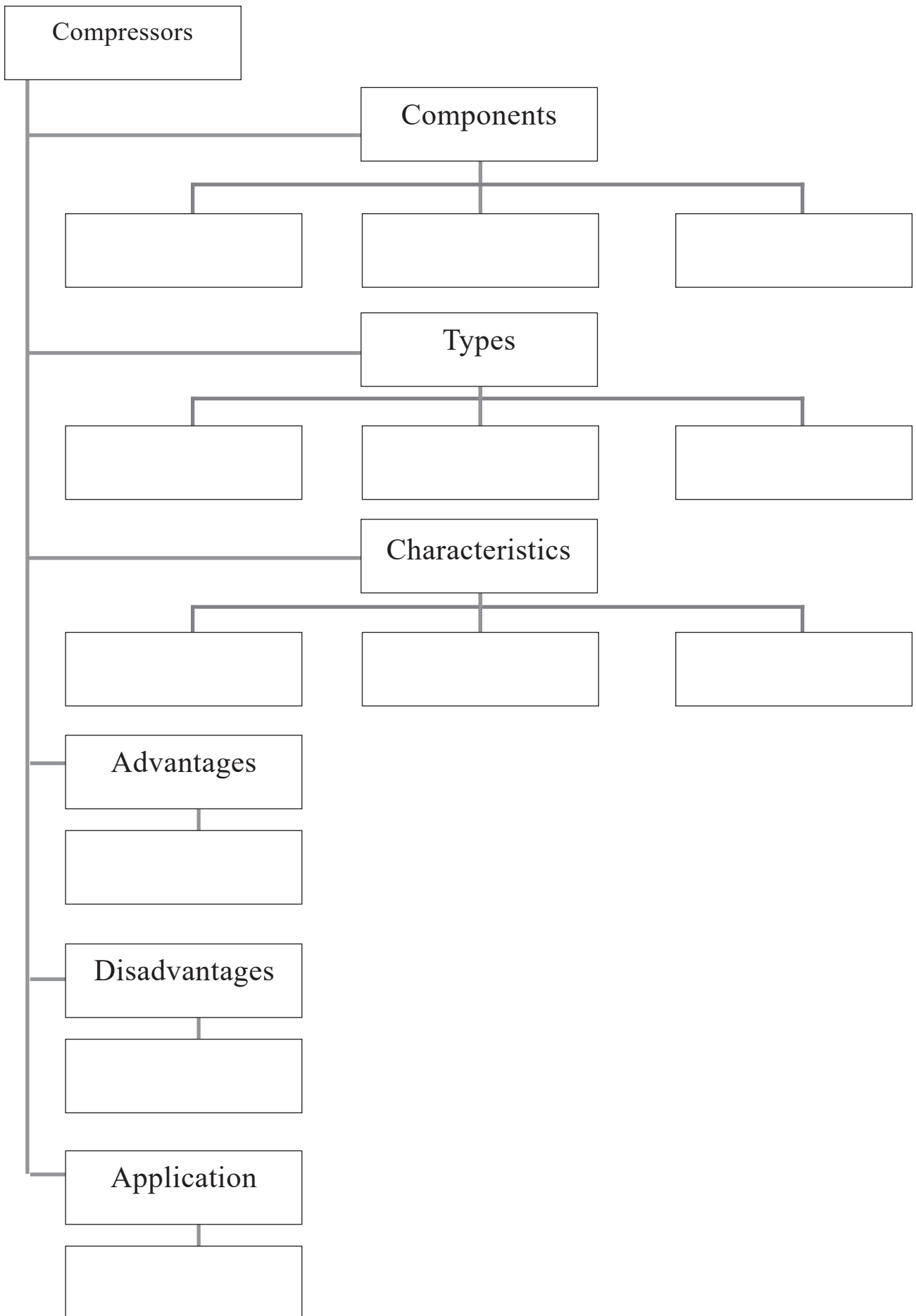
impeller manifold rim chief multiple single ruggedness
shock wave chief stage diffuser acceleration plenum
chamber excessively double-entry rapid attribute inefficient
flexibility massive centrifugal simplicity double-entry gas
turbine

construction

characteristics

Reading

1. Read the text and write a heading for each paragraph.
2. Fill in the diagram with missing information from the text.



The Centrifugal-Flow Compressor

The centrifugal compressor consists basically of an impeller and a diffuser manifold. Other components such as compressor manifold may be added to direct the compressed air into the combustion chamber. As the impeller revolves at high speed, air is drawn in at the eye. Centrifugal force provides high acceleration to this air and causes it to move outward from the axis of rotation toward the rim of the rotor where it is ejected at high velocity and high kinetic energy. The pressure rise is produced in part by expansion of the air in the diffuser manifold by conversion of the kinetic energy of motion into static pressure energy.

The centrifugal compressors can be manufactured in a variety of designs including single-stage, multiple-stage, and double-sided types. The centrifugal compressor has a number of features to recommend its use in certain types of gas turbine engines. Chief among its attributes are its simplicity, ruggedness, and low cost. Because of its massive construction, it is much less susceptible to damage from the injection of foreign objects.

The centrifugal compressor is capable to relatively high compressor ratio per stage. Above 80 percent efficiency may be reached with a compression ratio of 6 or 7 to 1. Above this ratio, efficiency drops off at a rapid rate because of excessively high impeller tip speeds and attending shock-wave formation. This rules out this type of compressor for use in larger engines since high compression ratios are necessary for low fuel consumption. Some centrifugal-flow engines obtain somewhat higher ratios through the use of multistage compressors.

Although the tip speed problem is reduced, efficiency is again lost because of the difficulty in turning the air as it passes from one stage to another. Double-entry compressors also help to solve the high-tip-speed problems, but this advantage is partially offset by the complications in engine design necessary to get air to the rear impeller, and by the requirement of a large plenum or air chamber, where the air from the inlet duct is brought to a slower speed for efficient direction change and higher pressures. The plenum chamber acts as a diffuser by which means the rear impeller can receive its air.

Because of the problems inherent in this type of design the centrifugal compressor finds its greatest application on the smaller engines, where simplicity, flexibility of operation and ruggedness are the principle requirements rather than small frontal area, and ability to handle high air flows and pressures with low loss of efficiency.

Comprehension Check

1. a) Answer the following questions.

1. What does a centrifugal compressor consist of?
2. What does centrifugal force provide?
3. What is the pressure rise produced by?
4. What types of design of a centrifugal compressor exist?
5. What are the advantages of a centrifugal compressor?
6. Why is a centrifugal compressor much less susceptible to damage from foreign object?
7. When does the efficiency drop off at a rapid rate?
8. By means of what do some centrifugal-flow compressors obtain higher ratios?

b) Think of 3 more questions to the text.

2. Complete the following sentences using the ideas from the text.

1. Main parts of the centrifugal compressor are ...
2. The pressure rise is partly generated by ...
3. The centrifugal compressors has different designs such as ...
4. Due to its massive construction, this type of compressor is far less susceptible to ...
5. A compression ratio of 6 or 7 to 1 may result in ...
6. High compression ratios are necessary for ...
7. The problem of efficiency has not yet solved because of ...
8. ... help to solve the high-tip-speed problems.
9. The plenum chamber acts as ...
10. The centrifugal compressor is mostly used

3. a) Match these English words with their Russian equivalents:

a) impeller manifold rim ruggedness tip ingestion stage
plenum chamber conversion eye in turn feature damage expansion

b) to draw in to direct to revolve to cause to drop off to rule
out to obtain to offset to handle

c) susceptible capable chief attending partially inherent
single multiple outward

1) рабочее колесо камера сгорания признак расширение
повреждение превращение отверстие кромка прочность
засасывание в свою очередь свойство кончик трубопровод
ступень

2) достигать исключать управлять снижать вызывать
втягивать направлять вращать компенсировать

3) множественный способный извне частично подверженный
присущий главный сопутствующий

b) Mark the stress of all the words in a) according to the part of speech they belong to. Practise their pronunciation aloud.

4. a) Match verbs from the text with their definitions:

- to put something with another thing or group of things
- to make goods in large quantities in a factory
- to deliberately let something fall
- to balance the effect of something, with the result that there is no advantage or disadvantage
- to stop considering something as a possibility

b) Choose any 5 English words from the banner and explain them.

Language Focus

1. Find pairs of synonyms among the words.

- | | |
|----------------|----------------|
| 1. edge | a. basically |
| 2. speed | b. velocity |
| 3. mainly | c. rim |
| 4. a number of | d. manufacture |
| 5. produce | e. variety of |
| 6. main | f. rapid |
| 7. quick | g. obtain |
| 8. get | h. chief |

2. Find the antonyms among the words.

- | | |
|--------------|----------------|
| 1. low | a. inward |
| 2. less | b. more |
| 3. rear | c. below |
| 4. slow | d. front |
| 5. outward | e. outlet |
| 6. inlet | f. quick |
| 7. above | g. inefficient |
| 8. efficient | h. high |

3. a) Match the adjectives with their definitions:

- | | |
|-------------|---|
| 1. kinetic | a. main or most important |
| 2. static | b. very large or heavy |
| 3. certain | c. relating to, caused by, or producing movement |
| 4. chief | d. happening, moving, or acting quickly |
| 5. massive | e. at the back of smth |
| 6. rapid | f. not moving or changeable |
| 7. rear | g. this quality is basic or essential feature that gives smth its character |
| 8. inherent | h. having no doubt that smth is true |

b) Reproduce the context where they are used.

4. Fill in the gaps using the words from the box. Note, there is one extra word! Translate the sentences into Russian.

includes, an increase, forms, through, convert,
incompressible, contrast, deal, experience, greater

1. Centrifugal compressors, (sometimes referred to as radial compressors) are a special class of radial-flow work-absorbing turbomachinery that _____ pumps, fans, blowers and compressors.
2. The earliest _____ of these dynamic turbomachines were pumps, fans and blowers.
3. What differentiates these early turbomachines from compressors is that the working fluid can be considered _____ thus permitting accurate analysis through Bernoulli's equation.
4. In contrast, modern centrifugal compressors are higher in speed and analysis must _____ with compressible flow.
5. For purposes of definition, centrifugal compressors often have density increases _____ than 5 percent.
6. Also, they often _____ relative fluid velocities above Mach 0.3 when the working fluid is air or nitrogen.
7. In _____, fans or blowers are often considered to have density increases of less than 5 percent and peak relative fluid velocities below Mach 0.3
8. In an idealized sense, the dynamic compressor achieves a pressure rise by adding kinetic-energy/velocity to a continuous flow of fluid _____ the rotor or impeller.
9. This kinetic energy is then converted to _____ in static pressure by slowing the flow through a diffuser.

5. Use the prepositions from the box to complete the sentences in the text. Translate the text.

to, throughout, without, of, in, with, into

Centrifugal compressors are used _____ industry because they have fewer rubbing parts, are relatively energy efficient, and give higher airflow than a similarly sized reciprocating compressor (i.e. positive-displacement). Their primary drawback is that they cannot achieve the high compression ratio reciprocating compressors _____ multiple stages. Centrifugal fan/blowers are more suited _____ continuous-duty applications such as ventilation fans, air movers, cooling units, and other uses that require high volume _____ little or no pressure increase. _____ contrast, multi-stage centrifugal compressors often achieve discharge pressures of 8,000 _____ 10,000 psi (59 MPa to 69MPa). One example _____ an application _____ centrifugal compressors is their use _____ re-injecting natural gas back _____ oil fields to increase oil production.

6. Fill in the gaps with the suitable derivative of the word given in brackets. Translate the sentences.

-ing, -ly, -tion, -able, -ment, -ence, -ic, -ance, -al

Operating Limits

Many centrifugal compressors have one or more of the following (**to operate**) limits:

Minimum Operating Speed – the minimum speed for (**to accept**) operation, below this value the compressor may be controlled to stop or go into an “Idle” condition.

Maximum (to allow) Speed – the maximum operating speed for the compressor. Beyond this value stresses may rise above prescribed limits and rotor vibrations may increase rapidly. At speeds above this level the (**to equip**) will likely become very dangerous and be controlled to slower speeds.

Stonewall or Choke – occurs under one of 2 conditions. (**Typical**) for high speed equipment, as flow increases the velocity of the gas/fluid can approach the gas/fluid’s sonic speed somewhere within the compressor stage. This (**to locate**) may occur at the impeller inlet “throat” or at the vaned diffuser inlet “throat”. In most cases, it is generally not (**detriment**) to the compressor. For low speed equipment, as flows increase, losses increase such that the pressure ratio drops to 1:1.

Surge – is the point at which the compressor cannot add enough energy to overcome the system (**resist**). This causes a rapid flow reversal (i.e. surge). As a result, high vibration, temperature increases, and rapid changes in axial thrust can

occur. These (**occur**) can damage the rotor seals, rotor bearings, the compressor driver and cycle operation. Most turbomachines are designed to easily withstand (**occasion**) surging. However, if the turbomachine is forced to surge repeatedly for a long period of time or if the turbomachine is poorly designed, repeated surges can result in a (**catastrophe**) failure. Of particular interest, is that while turbomachines may be very durable, the cycles/processes that they are used within can be far less robust.

Speaking

Work in pairs. Conduct a dialogue between a senior student and a freshman who asks questions in order to get as much information as possible while discussing similarities and distinctions of an axial-flow compressor and a centrifugal-flow one. You should touch upon such items as:

- * components
- * characteristics
- * preferences
- * drawbacks
- * sphere of application

Phrases below may help you to successfully conduct your dialogue:

a) for a senior student

- Hello! / Good morning! / Good afternoon!
- Can I help you? / What can I do for you? / Are you interested in...?
- As far as I know you (are interested in).../ Let me tell you about .../ I want to point out that .../ I would like to note that ...
- That's a good question.../ I'm not sure, but.../ It seems to me that...
- Do you know anything about...? / Would you agree with...?
- It was nice to meet you. / Hope to see you soon. / Good-bye.

b) for a freshman

- Hello! / Good morning! / Good afternoon!
- I find it hard to... / I have some problems with... / I'm interested in...
- I would like to ask you about.../ Can you tell me.../ Can you describe...

- Could you be more specific about...? / Can you give any examples?
- Thank you for your help.
- It was nice to meet you. / Hope to see you soon. / Good-bye.

c) for both students

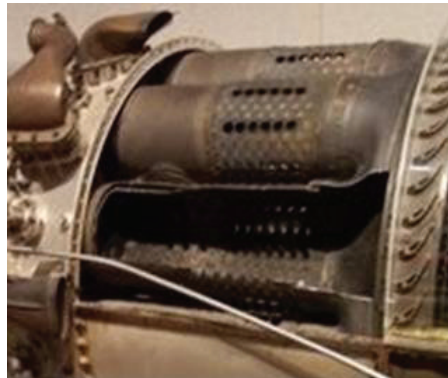
- I quite agree.
- You are right.
- That's true.
- Absolutely.
- No doubt about it.
- That's just what I was thinking.
- I wish, I could agree but...
- I am not sure about it.
- I wouldn't say that.
- Would you say that...?

Writing

Summarize the information given in the text “Centrifugal-flow compressors.” Use the key-patterns from the section Writing of the previous unit.

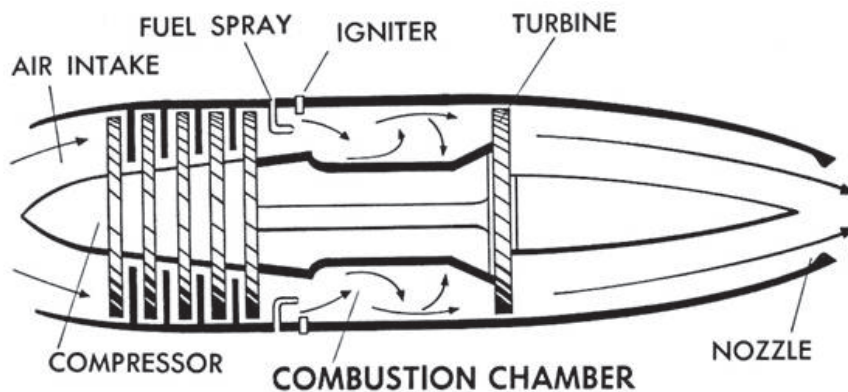
UNIT 14

Operation of the Combustion Chamber



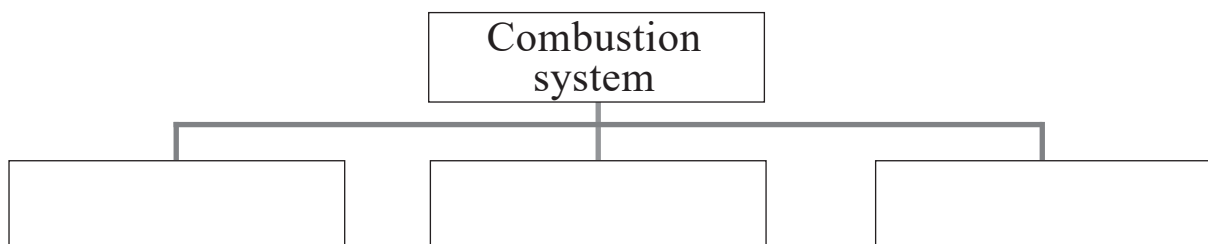
Lead in

1. Look at the picture, which shows main components of a gas-turbine engine.
What role does each of these components perform in a combustion chamber?
What is the function of the combustion chamber?
2. Look through the text to check if your predictions were correct.



Reading

1. Divide the text into paragraphs. Give a title for each one. Choose the key words of each part.
2. While reading make a graphic representation of the text.



Operation of the Combustion Chamber

Fuel is introduced at the front end of the burner in either a highly atomized spray from specially designed nozzles, or in a prevaporized form from devices called vaporizing tubes. Air flows in around the fuel nozzle and through the first row of combustion air holes in the **liner**. The burner geometry is such that the air near the nozzle stays close to the front wall of the liner for **cooling and cleaning purposes**, while the air entering through opposing liner holes mixes rapidly with the fuel to form a combustible mixture. **Additional** air is introduced through the remaining air holes in the liner. The air entering the forward section of the liner tends to recirculate and move upstream against the fuel spray. During combustion this action **permits** rapid mixing and **prevents** flame blowout by forming a low-velocity stabilization zone which acts as a continuous **pilot** for the rest of the burner. The air entering the downstream part of the liner provides the correct mixture for combustion, and it creates the intense turbulence that is necessary for mixing the fuel and air and for transferring energy from the burned to the unburned gases.

Since there are only two igniter plugs in an engine, cross ignition tubes are necessary in the can-annular types of burners in order that burning may be **initiated** in the other cans or inner liners. The igniter plug is usually located in the upstream reverse-flow region of the burner. After ignition, the flame quickly **spreads** to the primary or combustion zone where there is approximately the correct proportion of air to completely burn the fuel. If all the air flowing through the engine were mixed with the fuel at this point, the mixture would be **outside** the combustible limits for the fuels normally used. Therefore only about one-third to one-half is allowed **to enter** the combustion zone of the burner. About 25 percent of the air **actually** takes place in the combustion process. The gases that result from combustion have temperatures of 3560°F (1900°C). Before entering the turbine the gases must be cooled to approximately half this value, which is determined by the design of the turbine and the **materials involved**. Cooling is done by diluting the hot gases with secondary air that enters through a set of relatively large holes located toward the rear of the liner. The liner walls must also be protected from the high temperature of combustion. This is usually accomplished by introducing air at several stations along the liner, thereby forming an insulated blanket between the hot gases and the metal walls.

Comprehension Check

1. Match parts of the sentences in columns A and B.

<i>A</i>	<i>B</i>
1. Fuel is introduced at the front end of the burner in either	a. must also be protected from the high temperature of combustion.
2. Before entering the turbine the gases	b. the primary or combustion zone where there is approximately the correct proportion of air to completely burn the fuel.
3. The liner walls	c. the first row of combustion air holes in the liner.
4. After ignition, the flame quickly spreads to	d. the remaining air holes in the liner.
5. Air flows in around the fuel nozzle and through	e. must be cooled to approximately half this value, which is determined by the design of the turbine and the materials involved.
6. Additional air is introduced through	f. a highly atomized spray from specially designed nozzles, or in a prevaporized form from devices called vaporizing tubes.

2. a) Give the Russian equivalents to the words and word combinations from the text.

A. air flow • fuel nozzles • holes • liner • burner • for cooling and cleaning purposes • combustible mixture • flame blowout • diluting • low-velocity stabilization zone • igniter plug • cross-ignition tubes • at this point • combustible limits • reverse-flow region • materials involved • diluting • an insulated blanket

B. atomized • prevaporized • rapidly • upstream

C. to introduce • to tend to • to prevent • to transfer • to initiate • to spread • to take place • to determine • to protect • to accomplish

b) Reproduce the context.

3. Agree or disagree with the statements. Correct the wrong ones.

1) Fuel is introduced at the rear end of the burner in either a highly atomized spray from specially designed nozzles.

2) Air flows in around the fuel nozzle and through the last row of combustion air holes in the liner.

3) Highly pressurized gas is introduced through the remaining air holes in the liner.

4) During combustion this action permits slow mixing and prevents flame blowout by forming a low-velocity stabilization zone.

5) The air entering the downstream part of the liner provides the correct mixture for combustion.

6) Since there is only one igniter plug in an engine, cross ignition tubes are not necessary in the can-annular types of burners in order that burning may be initiated in the other cans or inner liners.

7) The igniter plug is usually located in the downstream reverse-flow region of the burner.

8) If all the air flowing through the engine were mixed with the fuel at this point, the mixture would be inside the combustible limits for the fuels normally used.

9) Before entering the turbine the gases must be cooled to approximately one third this value.

10) The liner walls must also be protected from the high temperature of combustion.

4. a) Answer the following questions.

1. How is the fuel introduced to the combustion chamber?

2. What is the burner geometry?

3. What is a combustible mixture?

4. How is a flame blowout prevented?

5. What is turbulence necessary for?

6. How many igniter plugs are there in an engine?

7. Where are igniter plugs located?

8. When would the combustible mixture be outside the limits?

b) Think of three more questions and write them down.

Language Focus

1. a) Find pairs of synonyms among the words

- | | |
|---------------|-------------|
| 1. rapidly | a. quickly |
| 2. velocity | b. begin |
| 3. purpose | c. aim |
| 4. transfer | d. fully |
| 5. locate | e. situate |
| 6. completely | f. transmit |
| 7. initiate | g. speed |

b) Find pairs of antonyms among the words.

- | | |
|----------------|---------------|
| 1. front | a. downstream |
| 2. forward | b. rear |
| 3. upstream | c. backward |
| 4. unburned | d. primary |
| 5. result from | e. outer |
| 6. inner | f. burned |
| 7. outside | g. after |
| 8. secondary | h. result in |
| 9. before | i. inside |

c) Mark the stress of all the words in **a)** and **b)**. Practise their pronunciation aloud.

2. a) Find words in the text that mean:

1. a narrow part at the end of a tube through which liquid flows.
2. an occasion when a flame suddenly stops to blow.
3. sudden violent movements of air or water.
4. making a liquid less strong by adding water or another liquid.
5. a thick layer of something.

3. There are some words in bold in the text. Explain their meaning according to the context.
4. Use the prepositions in the oval to complete the sentences in the text. Translate the text with the help of a dictionary in written.

at, in, through, of, for, to, through, from

Combustion Chamber GE J79

Flame fronts generally travel _____ just Mach 0.05, whereas air flows _____ jet engines are considerably faster than this. Combustors typically employ structures to give a sheltered (закрытая) combustion zone called a flame holder. Combustor configurations include can, annular, and can-annular.

Great care must be taken to keep the flame burning _____ a moderately fast moving airstream, at all throttle conditions, as efficiently as possible. Since the turbine cannot withstand stoichiometric temperatures (a mixture ratio of around 15:1), some _____ the compressor air is used to quench the exit temperature of the combustor to an acceptable level (an overall mixture ratio _____ between 45:1 and 130:1 is used). Air used _____ combustion is considered to be primary airflow, while excess air used _____ cooling is called secondary airflow. The secondary airflow is ported _____ many small holes _____ the burner cans to create a blanket _____ cooler air to insulate the metal surfaces of the combustion can _____ the flame. If the metal were subjected _____ the direct flame for any length of time, it would eventually burn through.

5. a) Collocate words in the table.

<i>A</i>	<i>B</i>
1. atomized	blowout
2. vaporizing	zone
3. cooling	turbulence
4. combustible	tube
5. flame	plug
6. stabilization	spray
7. intense	region
8. igniter	involved
9. reverse-flow	mixture
10. materials	air
11. secondary	purpose
12. insulated	blanket

- b) Make up sentences with these word combinations in written.

6. Fill in the gaps using the words from the oval. Note, there is one extra word! Translate the text into Russian in written.

nozzle, liner, streams, manifold, spark, injector, atomizer

A *firing chamber* is the chamber of a rocket engine in which the fuel and the oxidizer burn to produce high pressure gas expelled from the engine _____ to provide thrust. To begin with, the fuel and oxidizer pass (separate) through a complex _____ in which each component is broken down into smaller and smaller flow _____, in the same way that arteries in the body divide into increasingly small capillaries. Then the propellants are injected into the combustion chamber via the _____ – a plate at the top of the chamber which takes the small flow streams and forces them through an _____. The purpose of the injector is to mix the fuel and oxidizer molecules as thoroughly and evenly as possible. Once mixed, the fuel and oxidizer are ignited by the intense heat inside the chamber. To start the combustion, an ignition source (such as an electric _____) may be needed. Alternatively, some propellants are hypergolic – they spontaneously combust on contact – and do not need an ignition source.

7. The text below contains 10 spelling mistakes. Find and correct them.

Incomplete combustion (a state in wich not all the fuel in the combustion chamber burns) may rezult from inadequate chamber design, or it may be deliberately designed into the sitem so that the unburned fuel akts as a chamber coolant. Generaly, incomplete combustion is indicative of a system not functioning efficiently.

Combustion chamber is a space over, or in front of, a boiler furnace where the gases from the fire becomes more thoroughly mixed and burnt. The clearance space in the cylinder of an internal combustion engine is compresed and ignited.

Speaking

Work in pairs. Conduct a dialogue between a senior student and a freshman who asks questions in order to get as much information as possible on operation of a combustion chamber. You should touch upon such items as:

- * introducing of fuel
- * air circulation
- * mixing the fuel and the air
- * ignition
- * resultant gases
- * protection from high temperature of combustion

Phrases below may help you to successfully conduct your dialogue:

a) for a senior student

- Hello! / Good morning! / Good afternoon!
- Can I help you? / What can I do for you ? / Are you interested in...?
- As far as I know you (are interested in).../ Let me tell you about .../ I want to point out that .../ I would like to note that ...
- That’s a good question.../ I’m not sure, but.../ It seems to me that...
- Do you know anything about...? / Would you agree with...?
- It was nice to meet you. / Hope to see you soon. / Good-bye.

b) for a freshman

- Hello! / Good morning! / Good afternoon!
- I find it hard to... / I have some problems with... / I’m interested in...
- I would like to ask you about.../ Can you tell me.../ Can you describe...
- Could you be more specific about...? / Can you give any examples?
- Thank you for your help.
- It was nice to meet you. / Hope to see you soon. / Good-bye.

c) for both students

- The point is...
- It seems to me...
- As for me...
- I am sure. (I am not sure)
- I wouldn’t say that...
- On the contrary...

Writing

Summarize the information given in the text “Operation of the combustion chamber”.
Use the following phrases:

As the title implies the article describes...
The article deals with...
The text is of interest to...
It is spoken in detail about...
It should be stressed that...
A mention should be made that...
The text is of great help to...
The difference between the terms ... and... should be stressed.
It is discussed...

UNIT 15

Supersonic Ducts



Lead in

1. Answer the following questions.
 1. What does the term “duct” mean?
 2. What types of ducts have you read or learnt before?
 3. How is each of the ducts mentioned by you designed?
2. Match the keywords with their Russian equivalents.

- | | |
|----------------|-------------------------------------|
| 1. supersonic | a. ударная волна, скачок уплотнения |
| 2. transonic | b. заглатывать |
| 3. subsonic | c. тратить впустую |
| 4. overhaul | d. характеристики |
| 5. performance | e. дозвуковой |
| 6. shock wave | f. амортизирующая игла |
| 7. buzz | g. переработка, ремонт, разборка |
| 8. accomplish | h. гудящий звук |
| 9. spike | i. наклонный, не прямой, косой |
| 10. establish | j. угол |
| 11. oblique | k. устанавливать |
| 12. angle | l. сверхзвуковой |
| 13. occur | m. околозвуковой |
| 14. waste | n. выполнять |
| 15. swallow | o. происходить, иметь место |

Reading

1. Read the text and highlight the ideas not mentioned in the discussion.

Supersonic Ducts

A. The supersonic inlet duct must operate in three speed zones: subsonic, transonic, supersonic.

B. Although each of these speed zones needs a slightly different inlet duct design, good overhaul performance can be achieved by designing the supersonic shape with some modifications.

C. The supersonic duct problems start when the aircraft begins to fly at or near the speed of sound. At these sonic speeds shock waves are developed which, if not controlled, will give high duct loss in pressure and airflow, and will set up vibrating conditions in the inlet duct called inlet buzz. Buzz is an airflow instability caused by the shock wave rapidly being alternately swallowed and expelled at the inlet of the duct.

D. Air which enters the compressor section of the engine must usually be slowed to subsonic velocity, and this process should be accomplished with the least possible waste of energy. At supersonic speeds the inlet duct does the job by slowing the air with the weakest possible series or combination of shocks to minimize energy loss and temperature rise.

E. At transonic speeds (near Mach 1), the inlet duct is usually designed to keep the shock waves out of the duct. This is done by locating the inlet duct behind a spike or probe so that at airspeeds slightly above Mach 1.0 the spike will establish a normal shock (bow wave) in front of the inlet duct. This normal shock wave will produce a pressure rise and a velocity decrease to subsonic velocities before the air strikes the actual inlet duct. The inlet will then be a subsonic design behind a normal shock front. At low supersonic Mach numbers, the strength of the normal shock wave is not too great, and this type of inlet is quite practical. But at higher Mach numbers the single normal shock wave is very strong and causes a great reduction in the total pressure recovered by the duct and an excessive air temperature rise inside the duct.

F. At slightly higher airspeeds the normal bow wave will change into an oblique shock. Since the air velocity behind an oblique shock is still supersonic, to keep the supersonic velocities out of the inlet duct, the duct will need to set up a normal shock wave at the duct inlet. The airflow is controlled so that the air velocity at the duct inlet is exactly equal to the speed of sound. At this time the duct pressure rise will be due to: 1) an oblique shock pressure rise; 2) a normal shock pressure rise; 3) a subsonic diverging section pressure rise.

G. As the airspeed is increased, the angle of the oblique shock will be forced back by the higher air velocity until the oblique shock contacts the outer lip of the duct. When this occurs there will be a slight increase in thrust due to an increase in engine inlet pressure airflow, because the energy contained in the shock front is now enclosed within the duct and delivered to it with less pressure loss. This point is called the duct recovery point.

H. At high Mach numbers (about 1.4 and above) the inlet duct must set up one or more oblique shocks and a normal shock. The oblique shocks will slow the supersonic velocities, the normal shock will drop the velocity to subsonic then the subsonic section will further decrease the velocity before the air enters the compressor. Each decrease in velocity will produce a pressure rise.

Comprehension Check

1. Find in the text the English equivalents to the phrases:

будут создавать вибрационные условия; точка восстановления давления в канале; ударная волна попеременно заглатывается или выталкивается на входе в канал; удерживать ударную волну вне сопла

2. a) In the text find definitions of:

- buzz
- duct recovery point

b) Give your own explanation of the terms:

- normal shock wave
- oblique shock

3. Say if the statements are true or false. Correct the false once.

1. The supersonic duct problems start when the aircraft begins to fly at transonic speed.
2. The normal shock wave will produce a pressure rise and a velocity decrease to subsonic velocities after the air strikes the inlet duct.
3. The lower the supersonic Mach numbers, the higher the strength of the normal shock wave.
4. At higher Mach numbers the single normal shock wave is strong.
5. The duct will need to form a normal shock wave at the duct inlet to keep the supersonic velocities out of the inlet duct.

4. a) In the text find definitions of:

1. In what zones must the supersonic inlet duct operate?
2. When are shock waves developed?
3. What affect is caused by shock wave appearance?
4. When is the single normal shock wave strong?
5. What is the reason of the duct pressure rise?

b) Put 3 more questions to the text:

Language Focus

1. Highlight all the prepositions in the text.

2. a) Distribute them into the columns according to the meaning they contain in parts A-H2. a) Distribute them into the columns according to the meaning they contain in parts A-H.

Parts	Direction	Phrasal verbs	Time	Merely grammatical relations	?
A					
B					
C					
D					
E					
F					
G					
H					

b) Think of an additional column and entitle it. Fill it in with the necessary prepositions.

c) Add 1-5 more examples and give their meaning using reference materials.

3. Fill in the gaps with the prepositions from the box below. Translate the sentences.

in; of (2); at; into; by; before; out; with; to (2); until

1. The starting _____ a turbojet, or any other gas-turbine engine, requires that the engine be rotated _____ a speed which will provide sufficient air fuel combustion and that the engine be accelerated _____ the point where the power developed _____ the turbine is adequate for engine self-rotation.

2. After combustion commences (light-off) the starter continuous to supply torque _____ the engine _____ engine speed reaches a predetermined level where engine is sufficient to maintain acceleration.

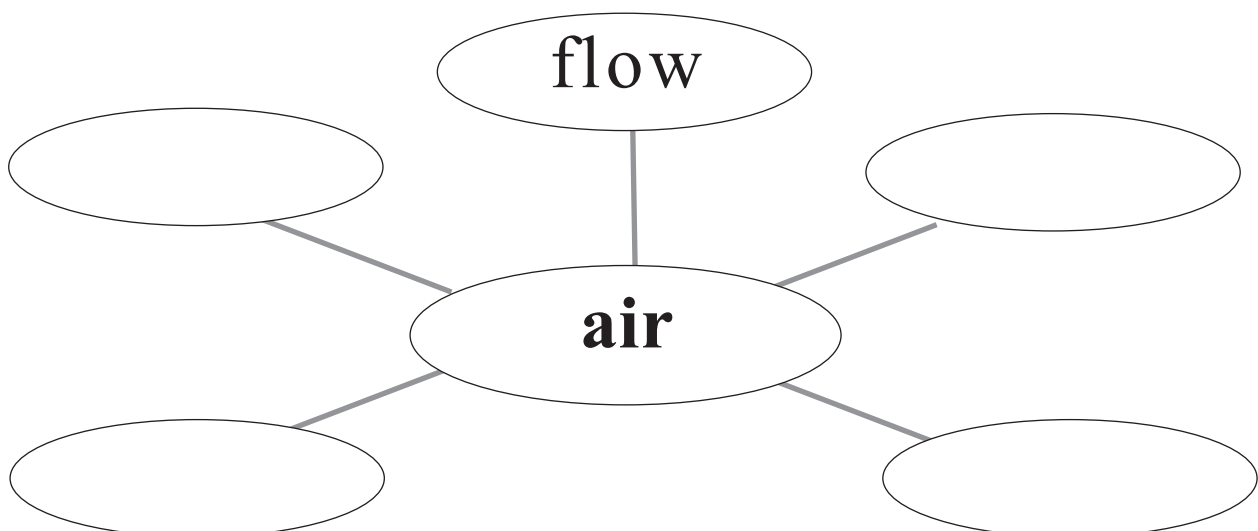
3. Early German engines averaged only ten hours of operation _____ failing often _____ chunks of metal flying _____ the back _____ the engine when the turbine overheated.

4. For a time some US jet engines included the ability to inject water _____ the engine to cool the compressed flow before combustion, usually during takeoff.

5. _____ most turbojet-powered aircraft, bleed air is extracted from the compressor section at various stages to perform a variety of jobs.

4. a) Combine the noun “air” with other nouns to make up new words or word combinations.

b) Explain their meaning.



Speaking

Work in pairs:

- a) Discuss the inlet duct design and its operation in three speed zones:
 - **Group A** – in subsonic
 - **Group B** – in transonic
 - **Group C** – in supersonic

- b) Draw a picture of the inlet duct peculiar for each zone.
 - **Group A** – for subsonic
 - **Group B** – for transonic
 - **Group C** – for supersonic

- c) Work with two other partners. Share the information you have. Compare the design and operation of the inlet duct in all three zones. Make up a table.

Writing

Summarize the information given in the text. Use the key-patterns.

The text covers the problem...
The article/text carries material on...
The paragraph deals with...
The text provides the reader with some data/information on...
It is interesting to note...
The information presented is of interest to...

UNIT 16

Inlet Ducts



Lead in

1. a) What role does the inlet duct perform during the flight?
b) What types of Inlet Ducts do you know?
2. Scan the text to see if your predictions were correct.

Reading

- a) Look through the text and find definitions of:
 - the duct pressure efficiency ratio;
 - the ram recovery point;
 - a bellmouth inlet;
- b) Explain the meaning of the words in bold from the context.

Inlet Ducts

Air inlet duct is normally considered an airframe part and made by the aircraft manufacturer. During flight operations it becomes very important to the overall jet engine performance, and will greatly influence jet engine thrust output. The faster the airplane goes, the more **critical** the duct design becomes. Engine thrust can be high only if the inlet duct supplies the engine with the required airflow at the highest possible pressure.

The inlet duct must operate from **static** ground run up to high aircraft Mach numbers with a high duct efficiency at all altitudes, attitudes, and flight speeds. To compound the problem, the amount of air required by a turbojet engine is approximately 10 times or more than that of a piston engine of comparable size.

Inlet Ducts should be as straight and **smooth** as possible, and should be designed in such a way that the boundary layer air (a layer of still, dead air lying next to the surface) be held to the minimum. The length, shape, and placement of the duct is determined to a great extent by the location of the engine in the aircraft.

Not only must the duct be large to supply the proper airflow, but it must be shaped correctly to deliver the air to the front of the compressor with an **even** pressure distribution. Poor air pressure and velocity distribution at the front of the compressor may result in **compressor stall**.

Another primary task a duct must do during flight operation is **to convert** the kinetic energy of the rapidly moving inlet stream into a ram pressure rise inside the duct. To do this it must be shaped so that the ram velocity is slowly and smoothly decreasing, while the ram pressure is slowly and smoothly rising.

Inlet Ducts are rated in two ways: the duct pressure efficiency ratio and the ram recovery point. The duct pressure efficiency ratio is defined as the ability of the duct to convert the kinetic or dynamic pressure energy at the inlet of the duct into static pressure energy at the inlet of the compressor without a loss in total pressure. It will have a high value of 98 percent if the friction loss is low and if the pressure rise is accomplished with small losses. The ram recovery point is that aircraft speed at which the ram pressure rise is equal to the friction pressure losses, or that airspeed at which the compressor inlet total pressure is equal to the outside **ambient** air pressure. A good subsonic duct will have a low ram recovery point (about 160 mph (280km/h)).

Inlet Ducts may be divided into two broad categories: subsonic ducts and supersonic ducts.

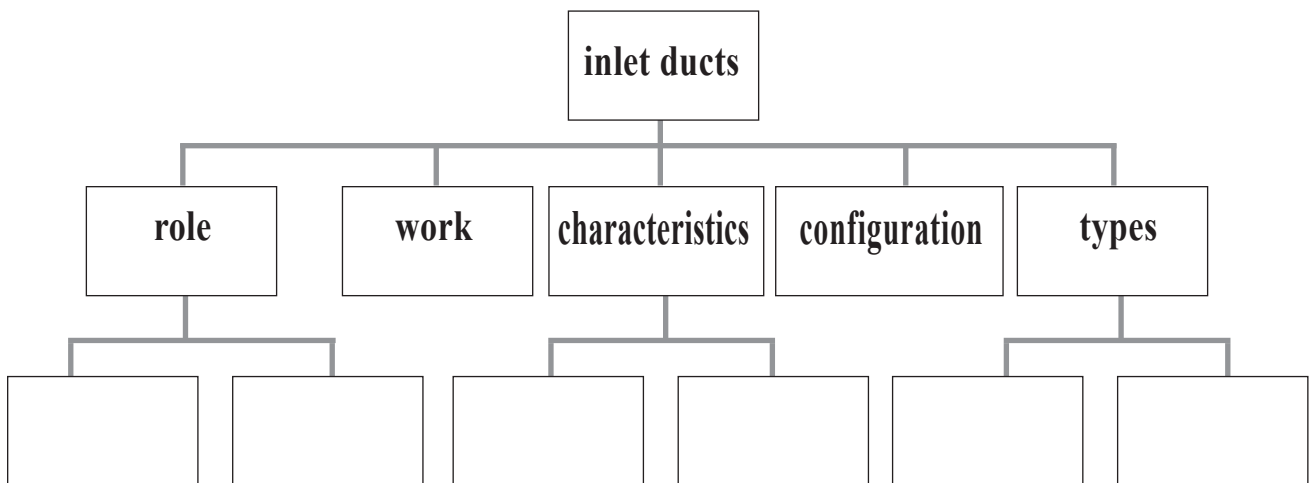
It is interesting to note that the engine manufacturers **rate** their engines using a bellmouth inlet. This type of inlet is **essentially** a bell-shaped funnel having carefully rounded shoulders, which offer practically no air resistance. The duct loss is so small that it is considered zero, and all engine **performance** data can be gathered without any correction for inlet duct loss being necessary. Normal duct inefficiencies may cause thrust losses of 5 percent or more because a decrease in duct efficiency of 1 percent will decrease airflow 1 percent, decrease jet velocity ½ percent, and result in 1 ½ percent thrust loss. The decrease in jet velocity occurs because it is necessary to increase the area of the jet nozzle **in order to** keep the turbine temperature within limits when duct losses occur.

Comprehension Check

1. The diagram below contains main issues of the text. But the blocks in the first row are jumbled.

a) Put them into the right order according to the contents of the text.

b) Fill in the diagram with the correct information.



2 a) Find the English equivalents to the following words and word combinations in the text:

a) уязвимый	ровный	внешний
неподвижный		плавно
b) число Маха	положение	распределение
срыв компрессора		основная задача
скоростной поток	сопротивление	трение
точка восстановления	скоростного потока	
граничный слой воздуха	потери	в допустимых пределах
c) для того чтобы	таким образом	по существу
d) сводиться к	доставлять	обеспечивать
привести к	удержать	происходить (случаться)
	определять(ся)	

b) What do they refer to? Say about it in your own words.

3. a) Answer the following questions:

1. What is the significance of the inlet duct?
2. What conditions must the inlet duct operate in?
3. How is the inlet duct to be designed?
4. Where does the inlet duct deliver the air?
5. What is one of the primary tasks of the inlet duct?
6. How are Inlet Ducts rated?
7. What categories may Inlet Ducts be divided into?

b) Think of 3 more questions and write them down.

Language Focus

1. Match the equivalents.

<i>A</i>	<i>B</i>
1. approximately	a. для того, чтобы
2. comparable size	b. приблизительно
3. in such a way	c. сопоставимый размер
4. result in	d. высокое значение
5. high value	e. вызывать
6. to be equal to	f. таким образом
7. offer resistance	g. в допустимых пределах
8. without any correction	h. приводить к
9. cause	i. оказывать сопротивление
10. in order to	j. быть равным чему-либо
11. within limits	k. без каких-либо поправок

2. a) Find pairs of synonyms among the words.

1. occur	a. right
2. convert	b. define
3. duct	c. take place
4. attitude	d. transform
5. amount	e. nozzle
6. shape	f. placement
7. extent	g. degree
8. location	h. position
9. determine	i. form
10. correct	k. value

b) Find pairs of antonyms among the words.

- | | |
|---------------|----------------|
| 1. supersonic | a. outlet |
| 2. increase | b. secondary |
| 3. inlet | c. outside |
| 4. primary | d. without |
| 5. inside | e. decrease |
| 6. with | f. subsonic |
| 7. result in | g. result from |

c) Mark the stress of all the words according to the part of speech they belong to. Practise their pronunciation aloud.

3. a) Match the verbs with their definitions.

- | <i>A</i> | <i>B</i> |
|------------------|--|
| 1. to influence | a. to provide someone or smth with smth that they need or want |
| 2. to cause | b. to change from one system, use, or method to another |
| 3. to supply | c. to consider that smth has a particular quality or has achieved a particular standard or level |
| 4. to convert | d. to succeed in doing smth, especially smth that you have been trying for a long period of time |
| 5. to rate | e. to affect smth happens |
| 6. to accomplish | f. to lead to |

b) Complete the sentences, using the verbs above.

1. The nozzle guide vanes must _____ part of the gas heat and pressure energy into dynamic and kinetic energy.
2. The nozzle small exit area _____ slower acceleration of the engine.
3. The second function of the nozzle that of turning the gases so that they strike the turbine blades at the correct angle is _____ by setting the blades at a specific angle to the axis of the engine.
4. Some pieces of new equipment will be _____ in a month.
5. Our company is _____ as one of the most reliable.
6. What were the factors that _____ you to sign this contract?

4. Fill in the gaps using the words from the box. There is one extra word! Translate the text into Russian.

supersonic; subsonic; decrease; shockwaves; minimize; increase

Air intake (Inlet) – The standard reference frame for a jet engine is the aircraft itself. For _____ aircraft, the air intake to a jet engine presents no special difficulties, and consists essentially of an opening which is designed to _____ drag, as with any other aircraft component. However, the air reaching the compressor of a normal jet engine must be travelling below the speed of sound, even for _____ aircraft, to sustain the flow mechanics of the compressor and turbine blades. At supersonic flight speeds, _____ form in the intake system and reduce the recovered pressure at inlet to the compressor. So some supersonic intakes use devices, such as a cone or ramp, to _____ pressure recovery, by making more efficient use of the shock wave system.

5. Use the prepositions in the box where it is necessary to complete the sentences in the text. Translate the text in writing.

to; of; for; into; throughout; on; from; until

There are basically two forms of shock waves:

1) Normal shock waves lie perpendicular _____ the direction _____ the flow. These form sharp fronts and shock the flow _____ subsonic speeds. Microscopically the air molecules smash the subsonic crowd _____ molecules like [alpha rays](#). Normal shock waves tend to cause a large drop in [stagnation pressure](#). Basically, the higher the supersonic entry Mach number _____ a normal shock wave, the lower the subsonic exit Mach number and the stronger the shock (i.e. the greater the loss in stagnation pressure across the shock wave).

2) Conical (3-dimensional) and oblique shock waves are angled rearwards, like the bow wave _____ a ship or boat, and radiate _____ a flow disturbance such as a cone or a ramp. _____ a given inlet Mach number, they are weaker than the equivalent normal shock wave and, although the flow slows down, it remains supersonic _____. Conical and oblique shock waves turn the flow, which continues in the new direction, _____ another flow disturbance is encountered downstream.

6. a) Using appropriate suffixes, transform the words in the table below into new ones as in the example. Fill the gaps in the text with a suitable derivative.

More (1) _____ supersonic intakes are designed to have a normal shock in the ducting downstream of intake lip, so that the flow at (2) _____ entry is always subsonic. However, if the engine is throttled back, there is a (3) _____ in the (4) _____ airflow of the LP compressor/fan, but (at supersonic conditions) the corrected airflow at the intake lip remains constant, because it is determined by the flight Mach number and intake incidence/yaw. This (5) _____ is overcome by the normal shock moving to a lower cross-sectional area in the ducting, to decrease the Mach number at entry to the shockwave. This (6) _____ the shockwave, improving the overall intake pressure (7) _____. So, the absolute airflow stays constant, whilst the corrected airflow at compressor entry falls (because of a (8) _____ entry pressure). Excess intake airflow may also be dumped overboard or into the exhaust system, to prevent the conical/oblique shock waves being disturbed by the (9) _____ shock being forced too far forward by engine throttling.

1	ADVANCE		
2	COMPRESS	<i>compressor</i>	noun
3	REDUCE		
4	CORRECT		
5	DISCONTINUE		
6	WEAK		
7	RECOVER		
8	HIGH		
9	NORM		

b) Mark the suffixes in the second column above. In the third column write down what part of speech a word in italics belongs to.

c) Say what information the text provides the reader with. Use no more than 2 sentences.

Speaking

Work in pairs. Use the information from the Internet and from this unit to speak on:

Student A: subsonic ducts

Student B: supersonic ducts.

Cover the following items:

- * background
- * characteristics
- * configuration
- * advantages

Work in pairs and compare the subsonic and supersonic ducts. Use the phrases below:

- I'd like to tell you
- I'd like to add
- It's quite right
- It's quite on the contrary
- If I'm not mistaken

UNIT 17

Turbine



Lead in

1. Discuss the following questions.

- a) What is the role of the turbine in an engine?
- b) What are its main components?
- c) How many types of turbines do you know? Where are they used?

2. Look through the text and choose the suitable title for it:

1. Turbine Operation
2. Turbine Construction
3. Types of Turbines

Reading 1

Read the text below and say which paragraph (A-F) tells you about:

1. Operations the blades undergo before their certification.
2. Work and use of multistage turbine.
4. Shrouded and unshrouded blades.
5. The turbine wheel.
6. The turbine assembly.
7. Cooling.

A. The turbine wheel is one of the most highly stressed parts of the engine. Not only must it operate at temperatures of approximately 1800°F (982°C), but it must do so under centrifugal loads imposed by high rotational speeds of over 60,000 rpm for small engines to 8,000 rpm for the larger ones. Consequently, the engine speed and turbine inlet temperature must be accurately controlled to keep the turbine within safe operating limits.

B. The turbine assembly is made of two main parts, the disk and the blades. The disk or wheel is a statically and dynamically balanced unit of specially alloyed steel usually containing large percentages of chromium, nickel, and cobalt. After forging, the disk is machined all over and carefully inspected using X-rays, sound waves, and other inspection methods to assure structural integrity. The blades or buckets are attached to the disk by means of a “fir tree” design to allow for different rates of expansion between the disk and the blade while still holding the blade firmly against centrifugal loads. The blade is kept from moving axially either by rivets, special locking tabs or devices, or another turbine stage. As the wheel is subjected to both high speed and high temperatures, blades can be easily deformed by growing in length (a condition known as creep) and by twisting and changing pitch. Since these distortions are accelerated by exceeding engine operating limits, it is important to operate within the temperature and rpm points set by the manufacturer.

C. Some turbine blades are open at the outer perimeter, whereas in others a shroud is used. The shroud acts to prevent blade-tip losses and excessive vibration. Distortion under high loads, which tend to twist the blade toward low pitch, is also reduced. The shrouded blade has an aerodynamic advantage in that thinner blade sections can be used and tip losses can be reduced by using a knife-edge or labyrinth seal at this point. Shrouding, however, requires that the turbine run cooler or at a reduced rpm because of the extra mass at the tip. On blades that are not shrouded, the tips are cut or recessed to a knife edge to permit a rapid “wearing-in” of the blade tip to the turbine casing with a corresponding increase in turbine efficiency.

D. Blades are forged from highly alloyed steel and are passed through a carefully controlled series of machining and inspection operations before being certified for use. Many engine manufacturers will stamp a “moment weight” number on the blade to retain rotor balance when replacement is necessary.

E. The temperature of the blade is usually kept within limits by passing relatively cool air bled from the compressor over the face of the turbine, thus cooling the disk and blade by the process of convection. This method of cooling may become more difficult, as high Mach number flights develop high compressor inlet and outlet temperatures.

F. Some gas turbine engines use a single-stage turbine, whereas other employ more than one turbine wheel. Multistage turbines are used where the power required to drive the compressor would necessitate a very large turbine wheel. Multistage wheels are also used for turboprops where the turbine has to extract enough power to drive both the compressor and the propeller. When two or more turbine wheels are used, a nozzle diaphragm is positioned directly in front of each turbine wheel. The operation of the multistage turbine is similar to that of the single stage, except that the succeeding stages operate at lower gas velocities, pressures, and temperatures. Since each turbine stage receives the air at a lower pressure than the preceding stage, more blade area is needed in the rear stage to assure an equitable load distribution between stages. The amount of energy removed from each stage is proportional to the amount of work done by each stage.

Comprehension Check

1. Find the English equivalents to the following words and word combinations.

в пределах процентное соотношение соответствующее
увеличение равномерное распределение нагрузки
оставшиеся турбины экстремальные условия наиболее
напряжённые части при сильных центробежных нагрузках
в пределах безопасных эксплуатационных режимов
для обеспечения структурной целостности

2. Look at these three figures. What does each of them illustrate?

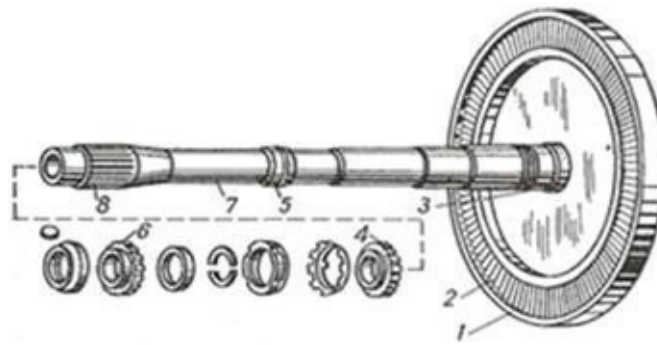


Fig. 1

a) Name all the components of the device in Figure.1.

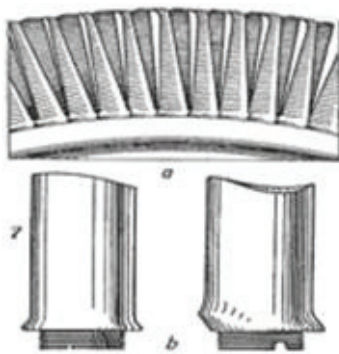


Fig. 2

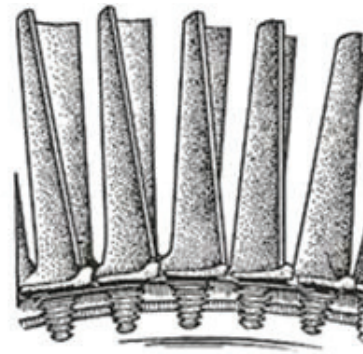


Fig. 3

b) What do you know about the device in Figure 2?

c) What part of the text does Figure 3 correspond to? Prove your answer.

3. Complete the sentences. If necessary refer to the text.

1. The engine speed and turbine inlet temperature must be accurately controlled _____ .
2. After forging, the disk is machined all over and carefully inspected using _____ .
3. Blades are forged from _____ .
4. The temperature of the blade is kept _____ , thus cooling the disk and blade by the process of convection.
5. Multistage turbines are used where _____ would necessitate a very large turbine wheel.
6. _____ , a nozzle diaphragm is positioned directly in front of each turbine wheel.
7. Since each turbine stage receives the air at a lower pressure than the preceding stage _____ .

4. Work in a group of three.

Group 1: make up questions (5-7) for parts A-C

Group 2: make up questions for parts D-F.

Ask each other questions on the parts you worked on and answer your partner's questions.

Reading 2

Read the text and guess the meaning of the words in bold.

With a few exceptions, gas turbine manufacturers have concentrated on the axial-flow turbine although some manufactures are building engines with a radial inflow turbine. The radial inflow turbine has the advantage of ruggedness and simplicity, and is relatively inexpensive and easy to manufacture when compared with axial-flow type. On this type of turbine, inlet gas flows through peripheral nozzles to enter the wheel passages in an inward radial direction. The speeding gas exerts a force on the wheel blades and then exhausts the air in an axial direction to the atmosphere. These turbine wheels used for small engines are well suited for a lower range of specific speeds and work at relatively high efficiency.

The axial-flow turbine is comprised of two main elements consisting of a set of stationary vanes and one or more turbine rotors. The turbine blades themselves are of two basic types, the impulse and the reaction. The modern aircraft gas turbine engine utilizes blades which have both impulse and reaction section.

The stationary part of the turbine assembly consists of a row of contoured vanes set at an angle to form a series of small nozzles which discharge gases into the blade of the turbine wheel. For this reason, the stationary vane assembly is usually referred to as the turbine nozzle, and the vanes themselves are called nozzle guide vanes.

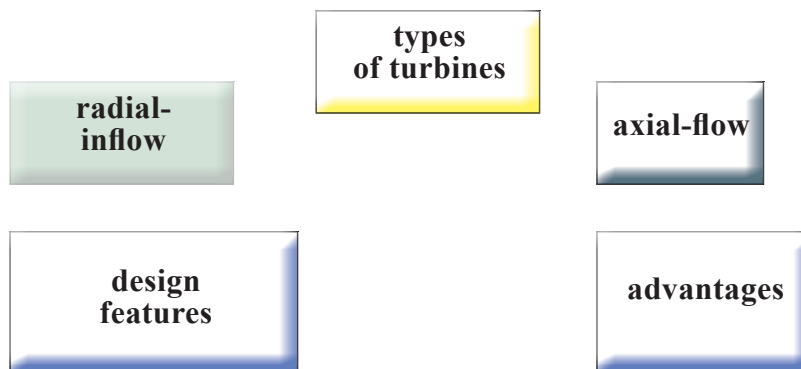
Comprehension Check

1. Name types of turbines mentioned in the text.
2. Show the flow of gas in the radial-inflow turbine.
3. a) Which of the two graphs below better reflects the content of the text? Discuss it with your partner. If neither, draw your own graph.

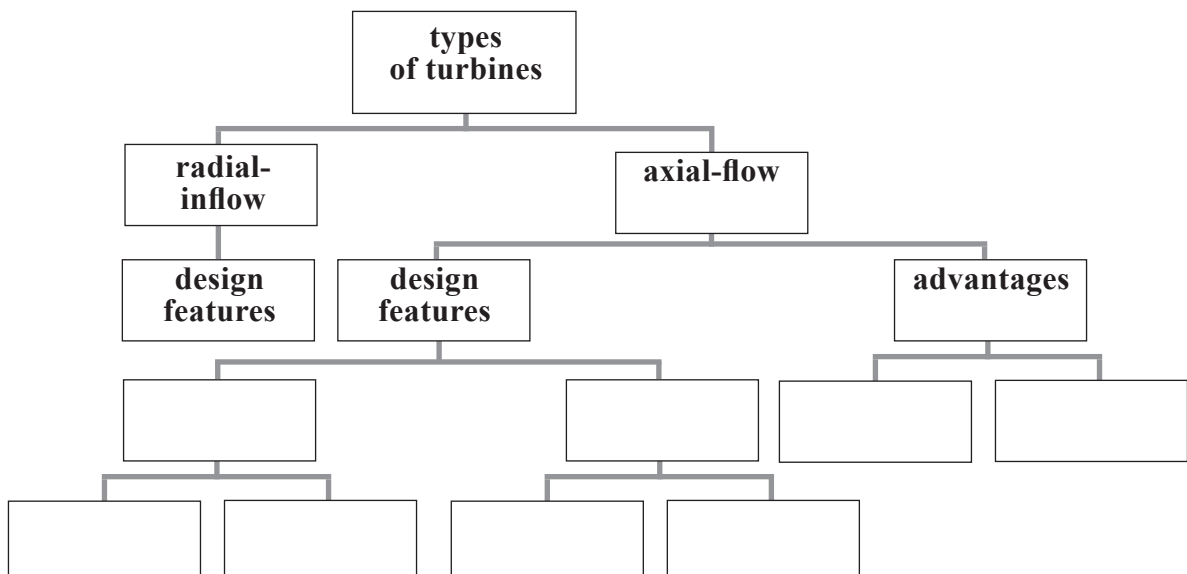
- b) Fill in the chosen graph with the words or phrases from the text.
 c) Compare the results with your peers from another group. If necessary make some changes. The phrases below may be useful:

- First of all I’d like to...
- I am arguing against...
- It is rather surprising...
- It is worth pointing out...
- Oh, let me think for a moment...
- Actually, I don’t know...
- Well, now...

I.



II.



Language Focus

1. a) Using the suffixes from the right, form adjectives from the nouns below. More than one variant is possible.

control	-ous
shroud	-al
proportion	-ful
rotation	-ed
excess	-less
care	-able
alloy	-ive
advantage	

b) Mark the stress of all the words. Practise their pronunciation aloud.

2. a) Find the right prepositions for each verb. There may be more than one combination!

b) Explain their meaning.

c) Which sentences in the text illustrate their use?

d) For the rest of the combinations give your own examples.

to keep	by
to attach	into
to tend	up
to convert	to
to forge	upon
to subject	from
	within

3. Fill in the gaps using the words from the oval. There is one extra word!

hot to cause combustion wheel seriously raise turbine
uncommon vibratory to flow various rim to encounter

Among the most _____ stressed components in a gas-turbine engine is the turbine wheel. The buckets of the wheel are subjected to high centrifugal stresses and to a fluctuating stream of _____ gases which _____ temperature and may, at the same time, introduce _____ stresses. The disk of the _____ is subjected to heat by conduction from the buckets and may, in some cases, be directly heated by the _____ gases. Temperatures of over 1500° F are not _____ near the _____ of the first-stage turbine disk. Where there is more than one _____ disk in an engine, the second and third-stage disks do not _____ such high temperatures. Turbine disks are often cooled by means of air bled from the compressor section and directed through _____ passages to _____ around the turbine disk.

4. a) Find the right words to fill the table. The first line has been done for you.

Verb	Translation	Noun	Translation
1. to flow	<i>протекать</i>	<i>flow</i>	<i>поток</i>
2. to force		force	сила

3. to exhaust		exhaust	
4. to use		use	
5. to work		work	работа
6. to set	устанавливать	set	
7. to assemble		assembly	
8. to form		form	форма
9. to discharge	разряжать	discharge	
10. to sound		sound	звук

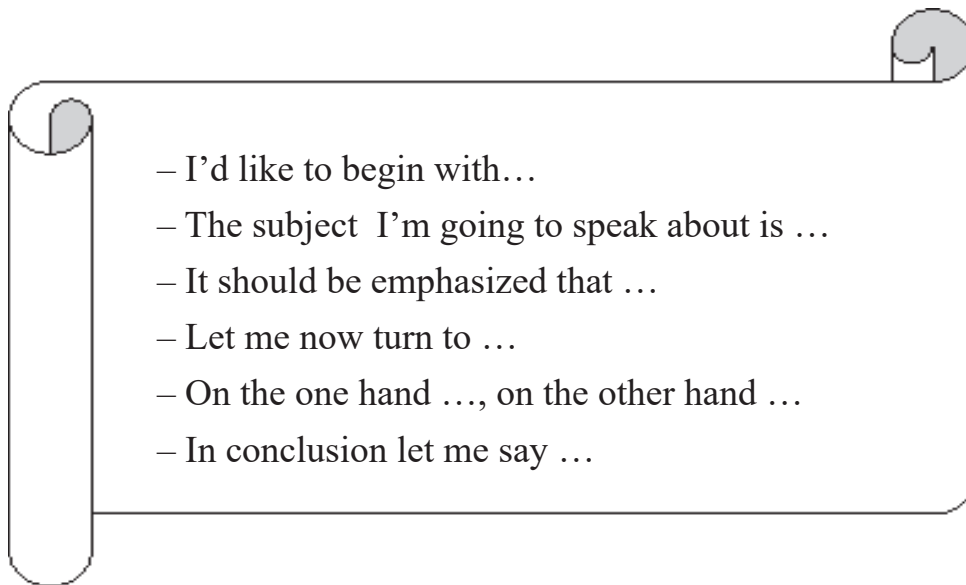
b) What part of speech do the words in bold belong to?

Translate the sentences.

1. By reason of the rapid expansion, the heated air and combustion products at increased velocity **force** their way through the only exit from chamber.
2. Thrust is an applied **force** tending to produce motion in a body or to alter the motion of a body.
3. These vanes direct the **flow** to the appropriate angle of attack for the blades on the periphery of the turbine wheel.
4. In that position the valve allows the oil to **flow** from the engine through the transfer rings.
5. Internal combustion engines **use** any fuels that can be combined with an oxidizer in the chamber.
6. Extensive **use** of titanium in the front part of the compressor and high-nickel steel alloys in the rear is made.
7. Daimler's new engine **set** the basis for all car engines going forward.
8. The axial-flow turbine is comprised of two main elements consisting of a **set** of stationary vanes and one or more turbine rotors.
9. The pattern of **sound** from a jet engine makes the noise problem even more bothersome than that coming from other types of engine.

Speaking

1. Use the information of this unit and from Internet to make a diagram on Turbine Construction.
2. Compare your diagram with the diagrams of your partner. Choose the diagram which better reflects the topic. Fill it in.
3. Speak on Turbine Construction using your diagram. The phrases below may be useful.



Writing

The text describes the fir-tree design of blade attachment to the disk. It is considered to be the most appropriate and the most widely used attachment. Do a search on other types of the blade attachment. Compare them with the fir-tree design. Write a report on your search (100-200 words).

Glossary for Part I

ability – способность	beam – балка
absorb, v – поглощать	bending – изгиб
acceleration – ускорение	biplane – биплан
accessories – вспомогательное оборудование, вспомогательные агрегаты двигателя	blade – лопасть
accomplish – выполнять	blading – комплект лопаток
achieve, v – достигать, выполнять	blanket – слой
adjustable – регулируемый	bleed, v – спускать (воздух)
advance – успех, прогресс	blowout – срыв пламени
aileron – элерон	brace – подкос
air flow – воздушный поток	bring down, v – снижать
air intake – воздухозаборник компрессора	bulkhead – шпангоут
air stream – воздушный поток	burner – камера сгорания
airflow – воздушный поток	buzz – гул, гудящий звук
airfoil – аэродинамическая плоскость, аэродинамическая поверхность	can – отдельная камера сгорания
airplane – самолёт	can-annular burner – трубчато-кольцевая камера сгорания
alloyed steel – легированная сталь	cargo room – грузовой отсек
alternate – переменный, чередующийся, дополнительный	centrifugal compressor – центробежный компрессор
altitude – высота	centrifugal-flow compressor – центробежный компрессор
amount – величина, количество	chord – хорда
amphibian – амфибия	cockpit – кабина пилота
angle – угол	combustible – горючий
annular combustion chamber – кольцевая камера сгорания	combustion – горение
armament – вооружение	compartment – отсек, кабина
arrangement – компоновка, расположение	compression ratio – степень сжатия
assembly – агрегат, сборка	compressor stall – срыв компрессора
atomize, v – распылять	consumption – потребление, расход
attach, v – прикреплять	contaminate – загрязнять
attitude – пространственная ориентация ЛА	contoured – профильный
autogiro – автожир	control – управление
auxiliary – вспомогательный	control mechanism – механизм управления
avoid, v – избегать	control, v управлять
axial compressor – осевой компрессор	conventional – традиционный, обычный
axial-flow compressor – осевой компрессор	convert, v – превращать, преобразовывать
balance area – площадь компенсатора	crew – экипаж
bay – отсек, ниша	cross-ignition tube – трубопровод перекрестного зажигания

damage – повреждение	flexibility – гибкость, приспособляемость, маневренность
damage, v – повреждать	flight – полёт
decrease, v – уменьшать, снижать	flight controls – средства управления полётом
deflect, v – отклонять	flow – поток, v течь
demand – требование	flutter – флаттер
demand; v – требовать	flying boat – летающая лодка
design, v – проектировать	forging – ковка
develop, v – разрабатывать, развивать	frame – рама, каркас
development – разработка, развитие	framework – каркас
device – устройство, агрегат	frontal area – фронтальная поверхность
diffuser – диффузор	fuel – топливо
dilution – разжижение	fuel tank – топливный бак
directional control – управление по курсу	fully braked landing – остановка с полным торможением
directional stability – устойчивость на курсе	furnish, v – доставлять
discharge gases – выхлопные газы	fuselage – фюзеляж
dorsal fin – форкиль	girder type – балочный тип
draw in, v – втягивать (воздух)	glider – планер
duct – канал, труба, трубопровод, воздухозаборник	helicopter – вертолёт
dynamic balancing – динамическая балансировка	high wing monoplane – высокоплан
eject, v – выбрасывать, извергать	hinge – крепить шарнирно
electrical charge – электрический заряд	hinge moment – шарнирный момент
elevator – руль высоты	hinge, v – крепить шарнирно
empennage – хвостовое оперение	house, v – вмещать, содержать
engine – двигатель	ignitor plug – свеча зажигания
equip, v – оборудовать	impeller – рабочее колесо (турбины компрессора), impeller – рабочее колесо центробежного компрессора, крыльчатка
equipment – оборудование	impulse blade – активная лопатка
establish, v – устанавливать	ingestion – засасывание (в двигатель посторонних предметов)
even – равномерный	inlet duct – входной канал
excess – излишек, избыток	integrity – целостность
exhaust outlet – выходное отверстие	jet – реактивный; струя
exhaust system – выхлопная система, выхлопное устройство	jet engine – реактивный двигатель
extract, v – извлекать	join, v – соединять
facility – вспомогательное средство, средство обслуживания, оборудование	kind – вид, тип
fin – киль	knife edge – острая кромка
fit, v – оснащать, устанавливать	land, v – приземляться
flap – закрылок	landing – посадка

landing gear – шасси	plenum chamber – нагнетательная камера
lateral axis – боковая (поперечная) ось	pneumatic tyre – пневматическая шина
lift – подъёмная сила	power output – мощность на выходе
lifting force – подъёмная сила	power plant – силовая установка
light gauge metal – лёгкий листовый металл	power setting – режим работы двигателя
liner – жаровая труба (камеры сгорания)	pressure – давление
linkage – соединение	prevent, v – предотвращать
locking tab – шпонка	produce – производить
longeron – лонжерон	propel, v – двигать, толкать
longitudinal axis – продольная ось	propulsion – движение вперед
loss – потери	radial inflow turbine – центробежная турбина
low pitch – малый шаг (винта)	ram pressure – скоростной напор, полное давление (в воздухозаборнике)
low wing monoplane – низкоплан	ram recovery point – точка восстановления скоростного напора
machine, v – подвергать механической обработке	range – дальность, диапазон
main leg – основная стойка	ratio – отношение, коэффициент
manifold – трубопровод	reaction – противодействие, действие
mid wing monoplane – среднеплан	reaction blade – лопатка обратного действия
missile – реактивный снаряд, ракета	rearwards – назад, позади
monocoque type – монококовый тип фюзеляжа	recess, v – отодвигать
monoplane – моноплан	recirculate, v – рециркулировать
mount, v – устанавливать	reinforce, v – усиливать
movable – подвижный	reliability – надежность
multiple combustion chamber layout – трубчатая конструкция камеры сгорания	requirement – требование
nacelle – гондола	resistance – сопротивление
nose leg – носовая стойка	resultant thrust – результирующая тяга
nose over, v – капотировать	retractable – втягивающийся
nozzle – сопло	retractable landing gear – втягивающееся шасси
nuclear – ядерный	reverse – обратный
oblique shock – косой скачок уплотнения	rib – нервюра, ребро
occur, v – происходить, иметь место	rim – кромка
output – выход, продукция, мощность	rivet – заклепка
overhaul – ремонт, переборка, разборка	rivet, v – клепать
payload – полезная нагрузка	rotary air compressor – роторный компрессор
performance – работа, характеристики	rotor – несущий винт вертолёта
pilot – регулятор	rudder – руль направления, rudder – руль поворота
piston-engined aircraft – самолёт с поршневым двигателем	ruggedness – прочность
plane – плоскость, самолёт	

rule out, v – исключать	supply, v – обеспечивать, поставлять, доставлять
safety – безопасность	swallow, v – заглатывать
scientific – научный	sweptback – стреловидный
seal – уплотнение, герметизация	sweptback wing – стреловидное крыло
seaplane – гидросамолёт	sweptforward wing – крыло с обратной стреловидностью
section – сечение	swiveling mounting – шарнирное крепление
semimonocoque type – полумонококовый тип фюзеляжа	tail unit – хвостовое оперение
shear – срез, сдвиг	tail wheel (skid) – хвостовое колесо, опора
shock – удар	take off – взлёт
shock wave – ударная волна	take off, v – взлетать
shock-absorbing strut – амортизирующая стойка	technique – метод, способ, техника, технология
shrouded – бандажированная (о лопатке)	thrust – тяга
skid – хвостовая опора, хвостовое колесо, опора	tip – конец, концевая часть
skin – обшивка	torsion – кручение
smoothly – плавно, постепенно	tractor airscrew – тянущий воздушный винт
span – размах	trailing edge – задняя кромка
spanwise stiffener – продольный элемент жёсткости	transonic – околозвуковой
spar – лонжерон крыла	transverse – поперечный
speed – скорость	tricycle gear – трехопорное шасси
spike – амортизирующая игла	tricycle landing gear – трёхопорное шасси
spool – каскад (компрессора)	trimmer tab – триммер
spray – струя	truss type – ферменный тип
stabilizer – стабилизатор	turbulence – турбулентность
stage – ступень	undercarriage – шасси
stiffness – жёсткость	utilize, v – использовать
stream – поток	vane – лопасть, лопатка
stress – нагрузка, напряжение	vaporize, v – испарять
stressed skin – работающая обшивка	vehicle – летательный аппарат, аппарат для движения
stressed-skin fuselage – фюзеляж с работающей обшивкой	velocity – скорость
stringer – стрингер	weight – вес
strut – стойка	weld, v – сваривать
subsonic – дозвуковой	wheel well – ниша шасси
suck, v – всасывать	wing – крыло
supersonic – сверхзвуковой	wing centre-section – центроплан
supersonic jet plane – сверхзвуковой реактивный самолёт	wing root – корневая часть крыла
	wing tip – законцовка крыла
	withstand, v – выдерживать

Part II. INFORMATION TECHNOLOGIES FOR AVIATION AND COSMONAUTICS

UNIT 1

IT for Aviation

Lead in

1. Aviation industry was one of the first to start employing advanced information technologies. Make a list of all possible IT applications that you think are possible to be used in aviation.
2. Work in pairs. Compare your list of IT applications in aviation with that of your partner. Who has the longest list? Discuss the differences.

Reading

1. Read the following text and compare it with your list. Use a dictionary, if necessary.

A. Information Technologies in Aviation Industry

It is a safe bet to say that information technology has revolutionized the entire area of aviation and penetrated into each aspect of the industry. Very roughly the application of IT in aviation could be divided into 3 vast categories: aircraft engineering, flight management and airline operation.

Designing and developing new aircraft systems is time-consuming and expensive. The traditional procedure in a simplified way includes the following steps: depending on the original concept and customer requirements the designers develop airplane configuration, make primary aerodynamic computations, define the product basic characteristics. Then they select or design the main units and systems and finally produce a full-scale physical mock-up. All this is followed by bench and full-level tests and accompanied by a huge amount of detailed design documentation.

The new technology combines all sort of information about the product and its components within a single complex computerized system which processes all the data fed into it and creates an electronic model which can be further changed and updated. IT tools and techniques also play a critical role in testing the aircraft and training the workers.

The key information technologies in flight management are: communication, navigation (which is now changing from inertial navigation to satellite navigation thus providing the airplane with a much more accurate position) and surveillance which involves automatic sending a position report. The science and technology of the use of electronic devices on aircraft is called *avionics*.

Communications (primarily between the pilot and the air traffic controller) are still mostly performed by voice, however some datalink communications are gradually emerging generally through airline managed data communication networks such as ACARS.

The air traffic controller receives aircraft state information through surveillance systems and issues commands over voice communication channels. These commands are executed by the pilot using the aircraft autoflight and navigation systems. Surveillance systems also offer the potential of direct aircraft to aircraft surveillance which would allow aircraft to self separate in some conditions allowing a much faster and more efficient control process, and enhanced weather surveillance systems which could reduce the exposure to hazardous encounters and increase the safety.

Special computer tools for managing aircraft provide the required information for aircraft maintenance – planning the entire fleet’s maintenance schedule, determining the estimated budget for the schedule, seeing any potential problems and finding solutions before the situation becomes critical.

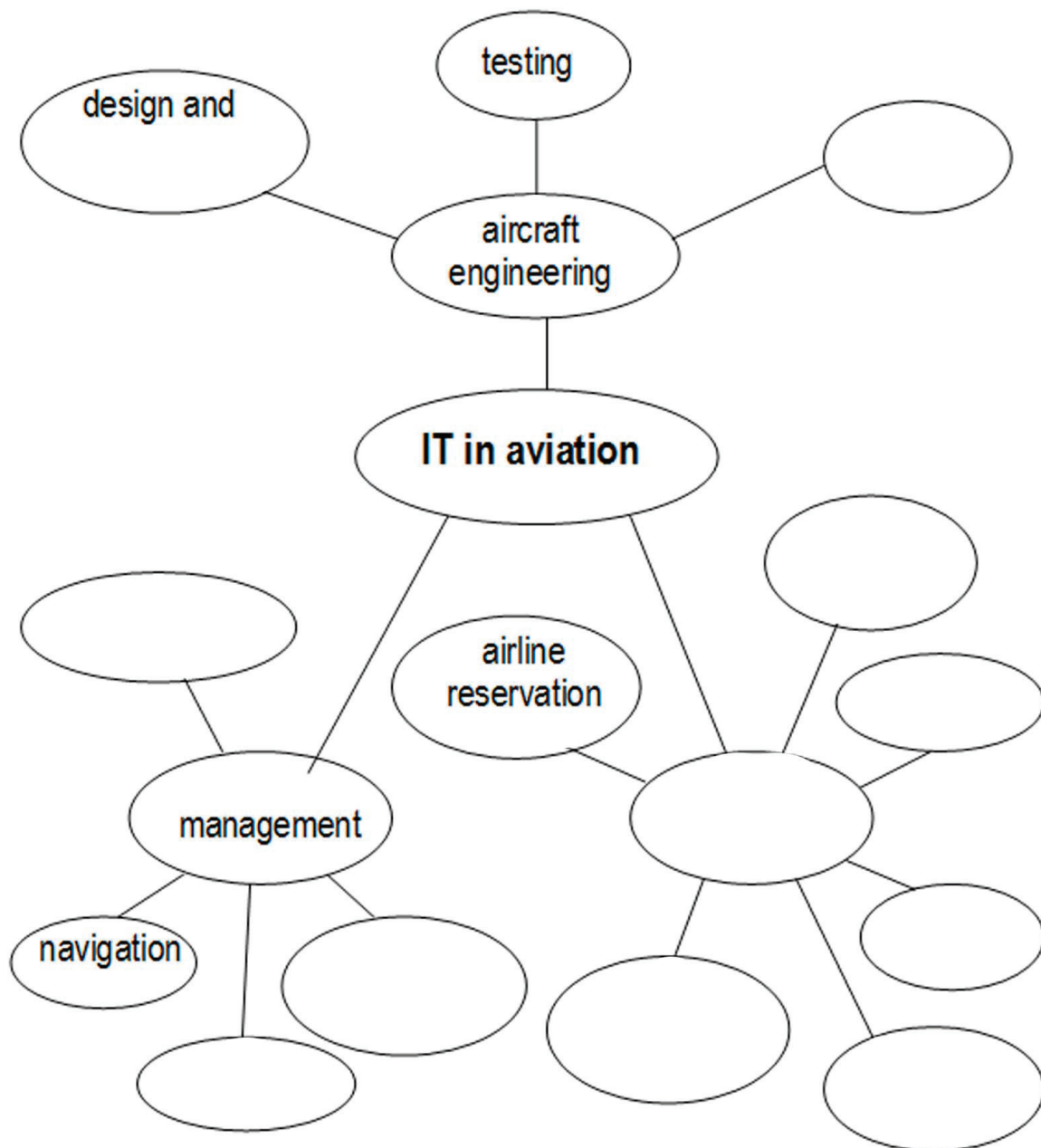
The airline industry has been affected by information technology in a great extent in various aspects like airline reservations, e-ticketing, security check, flight and airport management and control. Flight and airport management and planning include flight information display systems, airport operational database systems, air traffic control, security systems, staff management displays, finance and accounting systems, etc.

The five main computerized reservation systems are *Galileo*, *Sabre*, *Amadeus*, *Gabriel* and *Worldspan*. Then came online reservation system called e-ticketing which further helped to reduce the costs since it led to direct interaction between the passenger and the airline without inclusion of agents. IT has also led to the development of self-service kiosks to reduce queuing issues and speed up check in process, and developed radio frequency identification technique to resolve lost luggage issues.

In air transport industry where there is intensive competition, companies try to use every kind of new technology that gives them advantage. Developing information technologies and information systems makes this process faster, more appropriate and more reliable.

2. Using the text and the words in the box, fill in the diagram of IT applications in aviation.

- air traffic control • aircraft engineering • aircraft maintenance •
- airline operation • airline reservation • airport management •
- communication • design & development • e-ticketing •
- flight management • IT in aviation • navigation • security check •
- self-service kiosks • surveillance • testing • training •



3. The text names 5 main computer reservation systems. Which of them are used by Russian airlines? Go to the *Flyworld* website at www.flyworld.ru to find the information. What is the name of the Russian computer reservation system?

4. Read the text about integrated information technologies used in aircraft design.

B. Computer Aided Design and Manufacturing

Today's industries cannot survive worldwide competition unless they introduce new products with better quality, at low cost, and with short delivery time. For this purpose they need to use the computer's huge memory capacity, fast processing speed, and interactive graphics capabilities. Computer-aided design (CAD), computer-aided manufacturing (CAM), and computer-aided engineering (CAE) are the technologies used during the product development cycle.

A CAD system consists of IT hardware (H/W), specialized software (S/W) and peripherals. The core of a CAD system is the S/W, which makes use of graphics for product representation, databases for storing the product model, and drives the peripherals for product presentation.

The designer is the main actor in the process, in all phases from problem identification to the implementation phase. The role of the CAD is to help the designer by providing:

- accurate and easily modifiable graphical representation of the product;
- complex design analysis in short time.

The technique was initiated in Massachusetts Institute of Technology (MIT) by Ian Sutherland. The automotive and aerospace industries were the first users and the forerunners of development of CAD technology. The first systems were very expensive and performing only 2D modelling while current systems are 3D systems.

Wire-frame modelling was the first attempt to represent the 3D object. The representation was not perfect with many drawbacks from the point of view of precision, adequacy of the representation, etc. In simple terms a 2D-wire frame model was built by forming the skeleton of the part, consisting only of edges.

With a *surface model* we are modelling the skin of the part. Model editing is done by modifying the defining curves, by changing the numerical values of parameters or through using graphical or mathematical laws controlling the created shapes. The system also includes easy-to-use tools for evaluating the shape, the size and the curvature of complex models.

Solid modelling systems are considered to offer the most complete representation of a part. They combine modelling and topology. Usual operations integrated inside the solid modelling systems are: 2-D and 3-D wire-frame models, swept, lofted and revolved solids, and Booleans as well as parametric editing.

One of the most frequently used engineering analysis techniques is *finite element analysis* (FEA). FEA is used to analyse the functional performance of an object by dividing it into a number of small building blocks, called finite elements. The core of the FEA method is an idealization of the object or continuum by a finite number of discrete variables. For this purpose, the object is first divided into a grid of elements that forms a model of the real object. This process is also called meshing. Each element is a simple shape such as square, triangle, or cube or other standard shape for which the finite-element programme has information to write the governing equations in the form of a stiffness matrix.

The unknown parameters for each element are the displacements at the node points, which are the points at which the elements are connected. The finite-element programme assembles the stiffness matrices for these simple elements to form the global stiffness matrix for the entire model. A number of S/W packages have been developed for Static analysis, Transient dynamic analysis, Heat transfer analysis, Motion analysis, etc.

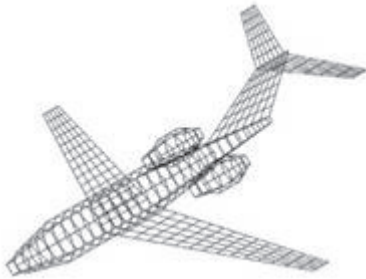
Once a design has been completed, after optimization or some tradeoff decisions, the design evaluation phase begins. Prototypes may be built for this purpose. The new technology called rapid prototyping is becoming popular for constructing prototypes. This technology (also called 3D printing) enables the construction of a prototype by depositing layers of an object from the bottom to the top. Thus it enables the construction of the prototype directly from its design.

The manufacturing begins with process planning, using the drawings from the design process, and it ends with the actual products. The manufacturing process includes the activities of production planning, design and procurement of new tools, ordering materials, NC (numerically controlled) programming, quality control, and packaging. The computer technologies for these activities can be classified as CAM (computer aided manufacturing).

One of the most mature areas of CAM is numerical control which is the technique of using programming instructions to control a machine tool that grinds, cuts, mills, turns, bends, etc. raw stock into a finished part. Another significant CAM function is the programming of robots, which may operate in a work-cell arrangement, selecting and positioning tools and workpieces for NC machines.

The technology which provides a way for systems to work together and exchange information at multiple points of continuous integration – from design through manufacturing and support – is called product data management (PDM).

5. The following pictures present 3 types of 3D modelling – wire-frame, surface and solid models. Match the names with the pictures.



6. Text B contains many abbreviated terms. Go to the *Acronym Finder* website at www.acronymfinder.com and find the meaning of these terms related to CAE:

CIM _____

CAPPC _____

CAQA _____

CAMH _____

CAMM _____

CADD _____

7. Complete the following categories using the terms from Text B:

Graphics	Manufacturing	Computing
<i>edge</i>	<i>tools</i>	<i>equation</i>
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

8. Look through Text B again and answer the questions.

- 1) What does a CAD system consist of?
- 2) Who is the main actor in computer-aided design process?
- 3) How does CAD help the designer?
- 4) What industries were the first to introduce CAD technology?
- 5) What are the main types of 3D models?
- 6) What is finite element analysis used for?
- 7) What is meshing?
- 8) What does rapid prototyping perform?
- 9) What are the 2 main areas of CAM?
- 10) PDM is restricted to the design stage, isn't it?

9. Match up the following terms with their definitions.

- | | |
|--------|--|
| 1. CAD | A. the technique where all the surfaces of the physical object (including the opposite ends and internal components) are represented through bare lines and arcs. It may not be suitable for complicated projects that require uncompromising realistic effects |
| 2. CAM | B. the use sophisticated, interactive graphical software to design, analyze, and manufacture products and processes |
| 3. CAE | C. a form of programmable automation in which the mechanical actions of a machine tool or other equipment are controlled by a program containing coded alphanumeric data |
| 4. PDM | D. the technology concerned with the use of computer systems to assist in the creation, modification, analysis, and optimization of a design |
| 5. FEA | E. a process used to build a physical model from a computer drawing by creating layers of the shape and joining them together. This technology provides a fast way of producing parts for machines, vehicles, etc. |
| 6. NC | F. the technique used to combine a number of solid objects into a single 3D design. Much like a physical object, a model also has additional properties like density, weight and centre of gravity because of which it is most preferred choice when it comes to designing prototype of a mechanical product |

7. 3D modelling G. the technology concerned with the support of the entire product life cycle including product or plant definition, production and business operations
8. wire-frame modelling H. the modelling of products and systems in a virtual environment, for the purpose of finding and solving potential (or existing) structural or performance problems
9. surface modelling I. the technology concerned with the use of computer systems to plan, manage, and control manufacturing operations through either direct or indirect computer interface with the plant's production resources
10. solid model J. the process of creating a model that represents a three dimensional object which can be alive or inanimate. The model is created using a set of points which are connected by various geometric data such as lines, and curved surfaces
11. rapid prototyping K. the technique where models are created by merging 3D surfaces. It is like a piece of paper that can be placed at various angles to specify different shapes

1		2		3		4		5		6		7		8		9		10		11	
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Language Focus

1. Complete the table with the correct forms of the words. Check that you know the correct pronunciation of all the words. Note that sometimes several forms are possible.

Verb	Noun	Adjective
	application	
develop		
		productive
compute		
	management	
		executive
	increase	
provide		
	operation	

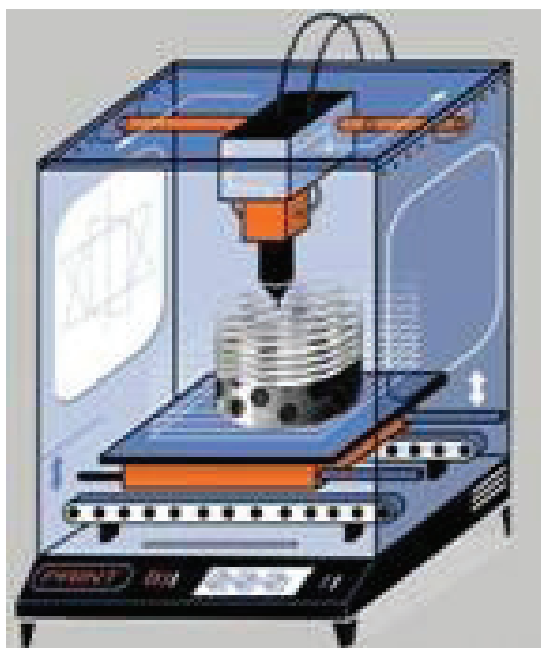
2. Read the text and decide which answer A, B, C or D best fits each space. Tick (✓) your answer. Listen to the recording to check your answers.

How 3D Printers Work

Using a 3D printer is like printing a letter; (0) ___ the print button on a computer screen and a digital file (1) ___, say, to an inkjet printer which deposits a layer of ink on the surface of a piece of paper to create an image in two dimensions. In 3D printing, however, the software takes a series of digital slices (2) ___ a computer-aided design and sends descriptions of those slices to the 3D printer, which adds successive thin layers until a solid object emerges. The big difference is that the “ink” a 3D printer uses is a material.

The layers can come together in a variety of ways. Some 3D printers use an inkjet process. *Objet*, an Israeli 3D-printer company, uses the inkjet head to spray an ultra-thin layer of (3) ___ plastic onto a build tray. The layer is cured by exposure to ultraviolet light. Another way is fused deposition modelling, a system used by *Stratasys*, a company based in Minneapolis. This involves melting plastic in an extrusion head to deposit a thin filament of material (4) ___ the layers.

Other systems use powders as the print (5) ___. The powder (6) ___ as a thin layer onto the build tray and solidified with a squirt of liquid binder. It can also be melted into the required pattern with a laser in a process called laser sintering, a technology which *EOS*, a German firm, uses in its (7) ___ machines. *Arcam*, a Swedish company, fuses the powder in its printers with an (8) ___ operating in a vacuum. And these are only some of the variations.



The materials that can be printed now (9) ___ from numerous plastics to metals, ceramics and rubber-like substances. Some machines can combine materials, making an object rigid at one end and soft at (10) ___ .

(Abridged from *The Economist*)

Example:

0. A press	B find	C hit ✓	D shoot
1. A sent	B sends	C is sent	D is sended
2. A in	B into	C by	D through
3. A liquid	B solid	C soft	D light
4. A for building	B to build	C to building	D for build
5. A environment	B way	C medium	D media
6. A can be spreaded	B can be spreading	C can to be spread	D can be spread
7. A adding-manufacturing	B added-manufactured	C additive-manufacturing	D addition-manufacturing
8. A electron ray	B electronic tube	C electron tube	D electron beam
9. A differ	B range	C change	D develop
10. A another	B other	C the other	D each other

3. Find the examples of infinitive, participle and gerund in the text. Write them out.

4. Put various types of questions to the text:

- a) a general (Yes/No) question;
- b) a tag question;
- c) an alternative (OR) question
- d) 2 special (Wh-) questions:
 - a question to the subject,
 - a question to another part of the sentence.

Listening

1. Go the site of *Flight Operation System* at <http://www.flightoperationsystem.com/index.aspx> . Watch the video presentation and answer the following questions on the use of information technologies in flight operations:

- 1) What is Flight Operation System?
- 2) Who is FOS designed for?
- 3) What are the advantages of FOS 2010?

- 4) What can flight operators expect within the first six months after introduction of the central booking system of aircraft available?
- 5) How does FOS 2010 save direct costs related to investment into new servers and infrastructure?
- 6) What information does a pilot registration card contain?
- 7) How can a user participate in generating a financial statement of the flight?
- 8) What are the other possibilities provided by FOS 2010?

2. Are you familiar with the term *cloud computing*? Use various internet resources to make up your own definition of this term. Work in pairs.



3. Go to the article “*Air transport industry launches first ‘community’ cloud*” published by *Computerworld UK* at <http://www.computerworlduk.com/news/cloud-computing/3272338/air-transport-industry-launches-first-community-cloud/> . Read it and decide when cloud technologies can be used in aviation industry.

4. SITA is a multinational IT company specialising in providing IT and telecommunication services to the air transport industry (ATI). Go to the video presentation “Real-world end-to-end applications of cloud computing” made by Benoit Verbaere, Senior Portfolio Manager, SITA, at <http://www.sita.aero/products-solutions/solutions/ati-cloud> . What does an integrated cloud services portfolio consist of?

5. According to the text, are the following statements true or false?

- 1) The role of the ATI cloud is to involve users into computer technologies.
- 2) Through the on-demand portal an IT manager can assign desktops and applications to new employees.
- 3) Cloud technology brings agility to the way the users are going to be able to do their job.
- 4) The applications assigned by an IT manager to new users range from generic applications to productivity applications.
- 5) A new employee can use his own computer to employ the business application provided by the IT manager.

Speaking

1. Make a presentation on one of the following topics:

- 1) Latest computer technologies in aviation.
- 2) New information technologies in airport operation.
- 3) Computer technologies in pilot training.
- 4) Types of flight simulators.
- 5) History of CAD/CAM.
- 6) Finite Element Analysis (FEA) software packages.

UNIT 2

IT in Cosmonautics

Lead in

1. In Part 1 of this unit we discussed applications of Information Technologies in aviation. Now think how these technologies can be used in cosmonautics? Will there be much difference?

2. Make two lists.

IT in aviation	IT in cosmonautics
1. _____	1. _____
2. _____	2. _____
3. _____	3. _____
4. _____	4. _____
5. _____	5. _____

3. Use on-line dictionaries and other Internet resources to find the definitions of the following terms:

- celestial body
- environmental conditions
- gravitational force
- carbon dioxide purifier
- in-built software
- customized equipment
- space control centre
- oxygen sensor
- surveillance satellite
- imaging
- humidity control
- debris
- propulsion
- space mission
- robotics
- dimensions
- space vehicle
- vigilance

4. Match various computer applications in space exploration and their descriptions.

Getting Into Space

1. *Designing the Spaceship*

A. Space missions need accurate planning and calculations of the trajectories, propulsion, and path that a space vehicle will take. It must be defined precisely after considering the motions and gravitational forces of various celestial bodies. The time, amount of fuel, duration of the mission, everything needs to be exact. Even a millisecond of miscalculation can be disastrous.

2. *Planning and Preparation*

B. The craft has in-built software for diagnostic tests and updates, that are constantly run to check the status of the equipment. If encountered with a problem, it reports it to the team on Earth, which will give or suggest a solution to that problem and get it solved.

3. *Space Simulations*

C. Computers help create the aircraft which is made from equipment that is customized and highly sophisticated. This spacecraft has to endure various threats, and numerous technicians and engineers work very minutely. After the spacecraft is built, it is run through many automated tests, which are created by computers to simulate cold, vacuum, and vibrations, that it will encounter in space.

4. *Fixing*

D. Placing a spacecraft at the exact accurate position, its trajectories, etc., all need to be precisely calculated. It is done in three dimensions. The engines that need to fire up, their time and duration, are all taken care of by computers. The navigation of the spacecraft and keeping a spacecraft on its course is something that computers monitor and keep in control 24/7.

5. *Navigation*

E. Computers allow scientists to simulate extreme environmental conditions and complicated flight situations in space. Recording the observations in detail and their analysis, helps scientists extend the horizons in space exploration, research, and development.

In Space

- 1. Imaging and Space Photography**

A. Computers constantly monitor objects like satellites, rockets, debris, etc., which revolve around the Earth. They keep a track, detect, and help identify various celestial bodies that orbit Earth. They help catalog the data sent by various surveillance satellites and space control centers.
- 2. Data Analysis and Storage**

B. Computers, with the help of large telescopes, capture high quality images of planets, the Earth, moon, asteroids, stars, comets, galaxies, other celestial bodies, and unknown matter that exists within the universe. Digital photography has changed the ways of astronomy, as we can alter the images and colors, use filters and satellite information to view the images more clearly. It is possible to enlarge images and see more than we could with our naked eyes.
- 3. Communication and Robotics**

C. The living conditions and environmental control systems of a spacecraft use computers to monitor the devices that keep the atmosphere in the spacecraft healthy and liveable. The humidity controls, oxygen sensors, carbon dioxide purifiers, thermostats, and other devices, are kept in check by the computers. If any problems arise, the crew is immediately alerted, and the problem is solved.
- 4. Life Support**

D. Research data is so vast and huge that, manual storage of this data would take years. Computers play a vital role in the compilation, storage, and sharing of this information. This technical information is collected, organized, and maintained effectively by computers, for scientists to be able to stay updated and gather real-time information all around the world.
- 5. Constant Vigilance**

E. Keeping in touch with the mission craft, transferring data, power management, motion, movement, sending and receiving new data or programming, is all done with the help of computers. The robots or rovers that are sent on a space mission are manipulated, controlled, and guided by computers.

Reading

1. Read the text about the history of IT in cosmonautics. Highlight the main stages of its development.

A. Space Exploration and Information Technology

Information Technology essentially means transmission, storage, distribution and processing data. Even before the computer era people collected and shared information thus creating knowledge. They looked to the stars and wondered what lay beyond the sky long before the first space flights.



Space exploration began with cultures explaining events by the position of stars. IT was there when Galileo Galilei (1564-1642) gazed through his telescope to discover the orbits of stars, moons and planets. But at that time technology was limited to a telescope with 3x magnification.

During the Scientific Revolution of the Modern Age space exploration and science were inseparable. The first attempt to launch an artificial satellite (by means of a straight-up vertical cannon shooting) was made by a French abbot Marin Mersenne (1588-1648), the author of classical works on the number theory and of the term “ballistics”.

Computing orbits became possible only with Isaak Newton’s (1643-1727) works and the ballistic pendulum allowing to measure the velocities of projectiles was invented by Benjamin Robins (1707-1752), a British mathematician and military engineer, only in 1742.

Eventually telescopes got better and information collaboration improved allowing for a number of great discoveries, but it wasn’t until the advent of computer technology and its facilitation of space exploration in the middle of the 20th century that a lot of these theories could be tested and improved, and new ones constructed.

The first flights into orbit were not flights in the traditional sense as there was no pilot to man the controls. It was due to the fact that the first computers were very bulky and heavy. The personnel on the ground was monitoring all aspects of the mission and had to be in constant communication with the spacecraft as it travelled through space, calculating velocities, trajectories and altitudes. They would collect data from on-board sensors as well as track information from ground control stations throughout the world, all communicating in real time.

With further development of manned space flights, a demand rose for on-board systems. Today computers are an integral part of all current spacecraft. They are used for guidance and navigation functions such as rendezvous, re-entry, and mid-course corrections, as well as for system management functions, data formatting, and attitude control. This transition has made it possible for current spacecraft to be more versatile. As missions change and become more complex, using software to adjust for the changes is much cheaper and faster than changing the hardware.

Thus, nowadays Information Technology and Computer Engineering are used at every stage of space flight – from research and development to spacecraft launching and operating, including:



- spacecraft guidance;
- automation for operations of manned space missions;
- advanced systems of data collection, processing and transmission by means of satellites for various purposes (meteorology, natural resources monitoring, navigation, etc.);
- global systems of satellite communication, television and radio broadcast, search-and rescue systems, and satellite navigation systems of communication with sea vehicles.

Moreover, Information Technology in cosmonautics is connected with acquisition, processing and using all types of information in space systems as well as with the necessity to protect this information while tackling particular problems during space flights.

2. Two words are often used in practically the same meaning – “**cosmonautics**” and “**astronautics**”. Do you know the difference between them? Find the relevant information in the Internet.

Can you guess the meaning of the term “**aeronautics**”?

3. One of the major applications of IT in cosmonautics is spacecraft navigation. Read Text B and find synonyms to the words in the box.

heliocentric	movement	obtaining	speed	place
give	precise	at the same time	fast	change

B. Spacecraft Navigation

Spacecraft navigation comprises two aspects: knowledge and prediction of spacecraft position and velocity (orbit determination) and firing the rocket motor to alter the spacecraft's velocity (flight path control).

A spacecraft on its way to a distant planet is actually in orbit about the sun, and the portion of its solar orbit between launch and destination is called the spacecraft's trajectory. Orbit determination involves finding the spacecraft's orbital elements and accounting for perturbations to its natural orbit. Flight path control involves commanding the spacecraft's propulsion system to alter the vehicle's velocity.

Since the Earth's own orbital parameters and motions are well known, the measurements the spacecraft's motion as seen from Earth can be converted into the sun-centered orbital parameters needed to describe the spacecraft's trajectory. The measurements made from Earth of the spacecraft's motion are:

- its distance or range from Earth,
- the component of its velocity that is directly toward or away from Earth, and
- its position in Earth's sky.

Some spacecraft can generate a fourth type of navigation data – optical navigation, when the spacecraft uses its imaging instrument to view a target planet or body against the background stars.

The basic factors involved in acquiring the navigation data are:

1) Spacecraft Velocity Measurement

Measurements of the Doppler shift of a [coherent](#) downlink carrier provide the radial component of a spacecraft's Earth-relative velocity.

2) Spacecraft Distance Measurement

A uniquely coded ranging pulse can be added to the uplink to a spacecraft and its transmission time recorded. When the spacecraft receives the ranging pulse, it returns the pulse on its downlink. The time it takes the spacecraft to turn the pulse around within its electronics is known from pre-launch testing.

3) Spacecraft Angular Measurement

The spacecraft's position in the sky is expressed in the angular quantities Right Ascension and Declination.

Extremely accurate angular measurements can be provided by VLBI, Very Long Baseline Interferometry. A VLBI observation of a spacecraft begins when two DSN (Deep Space Network) stations on different continents track a single spacecraft simultaneously. High-rate recordings are made of the downlink's wave fronts by each station, together with precise timing data.

Language Focus

1. Look at the two lists of words and make possible combinations using one word from each list.

e.g. *propulsion system*

propulsion	}	front
high		ascension
mathematical		component
navigation		data
radial		model
ranging		precision
precise		pulse
wave		system

Check yourself against Text B.

2. Match up the following terms with their definitions.

- | | |
|--------------------------------------|--|
| 1. perturbation | A. a method of improving angular resolution in the observation of radio sources; these are simultaneously observed by two radio telescopes which are very far apart, and the signals are recorded on a computer |
| 2. optical navigation | B. a sharp transient wave used to measure the distance from the object being tracked |
| 3. Doppler shift | C. an imaginary surface joining all points in space that are reached at the same instant by a wave propagating through a medium |
| 4. ranging pulse | D. change in the apparent frequency of a wave as observer and source move toward or away from each other |
| 5. Right Ascension | E. deviation of a celestial body from a regular orbit about its primary, caused by the presence of one or more other bodies that act upon the celestial body |
| 6. Very Long Baseline Interferometry | F. the celestial equivalent of longitude. The angular distance of a celestial body, measured eastward from the vernal equinox along the celestial equator to the hour circle of the body and expressed in degrees or hours |
| 7. wavefront | G. the use of onboard imaging to aid in the determination of the spacecraft trajectory |

1		2		3		4		5		6		7	
---	--	---	--	---	--	---	--	---	--	---	--	---	--

3. Find and circle the word in each group below that has a different underlined sound to the others.

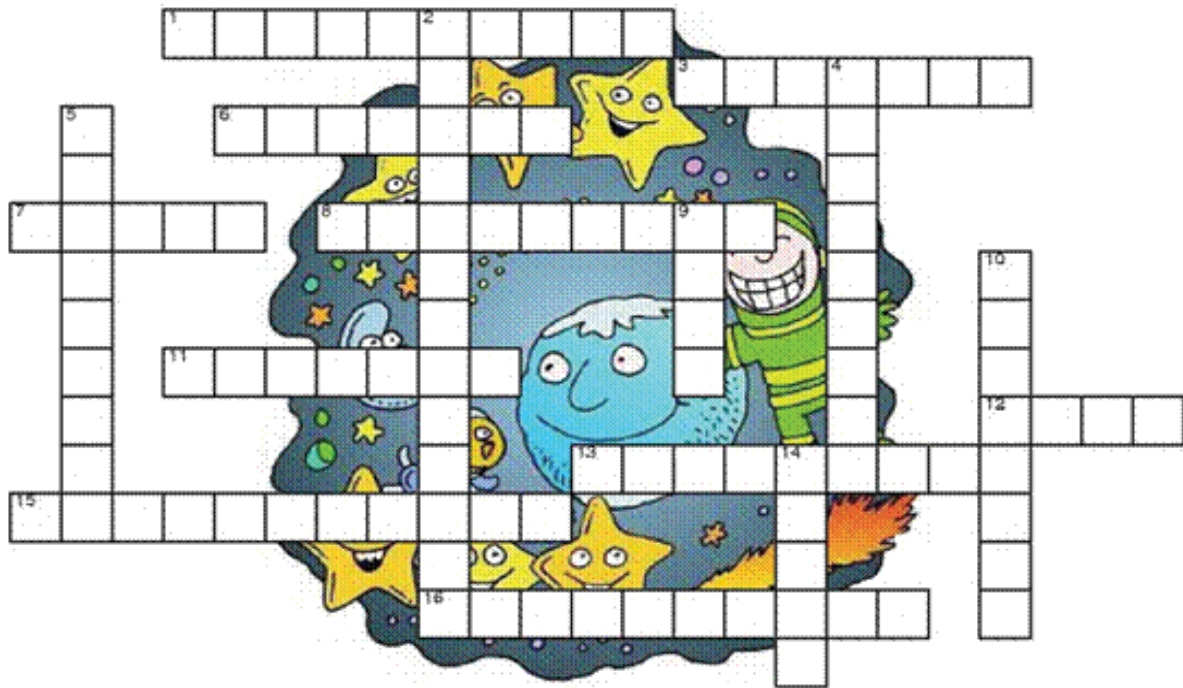
1. spacecraft pulse single position basic
2. hardware history vehicle coherent high
3. velocity circle receive precise celestial
4. range generate image target engineering
5. rocket motor motion component control
6. uplink function construct use adjust
7. aspect data factor angular satellite
8. path fourth Earth mathematical together

4. Rearrange the words to make sentences.

1. purposes / satellites / of / number / used / a / are / large / for
2. humans / a / spacecraft / no / on / robotic / with / board / is / spacecraft
3. the telescope / few / explore / space / before / had / people / to / the invention / of / tools
4. searching / to / a telescope / was / Sir Isaac Newton / for / the length / a way / of / reduce
5. galaxies / in / emitted / Karl Jansky / 1930's / radio / discovered / the / waves / that
6. advancements / led / major / and / breakthroughs / in / computers / have / research / to / space
7. work / telescope / does / space / the / Hubble / how / ?
8. supercomputers / for / what / used / are / ?
9. space / a / exploration / what / role / in / critical / plays / ?

5. Complete the following *Space Crossword Puzzle*.

Space Puzzle



Across

1. the high curving line in which an object moves
3. a flight into space
6. any of a series of satellites launched by the Soviet Union beginning in 1957
7. a person or creature from a planet other than Earth
8. the scientific study of the stars, planets, and other objects in the universe
11. a vehicle that travels into space and back to Earth and lands like a plane
12. a group of people with a particular skill to work together
13. a piece of rock that has fallen from space and landed on the ground
15. a place where someone or something is going
16. the skill of choosing a path so that a vehicle can go in a particular direction

Down

2. a group of stars in the sky named after the pattern they form
4. a piece of equipment used for training people to operate a vehicle by imitating the situations they will have to deal with
5. a piece of equipment shaped like a tube that you look through to make distant objects look closer and larger
9. the object similar to a planet that goes round the Earth and that you can see shining in the sky at night
10. one of the earliest known digital computer games
14. the path taken by an object moving around a larger object in space

6. Do you remember the three forms of the following irregular verbs?

<i>be</i> _____	<i>was/were</i> _____	been
_____	became	_____
begin	_____	_____
_____	did	_____
draw	_____	_____
_____	_____	found
_____	flew	_____
get	_____	_____
_____	_____	given
_____	grew	_____
have	_____	_____
keep	_____	_____
_____	_____	known
_____	lay	_____
lead	_____	_____
_____	made	_____
mean	_____	_____
_____	_____	seen
_____	took	_____

Comprehension Check

1. Read the article about how the world's space agencies use *nanotechnology* – a branch of engineering that deals with design and manufacture of extremely small electronic circuits and mechanical devices built at the molecular level of matter (a nanometre is one billionth (10^{-9}) of a metre, which is only the length of ten hydrogen atoms, or about one hundred thousandth of the width of a hair).

Nanotechnology Can Launch a New Age of Space Exploration

Nasa and the European Space Agency have some ambitious plans where nanotechnology will undoubtedly play a key role. Launching equipment into space is an expensive business: it costs \$10,000 to lift every 0.45kg of stuff into orbit. Making things smaller and lighter is, therefore, a natural route to reducing the cost of launching a spacecraft. It is no surprise then that the principles of nanotechnology – and the potential to reduce the mass and size of spacecraft and payloads – are focusing the minds of space engineers. When nanotechnology is really developed, even countries that don't presently think about space will be able to afford space exploration.

Taking its first step towards nano-sized instruments, Nasa has developed a sensor the size of a postage stamp that can detect toxins in the air. The sensor could also be modified to sample liquids and provide instantaneous analyses and diagnoses. If manned Mars missions were ever to become a reality, such capabilities would be vital.

The European Space Agency (Esa) has also been studying the potential of nanotechnology. Nanoengineering could produce surfaces that regulate spacecraft temperatures more efficiently than the materials used today. It could also generate more efficient solar cells which would replace large panels.

While making smaller components is an obvious way to reduce the mass and power consumption of an otherwise conventional spacecraft, nanotechnology offers much more potential than that. A team assembled at Northeastern University (Boston, Massachusetts) in 2006, investigates concepts that could become possible within 50 years. The researchers hit upon two ideas. The first is a lightweight spacesuit more flexible than current garments. It would consist of three layers and be suitable for spending long periods of time exploring the moon or Mars. Being thinner, however, the potential for damage would be higher, so they investigate how to make it repair itself using self-assembling nanounits held inside the suit's layers. The nanounits would be based upon proteins and free to move along the suit layers. In the event of a breach, they would spill out, attaching to one another and building bridges across the damage. They could even carry emergency drugs to immediately treat any wound the astronaut may have suffered.

The team's second idea is a "spider's web" of hairline tubes that could be deployed across large tracts of a planet's surface. Inside the tubes would be an army of nanosensors that could measure the surface temperature and composition. Each web would span a dozen kilometres and be capable of sensing a planetary environment in great detail.

In space itself, nanotechnology-based missions hold great promise. Instead of general purpose spacecraft, hundreds or even thousands of identical microchip-sized spacecraft could perform highly specific tasks. At present, Esa uses four nearly identical spacecraft called Cluster to measure the Earth's magnetic field and gauge its response to solar storms. Large numbers of smaller, nanotechnology-based spacecraft, known as "nanosats", could do a more detailed job by "carpeting" a much wider volume of space to provide continual monitoring of magnetic behaviour with high sensitivity.

Such nanosats would be so small that any gravitational attraction to the Earth would easily be overwhelmed by other forces, such as the pressure of sunlight and the slightest drag of the Earth's highest atmosphere. This means that a nanosat would find it much easier to escape Earth's gravitational pull altogether, opening up new possibilities for propulsion.

(Abridged from *The Guardian*)

2. According to the text, are the following statements true or false?

1. Launching equipment into space costs a lot of money.
2. With nanotechnologies more countries would be able to take part in space exploration.
3. The nano-based sensors developed by Nasa can sample liquids and solids.
4. Spacecraft with nano-scale components consume more power than conventional spacecraft.
5. Lightweight supersuits are very strong and never break.
6. A "spider's web" can measure very large areas of a planet's surface.
7. Nasa uses four spacecraft called *Cluster* to measure the Earth's magnetic field.
8. Nano-satellites are too light to resist the Earth's gravitational attraction.

3. In Part 1 of this Unit we discussed the use of 3-D printers in aviation. Now go to the article *NASA Preparing to Launch 3-D Printer into Space* at http://www.siliconvalley.com/ci_24205573/nasa-preparing-launch-3-d-printer-into-space?IADID=Search-www.siliconvalley.com-www.siliconvalley.com about using 3-D printers during space flights.

Answer the questions:

- 1) What are 3-D printers supposed to serve as?
- 2) What three concepts can one get rid of having 3-D printers?
- 3) What challenges does space travel present to 3-D printing?
- 4) How could a 3-D printer have helped the *Appollo 13* team during the notorious breakdown in 1970?
- 5) Who helped develop 3-D printing technology in 1988?
- 6) What is the main limitation to the application of 3-D printers for space travel?

Listening

1. Go to the site of *Massachusetts Institute of Technology* at <http://video.mit.edu/watch/nanosatellite-ready-to-search-for-another-earth-64/>. Watch the video about a new nano-satellite developed by Draper Laboratory and MIT. Fill the gaps using the information from the video.

- 1) Researchers at Draper Laboratory in Cambridge, Massachusetts, and MIT have developed the first _____ to search for _____ outside our solar system.
- 2) The nano-satellite called _____ is the size of a _____ and packs _____ and new _____.
- 3) The satellite is looking for a kind of planet we call _____ going in front of their _____ the same as the Earth, and they cause a tiny drop in _____ of the stars as they go _____ the star.
- 4) The satellite has a volume of _____, it's _____ tall, _____ wide, and _____ long.
- 5) There are basically _____ of the spacecraft.
- 6) The front part, what we call the observatory, or the _____ aspect of it; then there's the _____: the _____ systems, the _____ systems; and the third one is the _____ aspect of it.
- 7) So, if you think about it, it's a plane, and you have _____ on it, so if the spacecraft is _____ in one _____, it is _____ in _____ degrees of _____ in order to be _____ on the same star.

Speaking

1. An opinion poll has been carried out at *The Debate.org* site on whether space exploration is worth the money. Read the comments of the people who took part in the poll at <http://www.debate.org/opinions/is-space-exploration-worth-the-money> and discuss your opinion on this point with your partner. You may also take part in the poll and send your comments.

Writing

1. Write a short essay (about 250 words) on one of the following topics.

- 1) Robots in space.
- 2) Achieving contact with intelligent life beyond our solar system.
- 3) Fighting the space junk problem.
- 4) Computer security in space exploration.
- 5) Space race and space collaboration.
- 6) The future of computer technologies in space exploration.
- 7) Artificial intelligence in space exploration.
- 8) Science fiction becoming science fact.
- 9) Faster-Better-Cheaper space exploration missions.

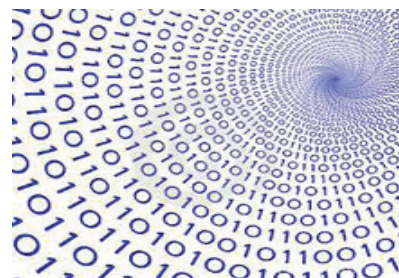
UNIT 3

Digital versus Analog

Lead in

1. What do you know about various ways of data transmission. Compare the text below with your ideas.

Data transmission is the process of sending data over a communication medium to one or more computing networks, communication or electronic devices. It enables data transfer in a point-to-point, point-to-multipoint and multipoint-to-multipoint environment.



Data transmission can be analog and digital. Communication systems based on analog signals dominated the first half of the 20th century. Starting in the early 1950s, however, the widespread availability of digital computers led to a digital revolution, which is now well under way. The technology ranges from popular gadgets to the sophisticated data-handling techniques of the synchronous satellites used in worldwide communications.

2. Work in pairs and discuss the following questions.

- 1) Which technique – analog or digital – is more efficient in terms of providing a better quality of data transmission?
- 2) Which transmission system is most likely to become the technology of the future?
- 3) What electronic gadgets would you prefer – analog or digital? Why? Think of as many arguments as possible to support your point of view.

3. Compare your views with those of other students. Do your opinions coincide or contradict?

4. Summarize your ideas and make a list of the most essential features and advantages of digital systems (consider the amounts of data to be transferred, the speed of transmission, a number of data channels required for transmission, the quality of a signal, noise immunity, etc.).

Vocabulary

1. Data transmission involves a set of special words and concepts. Some basic terms are given below. Match them up with the definitions on the right.

- | | |
|-----------------------|--|
| 1. multiplex | a. a telephone line or channel between two main offices or switching devices |
| 2. loop | b. the amount of detail that can be distinguished in an image; the degree of image sharpness measured by the number of pixels across and down on a screen |
| 3. increment | c. the use of a common communications channel for sending two or more messages or signals |
| 4. frequency-division | d. a distance that an object travels or is transported |
| 5. trunk | e. a method of transmitting and receiving independent signals over a common signal path by means of synchronized switches at each end of the transmission line so that each signal appears on the line only a fraction of time in an alternating pattern |
| 6. haul | f. a closed electric or magnetic circuit through which a signal can circulate or current flows |
| 7. time-division | g. the process of increasing in number, size, quantity, or extent |
| 8. resolution | h. a technique by which the total bandwidth available in a communication medium is divided into a series of non-overlapping frequency sub-bands, and each one is used to carry a separate signal |

2. Use the words from the box to complete the passage below.

continuous	bit streams	distortion	amplitude
multiplexers	discrete	communication medium	
networking	binary format	data exchange	

Analog and digital signals are used to transmit information. In both technologies the information, either audio or video, is transformed into electric signals. The difference between analog and digital technologies is that in analog technology information is converted into electric pulses of varying 1) _____ whereas, in digital technology, data is transformed into 2) _____ (zero or one) where each bit represents two distinct amplitudes.

An analog signal is any 3) _____ signal for which the time varying feature (variable) of the signal is a representation of some other time varying quantity, i.e. analogous to another time varying signal.

A digital signal uses 4) _____ (discontinuous) values. The digital data originates from the source device in the form of discrete signals or digital 5) _____. These data streams are placed over a 6) _____, such as copper wires, wireless carriers or optical fiber, for delivery to the destination device.

Transmission of digital signals is fixed in terms of amplitude. Transmitted data remains protected since the signals have more balanced structure. Analog signals, on the other hand, do not have any defined level of uniformity and controllability in terms of amplitude. As a result, these signals are more susceptible to 7) _____. This drawback significantly reduces the signal transmission for long distances. Moreover, these signals can be easily intervened and disturbed.

Digital signals are indispensable when information has to be sent for longer distance or the data is so significant that cannot be lost. In the field of communication, digital signals are used in cellular communications, internet 8) _____, high 9) _____ modes such as 3G, Bluetooth. In electronics, digital signals are applied in designing new codes for computer and mobile circuitry. Devices such as 10) _____, digital gates and other combinational and sequential circuit designs are some of the widespread applications of digital technology.

Reading

1. The following article is about the advantages of digital data transmission and networks. Read the article and highlight the arguments in favour of digital technology.

Digital Technology Benefits

The advent of digital electronic circuitry has brought revolutionary changes in the area of communication and industrial instrumentation. From early applications of digital computers in the 1960s to the first distributed control systems (DCS) in the 1970s and the “smart” transmitter revolution of the 1980s, digital technology has improved performance and expanded information-sharing capabilities of communications systems, measuring and control instruments.

One of the greatest advantages of digital technology over analog is the ability to communicate vast amounts of data over a limited number of data channels. In the world of 4-20 mA signaling each pair of wires can communicate only one variable. This one-signal-per-channel limit of 4-20 mA analog signals represents a technological “bottleneck” restricting data transfer between instruments and control systems. The data-rich capabilities of industrial instrumentation require a digital form of communication to overcome the drawback of analog 4-20 mA signals. With digital signaling, a single pair of wires or coaxial cable is able to convey a theoretically unlimited number of data points. This benefit comes at a price, though: in order to transfer multiple variables over a single channel (wire pair), we must transmit and receive those signals one at a time. This means a digital communications system will necessarily exhibit some degree of time delay in acquiring, transmitting, receiving, and interpreting a signal. Analog systems, by contrast, are virtually instantaneous.

With modern electronic technology, it is possible to create fast digital communication systems so that the time delays are negligible for most industrial processes, which renders the comparison— instantaneous versus time-delayed— insignificant. If time is no longer an issue, the advantage that digital communication has over analog in terms of channel usage makes it the superior choice. Another important advantage of digital data communication for industrial processes is increased noise immunity. Analog data is continuous by nature: a signal of 11.035 milliamps has a different meaning than a signal of 11.036 milliamps, because any measurable increment in signal represents a corresponding increment in the physical variable expressed by that signal. A voltage value in a 0-5 volt digital signaling system of 0.03 volts, however, means exactly the same thing as a voltage value of 0.04 volts: either one is interpreted as a “0” or “low” state. Any amount of electrical noise imposed on an analog signal corrupts the signal to some degree. A digital signal, on the contrary, may tolerate a substantial amount of electrical noise with no noticeable corruption.

Not surprisingly, though, the noise immunity enjoyed by digital signals comes with a price: a sacrifice in resolution. Analog signals are able to represent the smallest imaginable changes because they are continuously variable. Digital signals are limited in resolution by the number of bits in each data “word”.

With modern digital electronic technology, however, the “limited resolution” problem is of no importance. 16-bit converter chipsets available for input/output modules on digital systems provide a resolution, which is good enough for the vast majority of industrial measurement and control applications.

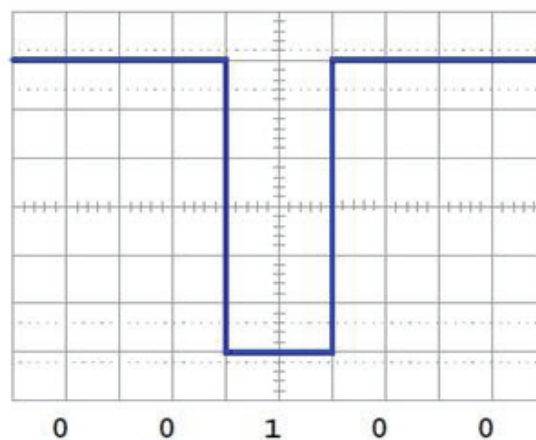
There are two techniques used for data transmission: serial and parallel. Serial transmission is the most applicable for industrial applications because for parallel transmission the number of wires matches the number of bits in each data “word”. Thus, parallel technique eliminates the “fewer wires” advantage of digital communications

and is rarely used in industry. In serial communications systems, digital data is sent over a wire pair (or fiber optic cable, or radio channel) one bit at a time.

To transfer digital data along a network, there must be an agreed standard between transmitting and receiving devices for encoding bits. A range of encoding methods are available, NRZ, Manchester, FSK being the most suitable for industrial networks.

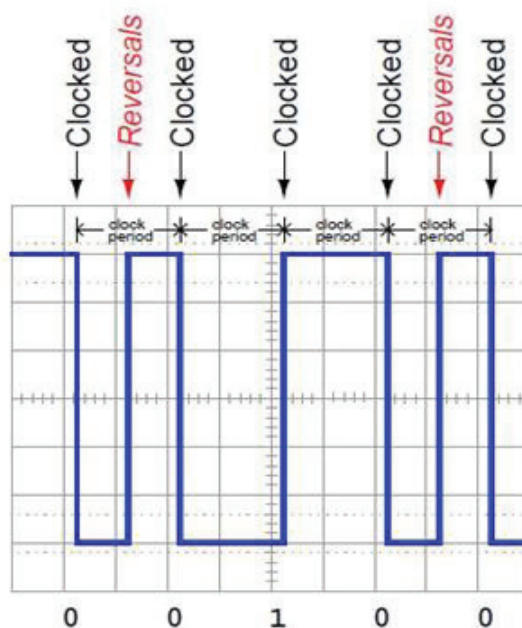
Digital communication standards represent binary “1” value as a “mark” state and “0” as a “space” state. “Marks” and “spaces” correspond to different voltage levels between conductors of the network circuit. This is referred to as Non-Return-to-Zero (NRZ) encoding.

Non-Return-to-Zero (NRZ) encoding



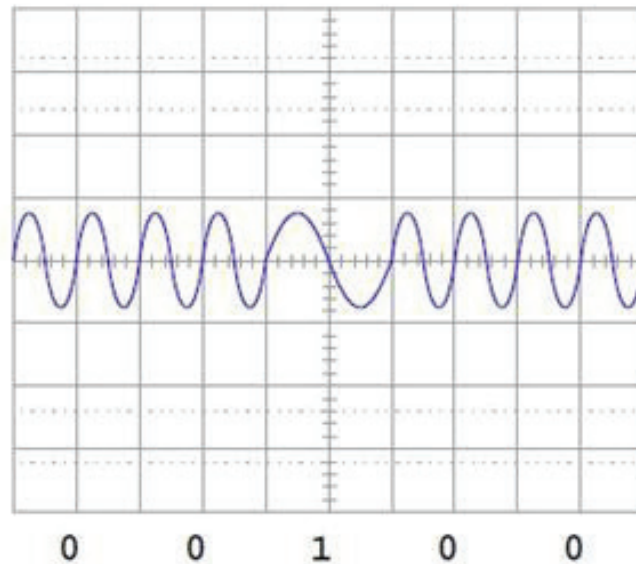
This is not the only way to represent binary bits, though. An alternative method is to use an oscillating (square-wave) signal, counting up and down transitions (pulse edges) at specific times to represent 1 and 0 states. This is called Manchester encoding.

Manchester encoding



Yet another method for encoding binary 1 and 0 states is to use sine waves of different frequencies (“tone bursts”). This is referred to as Frequency Shift Keying, or FSK, and it is the method of encoding used in the “smart” instrument communications standard.

Frequency Shift Key (FSK) encoding



Comprehension Check

1. Find words in the text that mean the following.

1. the speed and effectiveness of a machine or device
2. a specific problem in part of a process that slows down the whole process
3. the introduction of a new idea, product, technology
4. to succeed in dealing with or controlling a problem
5. to transfer data
6. to physically limit the movement of an object
7. a situation in which something happens later or more slowly than is planned or expected
8. to get something
9. a feature that allows not to be affected by something harmful
10. very unimportant or small
11. to recognize the difference between things
12. large in amount or degree

2. Match up the words below into pairs of opposites.

- | | |
|------------------|-----------------|
| 1. improve | a. continuous |
| 2. vast | b. parallel |
| 3. variable | c. corrupt |
| 4. benefit | d. limited |
| 5. instantaneous | e. important |
| 6. insignificant | f. sacrifice |
| 7. serial | g. time-delayed |

3. Complete the sentences to summarize the text.

- Digital electronic circuitry has revolutionized the areas of communication and industrial instrumentation because....
- Most significant benefits derived from digital technology are....
- Modern electronic technology enables to overcome some limitations that a digital communications system imposes, namely,
- Serial data transmission, as opposed to parallel, dominates industrial networks since....
- Encoding techniques such as are required for data transfer along a network.

4. Complete the table below.

System	Channel capacity	Speed	Noise immunity	Resolution
Analog				
Digital				

5. Work in pairs. Compare your ideas with those of your partner and discuss analog and digital system features. Decide on advantages that make digital technology a more perspective choice and think of feasible solutions to overcome digital transmission limitations.

Language Focus

1. You are going to read a text about two types of signals. Before you read, discuss the following questions with your partner.

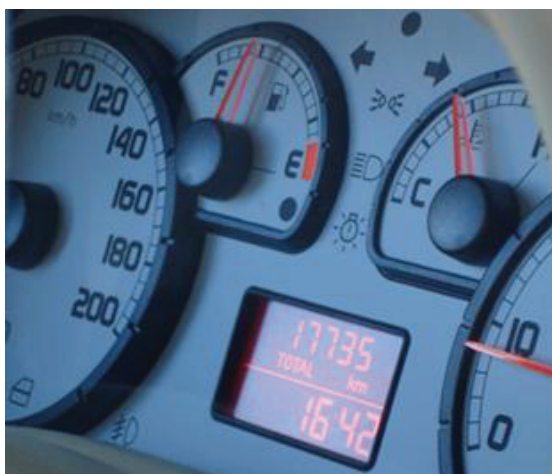
1. What is a signal?
2. What are the major differences between analog and digital signals?

2. Read the text quickly without paying attention to the gaps to check your ideas. What differences does the writer analyze?

3. Complete the text by filling in an appropriate word in each space. You need to use “grammar” words: articles, conjunctions, prepositions, auxiliary verbs, pronouns. There is an example at the beginning (0).

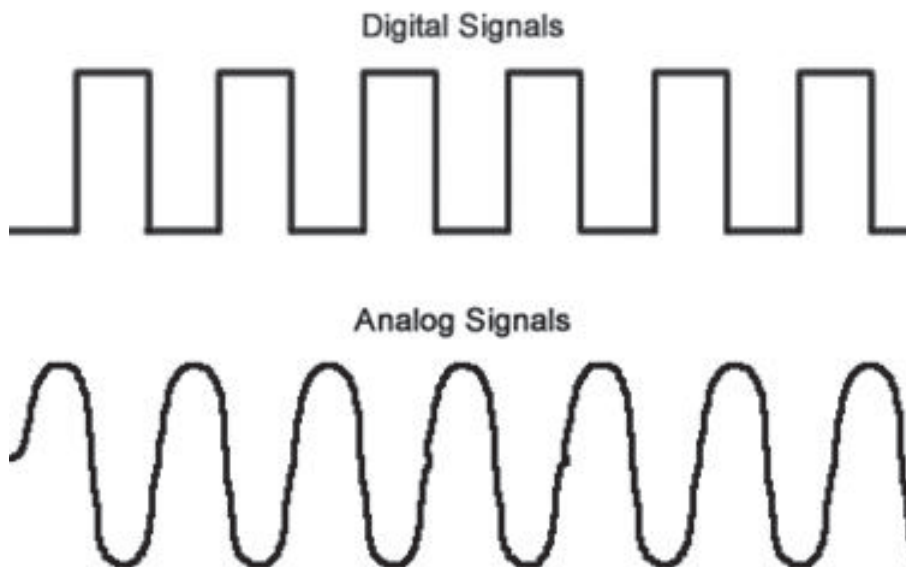
Basics of Analog and Digital Signals

A signal is a visual, audible or any other indication (0) or movement used to convey information. Signals are quite crucial to science and technology and divided 1)two classes: analog and digital. In an analog signal, 2)signal is varied continuously 3) respect to the information and can 4) identified at any instant. On the other hand, the information in a digital signal is encoded 5)discrete values, i.e. whole numbers. 6) , consider a sound signal to be measured in a time interval from 0 to 10 seconds. As for an analog signal, it is measured at 0, 0.5, 0.7, 1.5 seconds in values 7)are known as decimals, whereas a digital signal is only measured at discrete levels 8) 1, 2, 3, 4 in numbers that are not decimal.



Another characteristic that creates a significant difference 9)analog and digital signals is the amplitude limitation. Analog signals are independent of the bounds of amplitude. The amplitude depends 10)intensity of the input signal. In digital signals, the amplitude has only two states: ON and OFF. At the ON position, the signal has a high amplitude meaning it contains information 11)at the OFF state, the signal has a low amplitude, which usually means that no significant information 12)being conveyed through the signal.

In communication, analog signals are used when the data is to be sent over short distance. For analog signal transmission, 13) the transmitter and the receiver are located in the vicinity of each other so that information can be sent easily or the transmitter should have repeaters that repower data and transmit 14)to the next destination.



Digital signals are a processed form of analog signals created for communications purposes. To transform an analog signal to a digital one analog to digital converters (ADC) are used. The technical word for creating a digital signal out of an analog signal is called quantization. Analog signals are sampled at short intervals of time in order to be converted into digital. The rate at which they are sampled is called a sampling rate and for a proper conversion, the sampling rate is to be at least twice 15)fast the signal frequency. When the sampling rate is higher than the frequency, it is easy to digitize the signal and least amount of information is lost in the process.

4. Read the text about early digital communications systems. The sentences in the extract have been jumbled. Rearrange them in the correct order to make up a meaningful text.

- 1) A similar code system called the Continental Code was used for early radio communications.
- 2) In the days when human operators sent and interpreted Morse and Continental code messages, the standard delimiter was an extra time delay (pause) between characters and between words.
- 3) Morse code used for communicating alphanumerical information over telegraph systems was an early form of digital transmission.
- 4) The paper strips were then read electrically and converted into a serial stream of on-and-off pulses, which were transmitted along standard telegraph circuit lines.
- 5) Though being primitive, those codes incorporated basic principles for modern digital serial communications systems.
- 6) Each letter in the alphabet and each numerical digit (0-9) was represented in Morse code by a specific series of “dot” and “dash” symbols, a “dot” being a short pulse and a “dash” being a longer pulse.
- 7) Not only could unskilled operators use teletype machines, but also the data rate far exceeded what the best human operators could achieve.
- 8) The line would be either energized or not corresponding to marks or spaces made on the teletype paper.
- 9) First, a system of codes is required to represent letters and numbers to spell messages.
- 10) In later years, when teletype machines were designed to replace skilled operators, the concept of frame delineation became more crucial.
- 11) Telegraph systems were Boolean in nature representing “dots” and “dashes” by one electrical state of the telegraph line and pauses by another.
- 12) Next, some means must be employed to distinguish individual groups of bits (generally called frames or packets) from one another not to lose their meaning.
- 13) When key switches actuated manually were abandoned in favor of teletype machines, and Morse code was replaced by the Baudot (5-bit) code for representing alphanumeric characters, the electrical nature of the telegraph remained the same.
- 14) However, these machines required special “start” and “stop” signals to synchronize each character transfer, since unlike human operators they could not interpret pauses.
- 15) Those machines included a typewriter-style keyboard, which marked either paper strips or pages with dots corresponding to the 5-bit Baudot code.
- 16) A matching teletype machine at the receiving end converted the signal stream into printed characters (a telegram).

5. Evidently, in spite of their drawbacks early communications systems laid the groundwork for modern technologies. Work with a partner and discuss why those systems are regarded as the precursors of digital transmission.

6. Establishing methods for multiple devices to share access to a common communications channel is one of the crucial issues to consider before digital apparatus can transmit information to one another.

Read the extract below that addresses this problem. Seven sentences have been removed from the text. Choose from the sentences (A-H) the one, which fits each gap. There is one extra sentence you need not use.

Channel Arbitration

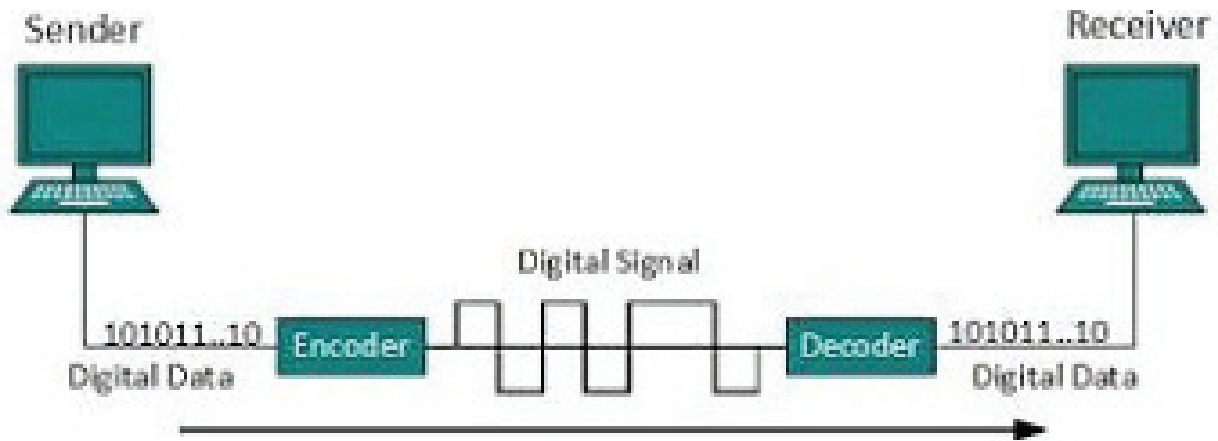
When two or more communication devices exchange data, their communication may be classified into one of two categories: simplex or duplex. A “simplex” network is one-way communication. 1) _____. A public-address system is another example of a simplex communication system, since audio information goes only in one direction (from the person with the microphone to the audience).

2) _____. Voice telephony is an analog example of two-way (duplex) communication, where any person at the receiving point can hear the other person talking.

3) _____. In a full-duplex system, both devices may transmit data to each other simultaneously because they have separate channels (separate wires, or optical fibers, or radio frequencies) for their respective transmissions. 4) _____. A telephone system is an example of a full-duplex system. A push-to-talk radio system (“walkie-talkie”) is an example of a half-duplex system, where each person must take turns to talk.

Most industrial data networks are half-duplex. When more than two devices share a network, there is lack of data channels to allow all of the devices to transmit and listen to each other simultaneously. 5) _____.

In half-duplex systems, there must some way to “inform” devices when they are allowed to transmit. 6) _____. The problem is analogous to two people pressing the “talk” buttons on their two-way radio units at the same time: neither of them can hear one another, and anyone else on this channel hears the garbled amalgam of those two persons’ superimposed transmissions. 7) _____. The problem of deciding “who” is allowed to “talk” at any given time is generally known as channel arbitration.



- A. In a half-duplex system, only one device may transmit at any time because the devices must share a common channel.
- B. In order to avoid this scenario in a half-duplex network, there must be some strategy to coordinate transmissions so that only one device may “talk” at a definite moment.
- C. A sensor outputting digital data to a remotely located indicator over a digital network is an example of simplex communication, where the flow of information goes from sensor to indicator, and never the other direction.
- D. Thus, virtually any network supporting more than two devices should be half-duplex and may be limited to simplex operation in some cases.
- E. Duplex communication refers to two-way data exchange.
- F. Once the data is transmitted, all slave devices may receive that transmission, since they all “listen” to the same communications channel.
- G. If multiple devices sharing one communications channel attempt to transmit simultaneously, their messages will “collide” in such a way that no device on the network will be able to interpret either message.
- H. Duplex communication is further subdivided into half-duplex and full-duplex, referring to whether the two-way communication is simultaneous or not.

Speaking

1. Work in groups of four. You are participants of a TV programme on Discovery Channel.

One of you is an interviewer; the others are representatives of a prosperous electronics company, scientific-research institute and large industrial enterprise. The debate will be dedicated to achievements in communications systems and perspectives for data transmission technology development.

Brainstorm relevant questions to be discussed, points of view, causes and effects, arguments and counterarguments. Make a presentation of your programme to the group. Decide whose programme is the most interesting and informative.

Writing

1. A popular scientific periodical, whose aim is to get young people interested in science and technology by informing them about breakthroughs in these areas, invites articles on the most promising scientific concepts, remarkable discoveries and significant technological advances.

Write an article about data transmission technologies for this periodical in which outline their features, performance, advantages and drawbacks, perspectives.

Before you start writing, think of

- your target reader,
- the style that would be suitable for this article (formal, informal or neutral),
- information it should contain,
- features you can use to make the article interesting for your readers (e.g. an attention-grabbing title, an interesting beginning, questions to encourage the readers to think, clear and strong opinions, a thought-provoking ending).

2. Write a plan. Write an article following your plan. Write 180-200 words.

UNIT 4

Digital Carrier Systems

Lead in

1. Data transfer can be implemented by carrier techniques or voice-frequency transmission.

Work with your partner and discuss advantages of carrier technology over voice-frequency transmission (consider the factor of economy – the number of channels needed to transmit data, cost of transmission, accuracy, reliability).

Work with another pair. Compare your ideas and decide which technique is more efficient.

2. Select some words that you would expect to find in an introductory text about transmission systems.

carrier	level	wire	power	supply
channel	interference	error		bandwidth
capacity	loop	modulation		spectrum
frequency	wave	conversion		range
speed	trunk	format		code

3. Add some more words related to data transmission systems. Make up sentences on the subject using the words from your lists.

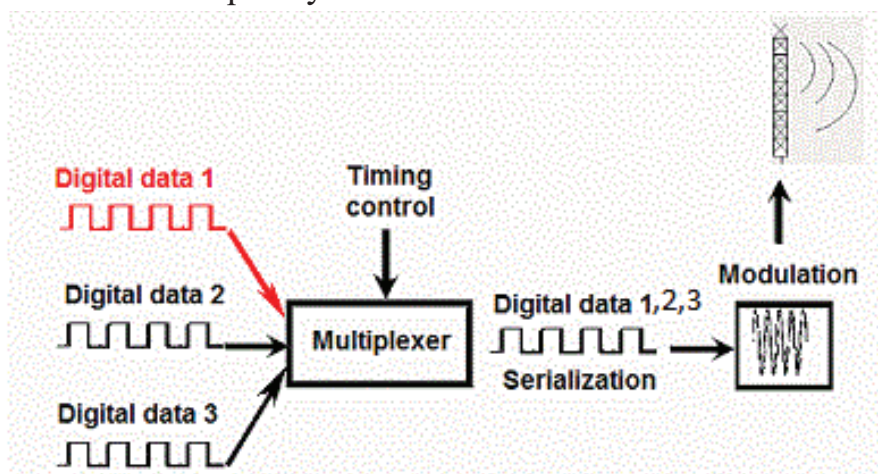
Reading

1. You are going to read a text about transmission systems. First, look through the text and decide which paragraphs are about these subjects:

- Digital carrier system application
- Telecommunication transmission procedure
- Digital transmission system operation
- Carrier technique advantages

2. Read the text more carefully and see if you find the words you selected.

- A. A telecommunication transmission link can be either a loop, which connects a user with a serving office, or a trunk, which connects two offices. Telephone transmission is implemented at voice frequency, or a number of voice-frequency channels can be multiplexed together using frequency-division techniques (analog carrier) or time-division techniques (digital carrier). The multiplexed signal can then be transmitted over guided wave media, such as wire and optical fibers, or through free space as in radio systems.
- B. The advantage of carrier techniques over voice-frequency transmission consists in the greater economy due to carrying many channels on a single medium element. Though *this* reduces the cost per channel mile, the cost is incurred in multiplexing the channels for transmission. Therefore, at first carrier systems were applied on long routes with many channels. Lower-cost digital multiplexers introduced in the early 1960s made it possible to use digital carrier in the exchange area under 50 miles. Digital carrier with digital switches eliminates the cost of digital-to-analog conversion *that* is required for a voice frequency or analog trunk and can be more economical than voice-frequency transmission.



- C. The first digital carrier was the 24-voice channel 1.544 Mb/s T1 system introduced in the USA in 1962 for short-haul (up to 50 mi) application. The major advantages of T1 over short-haul analog systems were the lower-cost terminals due to the ease of handling signal information on a digital system, a single codec (coder-decoder) sharing along 24 channels, and the economy of time-division multiplexing. T1 and subsequent higher-speed digital systems on a pair of coaxial cable and optical fiber dominated short- and medium-haul trunk applications for some years, and loop carrier was successfully introduced to loop applications. Digital fiber-optic systems have higher capacity and are much cheaper than analog coaxial systems. Fast development of digital systems – particularly in short- and medium-haul applications – have been urged by the need for digital connectivity arising from consumer requirements and the widespread use of digital switches.

D. Voice channels are converted to digital form and multiplexed into 24– or 30-channel digital groups in a primary pulse code modulation (PCM) multiplex also called a digital channel bank. If the channels are in digital form in a digital switch, the format for transmission is performed in an exchange terminal. The resulting primary-rate signal might then be transmitted directly to another switch or multiplexed with other signals to a higher rate before transmission. This multiplexing may be performed in separate multiplex or by the transmission system proper. The functions available in the terminal equipment of various transmission systems include monitoring of digital errors in transmission, power feeding for line repeaters, techniques for locating a defective line repeater, automatic switching to spare equipment (line or terminal) in case of failure. Other functions are automatic insertion of special signals (called AIS for alarm indication signal or “blue” signals) in case of loss of normal signal, generation of office alarms, and system-status reporting to central maintenance locations.

Comprehension Check

1. Which of these makes the best title for the whole text?

1. Transmission Systems for Telecommunication.
2. Transmission System Principles.
3. Transmission Systems – Overview.
4. Digital System Design and Operation.

2. Think of your own title for the text.

3. What do these words refer to?

1. *this* (paragraph B)

- a) voice-frequency transmission b) carrier techniques c) economy

2. *that* (paragraph B)

- a) an analog trunk b) digital-to-analog conversion c) digital carrier

3. *arising* (paragraph C)

- a) digital connectivity b) short-haul applications c) need

4. called (paragraph D)

- a) a primary PCM multiplex b) digital form c) digital groups

5. directly (paragraph D)

- a) transmission b) transmitted c) multiplexed

4. According to the text, are the following statements true or false? If they are false, explain why.

1. Similar multiplexing techniques are used for both analog and digital carrier.
2. Carrier techniques allow carrying many channels on a single medium, and consequently, provide greater economy than voice-frequency transmission.
3. Carrier technology is suitable only for long-haul applications.
4. High-speed digital systems dominated short- and medium-haul trunk applications for some years because of significant advantages over analog systems.
5. Consumers prefer analog systems rather than digital ones.
6. A primary pulse code modulation multiplex or a digital channel bank is one of the essential components for the process of converting voice channels to digital form.
7. The terminal equipment of a transmission system performs a very limited number of functions.

Language Focus

1. Fill in the gaps in the sentences below with the appropriate form of the words given.

1. transmitted, transmitting

Once data are a).....in pulsed form at an appropriate repetition rate, the advantage is that the same channel may be used for b)..... of several sets of information by time-multiplexing technique.

2. obtained, obtaining

The designer must evaluate all means ofthe desired system performance.

3. made, making

Better characteristics can be achieved bythe equipment more durable, mechanically and electrically.

4. transmitted/transmitting, received/receiving

In most systems a single antenna is used for both a).....and b)..... .

5. been, being

The instrument has the additional advantage ofvery simple and inexpensive in construction.

6. developed/developing, applied/applying

Nowadays innumerable components and systems are a).....for b).... in telecommunication and data– processing as well as in radio and TV.

7. proposed/proposing, based/basing

A new a).....worldwide telecommunications system b)..... on transmitters in space has the ability to connect two people anywhere on the globe.

8. spaced/spacing, linked/linking

The system includes 77 satellites uniformly a)..... 475 miles above the earth and b).....by digital signals to form a cellular network.

2. Telecommunication has merged with computer technologies to make the entire spectrum of voice, data, and graphics available. Read the text about Teletext and Videotex systems and decide which answer A, B, C, or D best fits each space. There is an example at the beginning (0).

Teletext and Videotex are information communications systems, which provide (0) B to visual (text or graphics) information.

Teletext is based on a broadcast capability (airwave or cable). Frames are transmitted as coded data rather than in video form to 1)... equipped television receivers. A large number of these frames are continuously transmitted from an information-storage 2)... in cyclic order during the vertical blanking interval of an in-use television channel or in an 3)... unused video channel. A user typically selects the frame or frames desired for viewing by 4)... frame-identification numbers on a key pad. The receiver 5)... the data signal associated with the desired frame from the overall bit stream. The data signals are then decoded, and information is stored in the Teletext receiver 6)... display on a television set.

Videotex is based on a two-way 7)... telecommunications system network (telephone or data). Information can be displayed on 8)... television sets or on special-purpose

data-display terminals. Information is transmitted as modulated data bi-directionally between the 9)... and the information source, which consists of a computer system and associated databases. A user selects the desired information 10)... the terminal input device, typically a key pad or a keyboard. User-to-user communications are possible with Videotex 11)... the use of telecommunications networks for transmission.

Although Teletext service has a greater transmission bandwidth and hence higher data-transmission speed than Videotex service, the total number of frames 12)... from the information source is much smaller due to the limited time a user is willing to wait for the desired frame to be “captured” from the continuously transmitted 13)... of frames. On the other hand, Teletext allows 14)... information access by a virtually unlimited number of users, while Videotex service has a limited simultaneous user capability due to 15)... on the information source unless additional computers are provided.

- | | | | |
|------------------|-----------------|-----------------|----------------|
| 0. A input | B <u>access</u> | C source | D feedback |
| 1. A suitably | B properly | C substantially | D efficiently |
| 2. A device | B equipment | C utility | D facility |
| 3. A entire | B whole | C complete | D overall |
| 4. A pushing | B typing | C entering | D arranging |
| 5. A eliminates | B extracts | C selects | D sorts out |
| 6. A to provide | B to generate | C to permit | D to hold |
| 7. A connected | B transmitted | C fed | D switched |
| 8. A modified | B varied | C updated | D transformed |
| 9. A display | B terminal | C storage | D processor |
| 10. A through | B by means of | C across | D via |
| 11. A because of | B owing to | C thanks to | D according to |
| 12. A suitable | B available | C appropriate | D sufficient |
| 13. A stream | B flow | C array | D chain |
| 14. A the same | B continuous | C simultaneous | D permanent |
| 15. A supplying | B loading | C communicating | D transferring |

3. The article below is about the digital flight data recorder, the system that is vitally important for preventing aircraft accidents. While reading the article, complete it using the words and phrases in the box.

an applied load force crash-proof container
recording media similar circumstances a binary
signal to determine a sonar transmitter a
crucial component moving parts filtration an
analog format sensors

Digital Flight Data Recorders

A flight data recorder is a system designed to collect and record data from a variety of 1)..... . These sensors are mounted throughout the aircraft to pick up data from appliances, components and co-dependent systems. All of this data is collected and stored digitally within a reflective, fluorescent yellow or orange 2)..... .

The collected data is critical in assisting accident investigators to understand what went wrong and caused an aircraft accident, especially if there are no survivors. Obviously, without this information there is a high probability that a similar accident might occur on another aircraft under 3)..... .

The Digital Flight Data Recorder (DFDR) provides data for designing the faults that are most likely to cause a catastrophe. Thus, it allows eliminating a disastrous repeat of accidents. Another benefit of the DFDR system is that it can become 4).....in a condition monitoring and reliability program.

The DFDR must meet a set of requirements, a high degree of “crashworthiness” being of vital importance. The unit must withstand a momentary shock force and a static crushing force at all of its six axis points of 5).....of 5,000 lbs for 5 minutes on each axis. It is also required that these units are mounted within the tail area of an aircraft, away from the potential crushing force of engines mounted nearby. The DFDR must be watertight to a depth of 20,000 feet in seawater, and survive at this depth for 30 days. It must be fitted with an underwater locator beacon which will act like 6).....sending a signal through the water that it might be laying in.

The first FDR was invented in 1939 and developed into a useable flight unit in the late 1940s. The first systems were quite simple because they were entirely electro-mechanical units with a foil as the 7).....and five styluses that scratched readings for Heading, Altitude, Airspeed, Vertical Acceleration and Time on one side of the foil. Soon this system was enhanced by adding three more styluses on the opposite side of the foil for Pitch, Roll and Flap information (total eight parameters).

With the arrival of the digital unit both the survivability and reliability of this valuable monitoring system radically improved thanks to the elimination of tapes, drive motors, belts, and all other 8).....that were necessary with all previous versions.

Prior to the introduction of the DFDR, all data was recorded and stored in 9).... . Analog data transmission systems easily pick up any noise along its transmission wiring caused by poor insulation, local interference and random thermal vibrations of the atomic particles in the wire conductors as well. All variations to the original analog signal appear as noise. As the signal is transmitted over long distances, this noise if not filtered ultimately degrades the signal sent from the parameter sensor. Digital data transmission systems convert the input data into 10)..... , i.e. a square-wave signal that is a pulse representing either an “on” or “off”, or a “1” or “0”. This digital signal is not affected by noise, and therefore delivers pure, unaltered data to the receiving DFDR without the need for 11).... , and the fear of losing signal data.

Every data input signal sent through a wire channel for a specific monitored system component or condition is called a parameter. The Type 1 DFDR records all of the parameters required 12).... accurately the aircraft’s flight path, speed, attitude, engine power, configuration and operation. The Type 2 and 2A in addition record configuration of lift and drag devices.

Today, the internationally recognized standard for digital data transmission on-board aircraft through an open digital-data-bus is ARINC standard 429, which employs unidirectional transmission of 32– bit words over two-wire twisted pairs.

ARINC is also the inventor and developer of the Aircraft Communications Addressing and Reporting System (ACARS), along with the concept of reliability analysis as it relates to Mean Time Between Failure (MTBF) for avionics systems.

(The extract from the article by Jeremy Cox, a former pilot and aircraft engineer, currently Vice President at Jet Brokers, Inc., a professional aircraft sales company).

Speaking

1. Imagine that you work for a company manufacturing digital systems for industrial applications. Your team of three or four people is responsible for developing a strategy for your latest product promotion to the market. Your team's tasks are:

- a) Decide on your target customers.
- b) Prepare a presentation for a focus group to inform potential customers about benefits of a product (its technical characteristics, performance, price, etc.).
- c) Make a plan for your company's advertising campaign specifying which advertising media (newspapers, specialized magazines, Internet, television, radio, posters and mail) to use to communicate your message.

Writing

1. Working in groups, write a script for a commercial to be broadcast on TV, radio or the Internet to advertise your product.

Think of a slogan for a product and possible effects (music, sounds) in addition to a voice to make your commercial more attractive and persuasive.

2. Role-play your commercial to the group.

UNIT 5

Avionics: On-Board Electronic Devices

Lead in

1. Operation of an aircraft is a very complicated process and a pilot needs an important information on different stages of flight.

a) Think what information would be necessary to a pilot when he is taking off, landing or cruising.

Make a list of on-board electronic devices which in your opinion provide a pilot with essential information.

b) Work in pairs. Compare your list of electronic devices with that of your partner. Discuss the differences and similarities in your lists.

Vocabulary

1. Match the key English words with their Russian translation.

- | | |
|----------------------------|--------------------------------------|
| 1. flight data recorder | a. взлет |
| 2. vehicle | b. преимущество |
| 3. take-off | c. отказ, авария |
| 4. altitude | d. твердотельный прибор |
| 5. landing | e. бортовой самописец, «черный ящик» |
| 6. range | f. данные, сведения, информация |
| 7. failure | g. дальность полета |
| 8. data | h. высота |
| 9. accurate | i. точный |
| 10. cruising | j. посадка, приземление |
| 11. advantage | k. летательный аппарат |
| 12. performance | l. авиадиспетчер |
| 13. solid-state device | m. полет с крейсерской скоростью |
| 14. traffic | n. летные характеристики |
| 15. trim | o. движение воздушного транспорта |
| 16. air traffic controller | p. балансировка |

Reading

1. Read the text below and compare information with your ideas.

All electronic systems used on aircraft, artificial satellites and spacecraft are called avionics. Avionic systems include communications, navigation, the display and management of multiple systems and the hundreds of systems that are fitted to aircraft to perform individual functions.

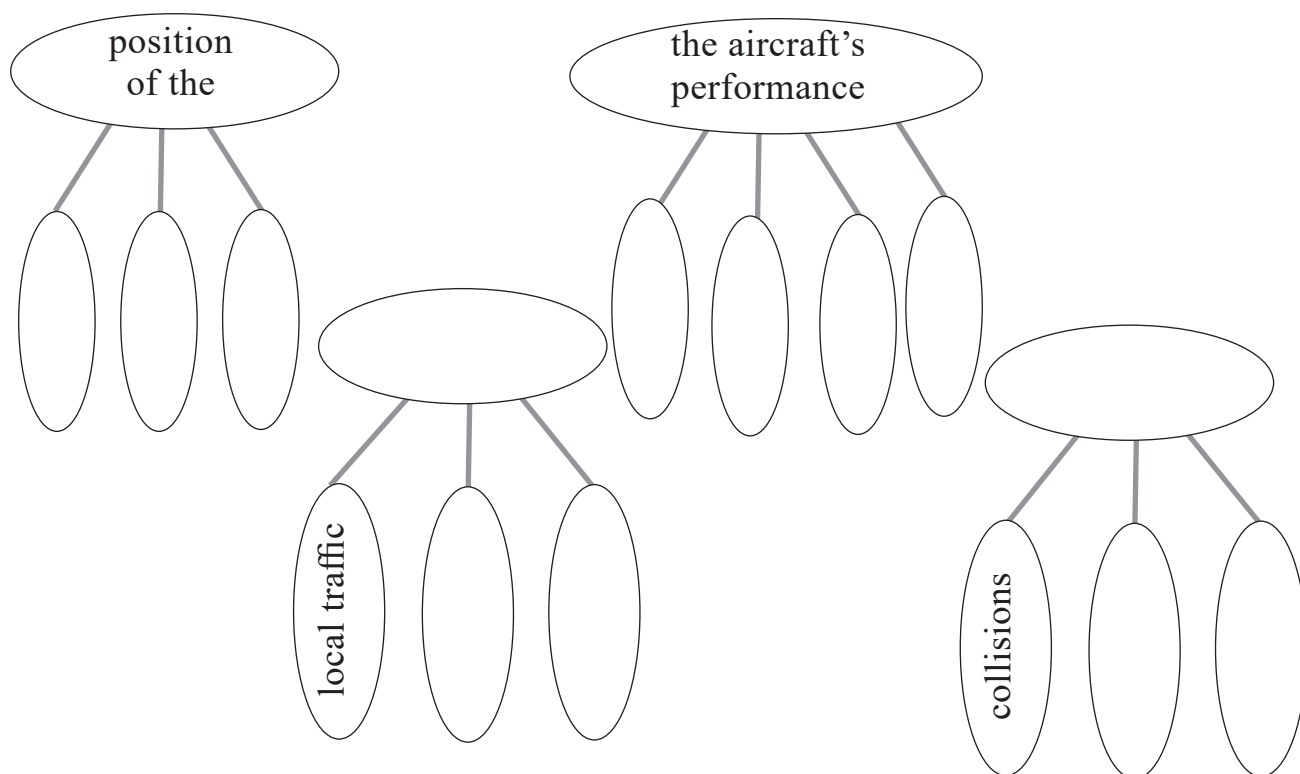
Any pilot has to know main information on take-off, landing and in flight including: a) the position of the vehicle (altitude, distance to destination, distance to departure point); b) the performance of the aircraft (airspeed, trim, range, fuel supply); c) outboard conditions (wind/ground speed, local traffic, weather conditions); d) possible extraordinary situations (collisions, fire, electrical system failure), etc.

Special on-board devices indicate Airspeed (how fast plane is going), Direction, Distance from departure cite, Fuel supply, Engine speed etc. Communication systems help pilots to speak to air traffic controllers. There is a flight data recorder which fixes all on-board happenings during a flight. At present practically all devices installed on aircraft for control, measuring and communication are digital. Many digital instruments are solid-state devices. They don't have any moving parts, they withstand high temperature, high pressure and mechanical shocks. They are accurate and simple in usage. In general all these characteristics make digital devices more suitable for use in aircraft.

Comprehension Check

1. Using the text and the words in the box fill in the diagram on different aspects in flight and the information a pilot needs.

fuel supply, outboard conditions, trim, wind/ground speed, ~~the aircraft's performance~~, distance departure point, ~~collisions~~, ~~position of the vehicle~~, electrical system failure, range, altitude, ~~local traffic~~, fire, distance to destination, air speed, extraordinary situation, weather conditions



Language Focus

1. Read the following quotes from different sources of information which give definition and the most accurate explanation of avionics notion. Decide which of them are the most acceptable and share your views with your group mates.

American Heritage Dictionary:

avionics (n)

1. (used with sing. verb)

The science and technology of electronics and the development of electronic devices as applied to aeronautics and astronautics.

Example: **Avionics** has become even more important with the development of the space program).

2. (used with a pl. verb)

The electronic systems, equipment, and other devices so developed.

Example: **The avionics** on this spacecraft represent a new generation of sophistication.

Columbia Encyclopedia:

avionics – electronic instruments used in air or space flight; also the design and production of such instruments. Early planes had few instruments, but as aviation and aircraft became more complex, so did instrumentation. Most of the new technology was electronic; hence, the expression “aviation electronics” arose and later shortened to “avionics”. Avionics includes numerous types of devices, including those used for navigation; control instruments that aid in steering and controlling the craft; and performance indicators, such as altimeters and velocity gauges.

Science Q & A:

avionics, a term derived by combining aviation and electronics, describes all of the electronic navigational communications and flight management aids with which airplanes are equipped today. In military aircraft it also covers electronically controlled weapons, reconnaissance, and detection systems. Until the 1940s, the systems involved in operating aircraft were purely mechanical, electric or magnetic, with radio apparatus being the most sophisticated instrumentation. The advent of radar and the great advance made in airborne detection during World War II led to the general adoption of electronic distance-measuring and navigation aids. In military aircraft such devices improve weapon delivery accuracy, and in commercial aircraft they provide greater safety in operation.



Mc Graw– Hill Dictionary of Aviation: **avionics**

A field of applied research in which electronic devices are adapted to use in aviation. Avionics are aeronautical electronics, not necessarily restricted to aero-dynes only. Although the term implies use of equipment in airborne applications only, it also extends to ground-based equipment like radar and surface-to– air weapons.

Scheme of Avionics



(<http://www.answers.com/topic/avionics>)

2. Study the following English names of the main instruments used in pilot's cabin and their Russian equivalents.

- 1 air speed indicator – указатель воздушной скорости
- 2 gyro compass – гироскоп (прибор для ориентации в пространстве)
- 3 altimeter – альтиметр, высотомер
- 4 vertical speed indicator – указатель скорости набора высоты
- 5 attitude indicator – указатель пространственного положения
- 6 turn coordinator – устройство для разворота

3. Choose the correct name of the instrument given in the list above and insert it in the gap of each paragraph below.

The 1 _____ shows the aircraft position relative to the horizon. There is a horizontal line across the middle of the instrument known as the artificial horizon. A white bar can be seen above or below the line, depending on whether the aircraft's nose is pointing up or down. It also shows the position of the wings relative to the horizon and indicates whether the plane is turning clockwise or anticlockwise. This instrument is very useful if visibility is bad.

The 2 _____ gives information about the aircraft's speed by measuring the pressure of moving air pushing against the front of the plane. This ensures that the pilot does not go too slow and stall the plane, or damage the plane by going too fast.

The 3 _____ is used as backup in case the attitude indicator fails. Its primary use, nevertheless, is for checking that the plane is turning properly and not slipping down sideways when it banks to the left or right.

The 4 _____ is a type of barometer marked in thousands of feet rather than inches of mercury. It measures the air pressure and shows how high above sea level the plane is flying. At high altitudes, there is less air and consequently lower air pressure. It must be set before take-off, as local sea level air pressure can change from day to day and all planes in one area need to have their instruments set to the same correct sea level pressure.

The 5 _____ is a direction indicator which uses an internal gyroscope instead of a magnet. Magnetic compasses are less accurate when the aircraft is changing direction and speed, or in rough weather. The gyro compass should be checked against the magnetic compass so that it can be recalibrated.

The 6 _____ measures rate of climb or descent.

4. The following pictures present 6 instruments mentioned in Task 2. Match the names with the pictures.



5. Choose the best option for each of the following sentences.

1. Attitude indicator is needed

- a. to show direction
- b. if cockpit visibility is bad
- c. to define air pressure

2. Gyro compass tells the pilot

- a. about speed
- b. about pressure
- c. about direction

3. Turn coordinator

- a. checks planes is turning correctly
- b. shows how fast plane is going
- c. measures rate of wind

4 Altimeter shows the pilot

- a. position of wings
- b. height above sea level
- c. changes in pressure

5. Airspeed indicator ensures pilot...

- a. maintains the right speed
- b. prevents enough plane turning
- c. measures pressure correctly

6. There are many abbreviations used in area of aviation.

a) Guess full names of the following abbreviated terms of onboard devices. Consult a dictionary if necessary.

ADF, DME, GPS, HSI, Comm, RADAR, RMI, VHF, AC, ATC, HF, VOR, AM

b) Match up these English terms with their Russian definitions.

- | | |
|----------|---|
| 1. ADF | a. Система связи |
| 2. DME | b. Радиолокатор |
| 3. GPS | с. Автоматический радиокompас (АРК) |
| 4. HSI | d. Радиомагнитный индикатор |
| 5. Comm | e. Телеметрическое оборудование |
| 6. RADAR | f. Индикатор навигационной обстановки |
| 7. RMI | g. Система определения положения |
| 8. VHF | h. Всенаправленный курсовой радиомаяк УКВ-диапазона |
| 9. AC | i. Управление воздушным движением |
| 10. ATC | j. Высокая частота |
| 11. HF | к. Переменный ток |
| 12. VOR | l. Амплитудная модуляция |
| 13. AM | m. Очень высокая частота (ОВЧ) |

7. Read the text and:

- a) decide which answer A, B or C best fits each space. Tick (✓) your answer and check it.
- b) write a suitable heading to each paragraph.

1 _____

The cockpit of an aircraft is a typical (0) ___ for avionic equipment, (1) ___ control, monitoring, communication, navigation, weather, and anti-collision systems. The majority of aircraft (2) ___ their avionics using 14- or 28-volt DC electrical systems; however, larger, more sophisticated aircraft (such as airliners or military (3) ___ aircraft) have AC systems operating at 400 Hz, 115 volts AC.

2 _____

Communications (4) ___ the flight desk to the ground and the flight desk to the passengers. On-board communications (5) ___ by public address systems and aircraft intercoms. The VHF aviation communication system works on the (6) ___ of 118.000 MHz¹ to 136.975 MHz. Each channel is spaced from the adjacent ones by 8.33 kHz² in Europe, 25 kHz elsewhere. VHF is also used for line of sight communication such as

aircraft-to-aircraft and aircraft-to-ATC. Amplitude modulation (AM) is used, and the conversation is performed in simplex mode. Aircraft communication can also take place using HF (especially for transoceanic flights) or satellite communication.

3 _____

Navigation is the determination of position and direction on or above the (7) ___ of the Earth. Avionics can use satellite-based systems (such as GPS and WAAS³), ground-based systems (such as VOR or LORAN⁴), or any combination thereof. Navigation systems (8)___ the position automatically and display it to the flight (9) ___ on moving map displays. Older avionics required a pilot or navigator to plot the intersection of signals on a paper map to (10) ___ an aircraft’s location; modern systems calculate the position automatically and display it to the flight crew on moving map displays.

Notes: ¹ MHz – megahertz.

² kHz – kilohertz.

³ WAAS – Wide Area Augmentation System (Система панорамного обзора).

⁴ LORAN – lo(ng)-ra(nge) n(avigation) – Импульсная дальномерная радионавигационная система.

Example:

<i>0. A place</i>	<i>B thing</i>	<i>C location ✓</i>
1. A becoming	B including	C thinking
2. A power	B pressure	C measure
3. A commercial	B combat	C all-weather
4. A connect	B contain	C include
5. A is provided	B provide	C are provided
6. A jassband	B airband	C such
7. A surface	B service	C system
8. A conclude	B calculate	C consult
9. A person	B people	C crew
10. A direct	B determine	C discuss

UNIT 6

Avionics: On-Board Equipment

Vocabulary

1. Study some basic terminology and word combinations given in English and in Russian.

air traffic control – управление воздушным движением

traffic alert and collision avoidance system (TCAS) – система слежения и предупреждения опасного сближения

midair collision – столкновение в воздухе

traffic alerting system (TRAS) – система предупреждения о движении

controlled flight into terrain (CFIT) – контролируемый диспетчерской службой полет на местности

ground-proximity warning systems (GPWS) – система предупреждения опасного сближения

“look ahead” – упреждение, опережение

“look down” – внизу

terrain awareness warning system – система, дающая информацию о местности

lightning detector – обнаружитель молнии

severe precipitation – стремительное падение

turbulence – турбулентность, болтанка

convective activity – активность сил природы

deviate (v) – отклоняться

wind shear – сдвиг ветра

Reading

1. Read the following text and do tasks after it.

Aircraft Flight Control Systems

Aircraft have means of automatically controlling flight. Today automated flight control is common to reduce pilot error and workload at key times like landing or takeoff. The first simple auto-pilots were used to control heading and altitude and had limited authority on things like thrust and flight control surfaces.

The advent of fly by wire and electro-actuated flight surfaces (rather than the traditional hydraulic) has increased safety. The software is very strictly tested.

Collision-avoidance systems

To supplement air traffic control, most large transport aircraft and many smaller ones use a traffic and collision avoidance system (TCAS), which can detect the location of nearby aircraft, and provide instructions for avoiding a midair collision.

Smaller aircraft may use simpler traffic alerting systems such as TRAS, which are passive (they do not actively interrogate the transponders of other aircraft) and do not provide advisories for conflict resolution.

To help avoid controlled flight into terrain (CFIT), aircraft use systems such as ground-proximity warning systems (GPWS), which use radar altimeters as a key element. One of the major weaknesses of GPWS is the lack of “look-ahead” information, because it only provides altitude above terrain “look-down”. In order to overcome this weakness, modern aircraft use a terrain awareness warning system (TAWS).

Weather systems

Weather systems such as weather radar (typically Arinc 708) and lightning detectors are important for aircraft flying at night or in instrument meteorological conditions, where it is not possible for pilots to see the weather ahead. Heavy precipitation (as sensed by radar) or severe turbulence (as sensed by lightning activity) are both indications of strong convective activity and severe turbulence, and weather systems allow pilots to deviate around these areas.

Modern weather systems also include wind shear and turbulence detection and terrain and traffic warning systems. In plane weather avionics are especially popular in Africa, India and other countries where air travel is a growing market, but ground support is not as well developed.

Comprehension Check

1. Define the main idea of each paragraph and find the supporting details that help to develop the main idea.
2. In the text find the meaning of TRAS, CFIT, GPWS and TAWS.
3. Match up the words from the text with their definitions:

alerting system	quick to notice any unusual and potentially dangerous or difficult circumstances; vigilant.
transponder	a device for receiving a radio signal and automatically transmitting a different signal.
turbulence	violent or unsteady movement of air or water, or of some other fluid.
terrain	a stretch of land especially with regard to its physical features.
convective activity	activity in which upward motion of warmer fluid in the centre is balanced by downward motion of cooler fluid at the periphery.
precipitation	the fact or quality of acting suddenly and rashly.
wind shear	variations in wind velocity occurring along a direction at right angles to the wind's direction and tending to exert a turning force.
deviate	depart from an established course.

Language Focus

- Name the tense form and comment on its use in this text. What tense form is predominant and why? Find the examples of Modal verbs and write them down.
- The text above contains a number of common verb-noun partnerships.

1. Match up the following verbs and nouns to make common collocations without looking back at the text. Check whether you know the meaning of each combination.

avoid	location
detect	instructions
supplement	systems
overcome	air traffic control
provide	weakness
use	midair collisions

2. Make as many words as possible from these roots.

use avoid allow divide detect

- Write sentences using the words you have made.

Example: **provide** / This system **provides** information about possible collisions.
provider / They are the main **providers** of avionic systems.

Reading

1. Scan the text and answer the following questions:

1. Are there any advantages of using a glass cockpit?
2. What modernizations have been made for improving reliability of glass cockpits?
3. What new systems do modern glass cockpits include?
4. Which airplanes use glass cockpits?

A glass cockpit is an aircraft cockpit that features electronic (digital) instrument displays. A glass cockpit has electronic (digital) instrument displays, typically large **LCD** screens, rather than the traditional style of analog dials and **gauges**. While a traditional cockpit relies on numerous mechanical gauges to display information, a glass cockpit uses several displays driven by flight management systems, that can be adjusted to display flight information as needed. This simplifies aircraft operation and navigation and allows pilots to focus only on the most pertinent information. They are also popular with airline companies as they usually eliminate the need for a flight engineer, saving costs. In recent years the technology has become widely available in small aircraft.

As aircraft displays have modernized, the sensors that feed them have modernized as well. Traditional gyroscopic flight instruments have been replaced by electronic Attitude and Heading Reference Systems (**AHRS**) and **Air Data Computers (ADCs)**, improving reliability and reducing cost and maintenance. GPS receivers are usually integrated into glass cockpits.

Early glass cockpits, found in the McDonnell Douglas MD-80/90, Boeing 737 Classic, 757 and 767-200/-300, and in the Airbus A300-600 and A310, used Electronic Flight Instrument Systems (EFIS) to display attitude and navigational information only, with traditional mechanical gauges retained for airspeed, altitude and vertical speed. Later glass cockpits, found in the Boeing 737NG, 747-400, 767-400, 777, A320 and later Airbuses, Ilyushin Il-96 and Tupolev Tu-204 have completely replaced the mechanical gauges and warning lights in previous generations of aircraft.

Modern glass cockpits might include **Synthetic Vision (SVS)** or Enhanced Vision systems (EVS). Synthetic Vision systems display a realistic 3D depiction of the outside world (similar to a flight simulator), based on a database of terrain and geophysical features in conjunction with the attitude and position information gathered from the aircraft navigational systems. Enhanced Vision systems add real-time information from external sensors, such as an infrared camera. All new airlines such as the Airbus A380, Boeing 787 and private jets such as Bombardier Global Express and Learjet use glass cockpits.

Notes: LSD (liquid-crystal display) – жидкокристаллический дисплей.

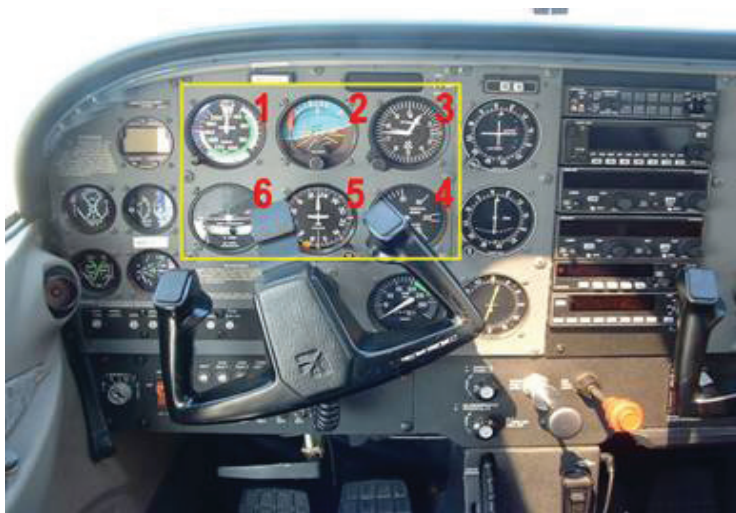
gauges – измерительные приборы.

ADCs (Air Data Computers) – вычислитель воздушных сигналов.

SVS (Synthetic Vision) – техническое зрение.

Speaking

1. Working with your partner discuss on-board digital instruments, devices, systems using terminology given in this Unit.



2. Speak about advantages of using a glass cockpit.

Use the following expressions:

- I would never believe
- To my mind....
- In my opinion....
- I could hardly imagine that....
- I didn't expect that...

Writing

1. Imagine that you have to prepare a written report on the use of modern avionic devices for annual students' conference.

Prove your knowledge of:

- a.** basic terminology of on-board equipment and abbreviations;
- b.** benefits of using a glass cockpit by famous airline companies in the 21-st century.

Make notes before you start.

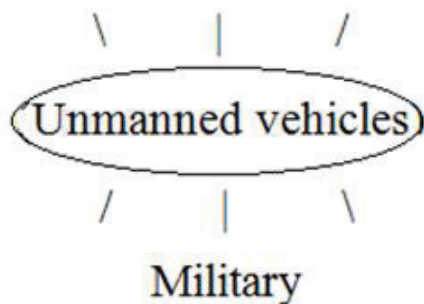
UNIT 7

Unmanned Aerial Vehicles



Lead in

1. Today unmanned vehicles are used in various spheres of our life. Work in pairs and discuss what these spheres are.



2. Name the advantages of using unmanned flight technology.

- 1) More reliable _____
- 2) Safer _____
- 3) _____
- 4) _____
- 5) _____
- 6) _____
- 7) _____

Reading

1. Read the text below focusing on what unmanned vehicles are and on their main types.

UNMANNED AERIAL VEHICLES

The **UAV** is an acronym for **Unmanned Aerial Vehicle**, which is an aircraft with no pilot on board. **UAVs** can be remote controlled aircraft (e.g. flown by a pilot at a ground control station) or can fly autonomously based on pre-programmed flight plans or more complex dynamic automation systems. UAVs are currently used for a number of missions, including reconnaissance and attack roles. The acronym UAV has been expanded in some cases to **UAVS (Unmanned Aircraft Vehicle System)**. The FAA has adopted the acronym **UAS (Unmanned Aircraft System)** to reflect the fact that these complex systems include ground stations and other elements besides the actual air vehicles.

Officially, the term ‘Unmanned Aerial Vehicle’ was changed to ‘Unmanned Aircraft System’ to reflect the fact that these complex systems include ground stations and other elements besides the actual air vehicles. The term UAS, however, is not widely used as the term **UAV** has become part of the modern lexicon.

Degree of Autonomy

Some early UAVs are called drones because they are no more sophisticated than a simple radio controlled aircraft being controlled by a human pilot (sometimes called the operator) at all times. More sophisticated versions may have built-in control and/or guidance systems to perform low level human pilot duties such as speed and flight path stabilization, and simple prescribed navigation functions such as waypoint following.

From this perspective, most early **UAVs** are not autonomous at all. In fact, the field of air vehicle autonomy is a recently emerging field, whose economics is largely driven by the military to develop battle ready technology for the war fighter. Compared to the manufacturing of UAV flight hardware, the market for autonomy technology is fairly immature and undeveloped. Because of this, autonomy has been and may continue to be the bottleneck for future UAV developments, and the overall value and rate of expansion of the future UAV market could be largely driven by advances to be made in the field of autonomy.

UAV Types

- **Target and decoy** – providing ground and aerial gunnery a target that simulates an enemy aircraft or missile
- **Reconnaissance** – providing battlefield intelligence
- **Combat** – providing attack capability for high-risk missions
- **Research and development** – used to further develop UAV technologies to be integrated into field deployed UAV aircraft
- **Civil and Commercial UAVs** – UAVs specifically designed for civil and commercial applications.

(from <http://www.theuav.com/>)

Comprehension Check

1. Read the text again and make a list of all unfamiliar words. Compare them with your partner. In pairs try to guess the meaning of these words.

2. Divide the text into logical parts. Highlight the topic sentence of each part.



3. a) In the text, find definitions of *UAV*, *UAS*, *drone*, *operator*, *Civil UAV*, *low level human pilot duties*.

b) Match the terms on the left with the definitions and explanations on the right. Compare them with the given in the context.

- | | |
|--------------------|--|
| 1. UAV | a. a system which performs low level human pilot duties. |
| 2. drone | b. the UAV specifically designed for civil applications. |
| 3. operator | c. an aircraft with no pilot on board. |
| 4. UAS | d. a human pilot who controls the UAV. |
| 5. Civil UAV | e. complex systems include ground stations and other elements besides the actual air vehicles. |
| 6. Guidance system | f. a simple radio controlled aircraft being controlled by a human pilot. |

4. Say if this statements are true or false. Correct the false statements.

- UAS included ground stations and other elements besides the actual air vehicles.
- UAVs are always controlled by the operator.
- UAVs cannot be used for gunnery a target.
- UAVs are less-risk than usual Aircraft Vehicles.
- UAVs are widely used for passenger service nowadays.
- The market for autonomy technology is fairly immature and undeveloped.

Language Focus

1. Read the text again and make a list of all unfamiliar words. Compare them with your partner. In pairs try to guess the meaning of these words.

2. a) Fill in the gaps in the sentences using the words from the box. Watch out! There's an extra word.

unlawful	outfitted	sharing	privacy	renting
remotely	pilotless	reconnaissance		

- 1) UAVs are ... piloted or self-piloted aircraft that can carry cameras, sensors, communications equipment or other payloads.
- 2) In the 60s an experimental ... aircraft Tu-121 was created for the purpose of distant pilotless intelligence
- 3) The Department of Homeland Security uses the drones to police the nation's borders to deter ... border crossings.
- 4) Currently, drones can be ... with high-powered cameras, thermal imaging devices, license plate readers and laser radar.
- 5) Commercial airlines and pilots are less than thrilled with the idea of ... the sky.
- 6) "There's going to be a lot more discussion of the ... issue" once police, the media, or private detectives are able to launch hard-to-see devices with cameras aboard.
- 7) A small-plane pilot, Russ Freeman stumbled into drone photography after helicopters became too expensive and cumbersome.

b) Use the words and expressions from the box in the sentences of your own.

3. Give the English equivalents to the words in brackets.

Autonomy is commonly defined as the ability to make decisions without human (вмешательство). To that end, (задача) of autonomy is to teach machines to be "smart" and act more like humans. The keen observer may associate this with the development in the field of (искусственный интеллект) made popular in the 1980s and 1990s such as expert systems, (нейронные сети), machine learning, natural language processing, and vision. However, the mode of technological development in the field of autonomy has mostly followed a bottom-up approach, and recent (достижения) have been largely

driven by the practitioners in the field of control science, not computer science. Similarly, autonomy has been and probably will continue to be considered (расширение) of the controls field. In the (обозримом) future, however, the two fields will merge to (в гораздо большей степени), and practitioners and researchers from both disciplines will work together to spawn rapid technological development in the area.

(from <http://www.theuav.com/>)

Speaking

1. Read the following text and discuss it with your partner using the following phrases.

- I want to say that...
- I'd like to say that...
- As far as I know...
- If I not mistaken...
- In my opinion...



Amazon.com hopes to deliver small packages to your home in just 30 minutes by unmanned drones within five years, chief executive Jeff Bezos said.

Bezos said Amazon already had the technology in place and had even flown a working prototype, which he showed off in a video the company published.

He promised “half-hour delivery, and we can carry objects, we think, up to five pounds, which covers 86 percent of the items that we deliver”.

The rest of the work, Bezos said, is in quality control and getting the plan OK'd by the Federal Aviation Administration – something technology experts said was unlikely on Bezos' time frame.

(from <http://www.nbcnews.com/news/other/jeff-bezos-tells-amazon-customers-expect-home-delivery-drones-f2D11680281>)

2. Use the text below to prepare a presentation on Russian UAVs. Search the Internet for additional information.

Russian UAVs

At the end of the 50s to address growing threats of the US nuclear attack the USSR leaders made a decision to develop a system of distant unmanned photo and radio reconnaissance named “Yastreb” (Russian for ‘falcon’). In the 60s an experimental unmanned aircraft Tu-121 was built for distant unmanned reconnaissance. According to its new purpose, it had to be equipped with photo and radio reconnaissance devices. The deadline was tight: factory flight tests had to begin in the third quarter of 1960s, integration testing – in a year, and in 1961 the plant in Voronezh had to release 18 production vehicles. The goal was achieved and the new unmanned reconnaissance aircraft got the name of Tu-123 (or DBR-1).

Working on Tu-123 and Yastreb, the design office faced a number of problems they had never had to deal with before:

- developing high-precision reconnaissance equipment and providing the conditions for its proper operation onboard;
- developing a navigation system to ensure the UAV’s autonomous flight along the target flight path and guiding it to the target area;
- landing the detachable container;
- necessity to ensure UAV’s self-contained land-base and employment due to lack of appropriate engineering facilities at the launching sites and their remote location from the stationary maintenance depots;
- moving the vehicles under their own power within 500 km range while maintaining their survivability;
- landing of the recoverable container with the reconnaissance equipment on the ground or water;
- efficient parachute landing system for the recoverable nose section, its separation from fuselage while in flight;
- provision of the surveillance data processing facilities;
- automatic checking of onboard equipment;
- developing and verifying the concept of various stages of system operation;
- developing the system operational documentation for combatant forces.



Along with A.A.Tupolev, all these problems were dealt with by V.P.Sakharov, who was responsible for the system design management, V.I.Bliznyuk (system elements alignment and aircraft arrangement), the launching vehicle was designed and developed by A.V.Nadashkevich; the manufacturing of the first pilot articles was supervised by V.P.Nikolayev; and the testing was prepared and performed by a special testing division headed by B.N.Grozdov.

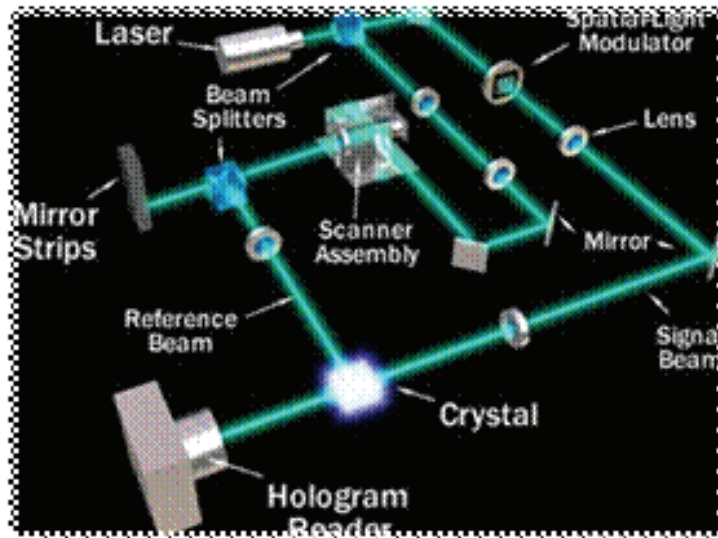
Writing

1. Write an essay (180-200 words) on one of the following topics:

- **Target and decoy** – providing ground and aerial gunnery a target that simulates an enemy aircraft or missile.
- **Applications of UAV.**
- **Pros and cons of UAV.**
- **UV as a breakthrough technology.**

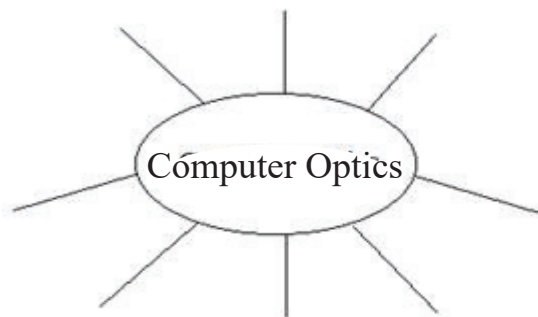
UNIT 8

Computer Optics



Lead in

1. Brainstorm as many features of the computer optics as possible.



2. Name the advantages of the computer optics and fill in the following table.

Holography	.....
Fiber optics	.....
CD	.....
DVD	.....
Blu-ray	.....

3. Match the terms on the left with the definitions and explanations on the right.

- | | |
|-------------------|--|
| 1. holography | a. a phenomena which occur when a wave encounters an obstacle or a slit. |
| 2. laser | b. a thin glass center of the fiber where the light travels. |
| 3. optical fiber | c. a device that emits light through a process of optical amplification based on the stimulated emission of electromagnetic radiation. |
| 4. core | d. a length of the shortest repeating part of a “sine wave”. |
| 5. cladding | e. an outer optical material surrounding the core that reflects the light back into the core. |
| 6. buffer coating | f. a technique which enables three-dimensional images (holograms) to be made. |
| 7. interference | g. a plastic coating that protects the fiber from damage and moisture. |
| 8. diffraction | h. a flexible, transparent fiber made of high quality extruded glass or plastic. |
| 9. wavelength | i. a superposition of two or more waves resulting in a new wave pattern |

Reading

1. Read the text below focusing on differences in various types of computer optics.

Computer Optics

Holography is a technique which enables three-dimensional images to be made. It involves the use of a laser, interference, diffraction, light intensity recording and suitable illumination of the recording.

If you look at these holograms from different angles, you see objects from different perspectives, just like you would if you were looking at a real object. Some holograms even appear to move as you walk past them and look at them from different angles. Others change colors or include views of completely different objects, depending on how you look at them.

There are two basic categories of holograms – transmission and reflection. Transmission holograms create a 3-D image when light that is all one wavelength, travels through them. Reflection holograms create a 3-D image when laser light or white light reflects off of their surface.

CDs and DVDs are the primary data storage methods for music, software, personal computing and video. A CD can hold 783 megabytes of data, which is equivalent to about one hour and 15 minutes of music, but Sony has plans to release a 1.3-gigabyte (GB) high-capacity CD. A double-sided, double-layer DVD can hold 15.9 GB of data, which is about eight hours of movies. These conventional storage mediums meet today's storage needs, but storage technologies have to evolve to keep pace with increasing consumer demand. CDs, DVDs and magnetic storage all store bits of information on the surface of a recording medium. In order to increase storage capabilities, scientists are now working on a new optical storage method, called holographic memory, that will go beneath the surface and use the volume of the recording medium for storage, instead of only the surface area.

Fiber optics (optical fibers) are long, thin strands of very pure glass about the diameter of a human hair. They are arranged in bundles called optical cables and used to transmit light signals over long distances.

If you look closely at a single optical fiber, you will see that it has the following parts:

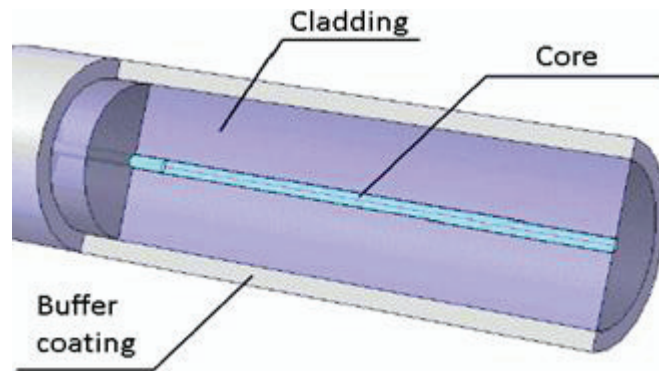
- Core – Thin glass center of the fiber where the light travels;
- Cladding – Outer optical material surrounding the core that reflects the light back into the core;
- Buffer coating – Plastic coating that protects the fiber from damage and moisture.

Hundreds or thousands of these optical fibers are arranged in bundles in optical cables. The bundles are protected by the cable's outer covering, called a jacket.

Optical fibers come in two types – single-mode fibers and multi-mode fibers.

Single-mode fibers have small cores and transmit infrared laser light (wavelength = 1,300 to 1,550 nanometers). Multi-mode fibers have larger cores and transmit infrared light (wavelength = 850 to 1,300 nm) from light-emitting diodes (LEDs).

Comprehension Check



1. Read the text again and write down all the words that you don't know. Guess the meaning of the words. Compare them with those of your partner.
2. Divide the text into logical parts. Highlight the topic sentence of each part.
3. Define the main idea of the paragraph about CD, DVD.
4. Decide if these statements are true or false. Correct the false ones.
 - Some holograms even appear to move as you walk past them and look at them from different angles.
 - Transmission holograms create a 3-D image when light that is various wavelength, travels through them.
 - A double-sided, double-layer DVD can hold 5 GB of data.
 - Scientists are now working on a new optical storage method, called holographic memory.
 - Buffer coating – Thin glass center of the fiber where the light travels.
 - Single-mode fibers have larger cores and transmit infrared light.
 - Multi-mode fibers have larger cores and transmit infrared light from light-emitting diodes.
5. Look at the text again and discuss these questions.
 1. What is a holography?
 2. How many categories of holograms do you know?
 3. How many megabytes of data can CD hold?
 4. What types of disks can hold 15.9 GB of data?
 5. How is a new method of optical storage called, that use the all volume of the recording medium for storage, rather than surface?
 6. What is a fiber optics?
 7. What is the wavelength of light used in multi-mode fibers?
 8. What components of optical fiber do you know?

Language Focus

1. Work in pairs:

a) Give the definitions of the following words and expressions.

DEFINITION

1. holography
2. transmission
3. reflection
4. holographic memory
5. fiber optics
6. core
7. cladding
8. buffer coating

b) Find in text the synonyms for the following words and expressions.

SYNONYM

1. 3D image
2. glass center
3. [protective layer](#)
4. reflective cover
5. light pipe

2. Fill in the gaps with a suitable word.

1. Holography is _____ which enables three-dimensional images to be made.
2. Reflection holograms create a 3D image when _____ or _____ reflects off of their surface.
3. Sony has plans to release a _____ high-capacity CD.
4. Storage technologies have _____ to keep pace with increasing consumer demand.

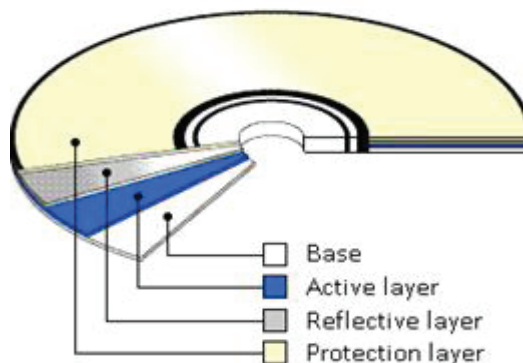
5. CDs, DVDs and _____ all store bits of information on the surface of a recording medium.
6. Fiber optics are long, thin strands of very pure glass about the diameter of _____.
7. Hundreds or thousands of these optical fibers are arranged _____ in optical cables.
8. Optical fibers come in two types - _____ and _____.
9. _____ have small cores and transmit infrared laser light.
10. Multi-mode fibers have larger cores and transmit _____ from light-emitting diodes.

3. Complete the sentences so that they make sense.

1. Some holograms even appear to move as _____.
2. _____ create a 3-D image when light that is all one wavelength, travels through them.
3. _____ for music, software, personal computing and video.
4. These conventional storage mediums meet _____.
5. They are arranged in bundles called optical cables and used to _____.
6. _____ surrounding the core that reflects the light back into the core.

4. Use the words from ex. 1 in the sentences of your own.

Speaking



1. You are visiting an international exhibition of computer optics. You see a lot of new gadgets, devices, technologies. Sure, you have a lot of questions. Think of the questions you would ask the experts.

Example:

- Please, tell me about the advantages of fiber optics.
- Could you tell me, where the holograms are used?
- What is the underlying principle of storage technology on CD?
- The following expressions might be helpful:

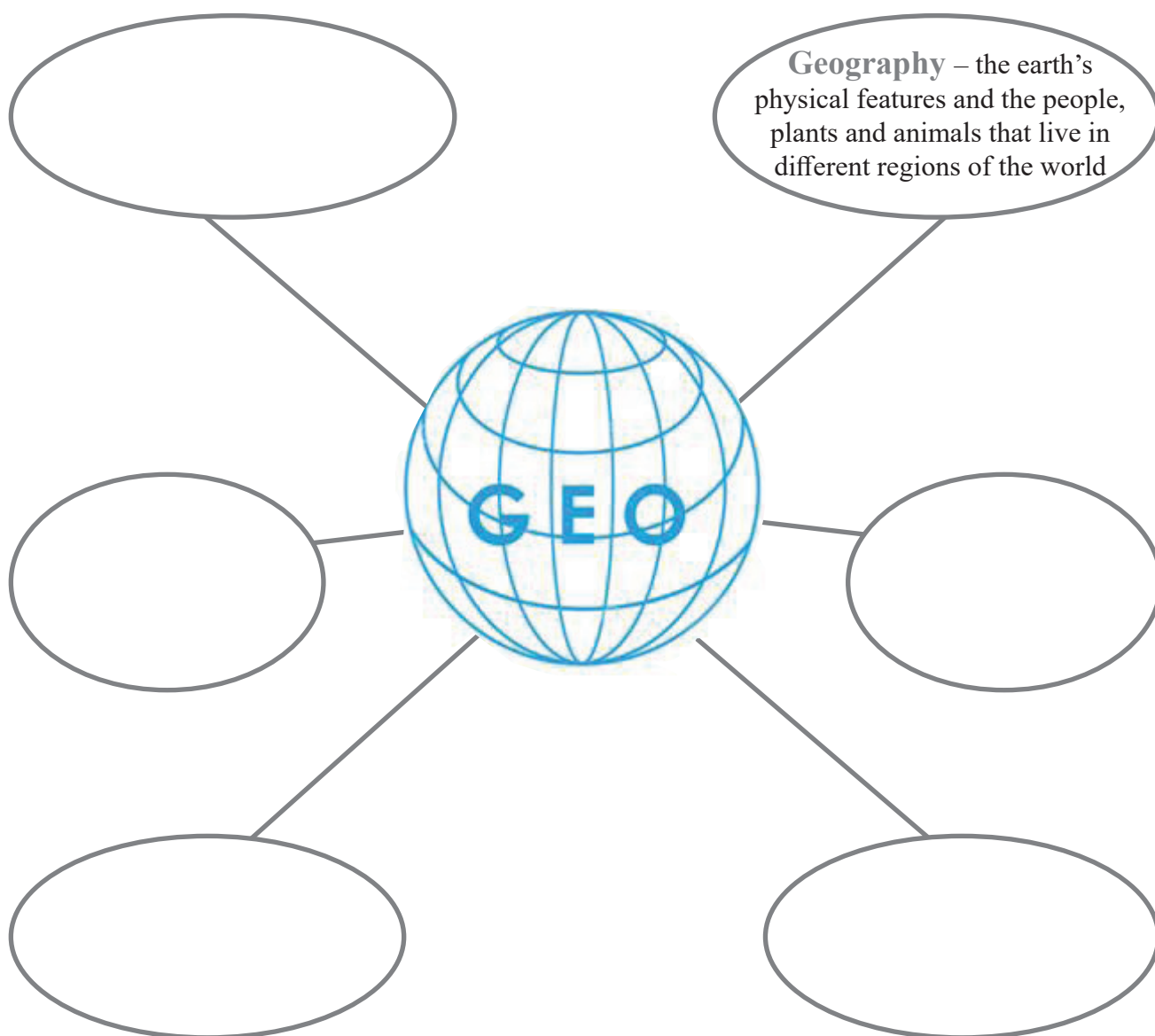
- I'd like to know...
- Could you tell me...?
- Excuse me, do you know...?
- Another thing I'd like to know is...

UNIT 9

Geoinformatics

Lead in

1. The term “Geoinformatics” comprises two components. What are they? What does “geo” mean? What language does it come from?
2. What other sciences contain “geo”? What are their subjects? Completer the diagramme.



3. Match the following terms and their definitions.

- | | |
|--|--|
| 1. Cartography | a. a system of satellites that provide autonomous geo-spatial positioning with global coverage |
| 2. Geodesy | b. the study and practice of making maps |
| 3. Geographic Information Systems | c. a variety of techniques which study entities using their topological , geometric , or geographic properties |
| 4. Global Navigation Satellite Systems | d. the process of using maps delivered by geographical information systems ; it is both a service activity and consumer activity |
| 5. Photogrammetry | e. the acquisition of information about an object or phenomenon without making physical contact with the object |
| 6. Remote Sensing | f. the scientific discipline that deals with the measurement and representation of the earth |
| 7. Spatial Analysis | g. the science of making measurements from photographs, especially for recovering the exact positions of surface points |
| 8. Web Mapping | h. a system designed to capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data |

4. Discuss the following.

1. What is Geoinformatics?
2. What gave rise to Geoinformatics?
3. What are Geographic Information systems?
4. What other fields is Geoinformatics connected with?
5. What components does Geoinformatics comprise?
6. What are the major applications of Geoinformatics?



Reading

1. Read the following text and check your answers. Use a dictionary, if necessary.

A. Geoinformatics

Geoinformatics – also called Geographic Information Science – is the science and the technology which develops and uses information science facilities to address the problems of geography, geosciences and related fields of engineering.

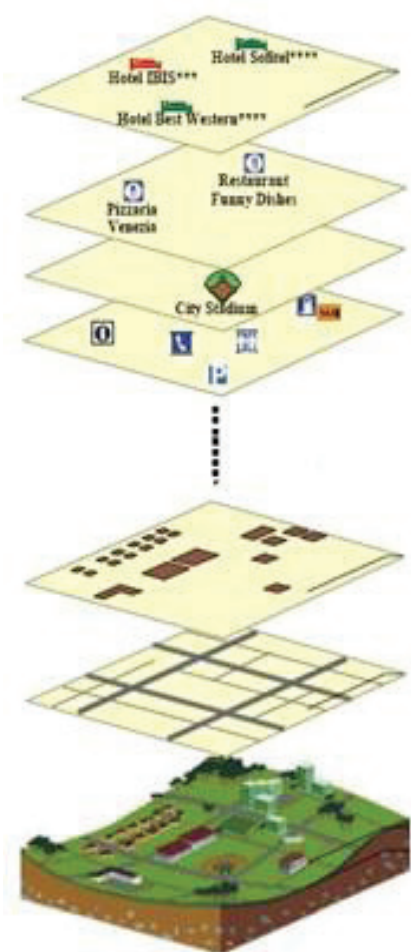
Governments, militaries, commercial enterprises, and other interests have always relied on information about the land, the location and characteristics of people and resources. For centuries, maps have served as the primary mechanism for managing and communicating geospatial information. In the 1960s, computerized geographic information systems (GIS) emerged as a means to manage and analyze such information more efficiently and effectively.

Since then, computing power has increased, data have become plentiful, software has become easier to use, and the scope and complexity of questions that Geoinformatics can solve has expanded dramatically.

A Geographic Information System (GIS) is a computer-based system that enables users to collect, store, process, analyze and present **spatial data** about the Earth's natural and man-made features. A GIS references these real-world spatial data elements to a coordinate system. These features can be separated into different **layers**. For example, layers can represent terrain

characteristics, census data, demographics information, environmental and ecological data, roads, land use, etc.

A GIS can also store **attribute data**, which is descriptive information of the map features. This attribute information is placed in a database separate from the graphics data but is linked to them. A GIS allows the examination of both spatial and attribute data at the same time.



GIS consists of four subsystems: input system, database management system, geographic analysis system and output system. GIS represents our world elements (the geographic data) in two formats: raster and vector.

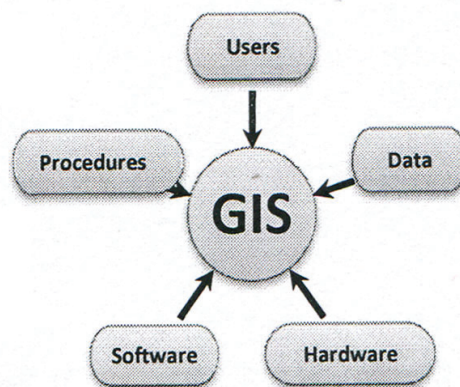
A **raster model** represents the world as a surface divided into a regular grid of cells. Raster models are useful for storing data that vary continuously, as in an aerial photograph, a satellite image, a surface of chemical concentrations, or an elevation surface. Each cell contains an attribute value and location coordinates.

In the **vector model**, geospatial data are represented in the form of co-ordinates. The basic units of spatial information are points, lines (arcs) and polygons. Each of these units is composed simply as a series of one or more co-ordinate points, for example, a line is a collection of related points, and a polygon is a collection of related lines. A point could be a tree, or a house; a line feature could be a road, or a river; the polygon features could be land parcels, lakes, etc. Vector models are useful for storing data that have discrete boundaries, such as country borders, land parcels, and streets.

Today, there are many types of GIS software product to choose from. The main categories that dominate nowadays are desktop, web mapping, server, virtual globe, developer and handheld. The GIS marketplace has four key vendors that deliver 'generic' platforms: ESRI, Intergraph, Autodesk, and GE Energy. The most popular software packages are: ArcGIS (ESRI, USA), GeoMedia (InterGraph, USA), GeoGraphics (Bentley Corp., USA), MapInfo (MapInfo Corp., USA), STAR (STAR Company, Belgium).

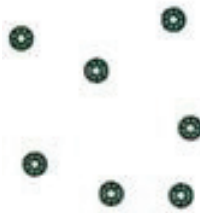
There are also open source applications, i.e. software that you can freely access and modify the source code for. Open source GIS programs are based on different base programming languages: "C" languages, Java, and .NET. These include: Quantum GIS (QGIS), PostGIS, MapServer, GRASS GIS, SAGA GIS, MapWindow GIS and others.

The future developments of GIS systems are likely to include the additional dimension of time, giving researchers the ability to examine different Earth processes over days, months and years. The advances in computer hardware, software and remote sensing technology will lead to more and more GIS adopting multimedia to represent data. The GIS of the future will also be more user-friendly and accessible to ordinary people.



2. The following pictures present different GIS terms used in the text. Match the names from the box with the pictures.

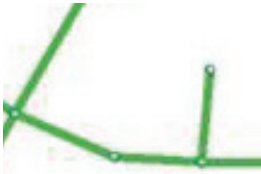
spatial information attribute information vector model
 raster model points lines polygons volume real world



1. _____

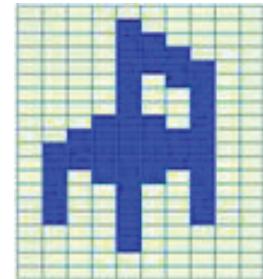
2. _____

3. _____



$53^{\circ}21'74.1674272398''N$

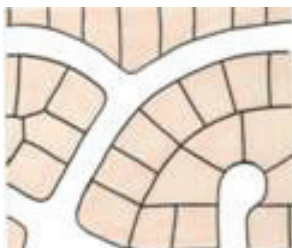
$50^{\circ}17'68.5394035652''E$



4. _____

5. _____

6. _____



7. _____

8. _____

9. _____

3. Match various geodata usage groups and usage scenarios.

- | | |
|---|---|
| 1. Urban and Regional Planning | a. producing maps and 3D visualizations; analyzing historical maps |
| 2. Physical Geography and Geology | b. verifying newly acquired data with existing geodata; merging new data into existing data sources; visualizing geodata |
| 3. Botany and Zoology | c. producing geologic and geomorphologic maps; analyzing the potential of natural hazards; modelling and 3D visualization of terrain surfaces and geologic structures (faults, joints, planes, etc.); climatic modelling; terrain modelling and analysis; modelling, analysis and visualization of hydrologic systems and water run-off |
| 4. Logistics | d. producing thematic maps; modelling, analyzing, simulating and visualizing socio-economic phenomena; geostatistics |
| 5. Human Geography | e. analyzing socio-economic phenomena and patterns; modelling and simulating effects of political decisions with a spatial component; visualizing planned changes in landscape and cityscape |
| 6. Surveying and Photogrammetry | f. planning and maintenance of network systems (data lines, sewers, electricity, gas, etc.) |
| 7. Leisure Activities | g. analyzing spatial distribution and spreading of diseases |
| 8. Marketing and Financial Services | h. study the distribution of plants and animals |
| 9. Medicine | i. geo-marketing; optimizing potential store locations; managing and optimizing advertising locations; real estate business |
| 10. Telecommunication, Supply and Disposal Industry | j. fleet management and route optimization; car navigation systems |
| 11. Cartography | k. navigation and routing services; planning and documenting leisure time activities |

1		2		3		4		5		6		7		8		9		10		11	
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4. Can you name any other applications of GIS?

5. Can you find fourteen GIS-related words in this wordsearch? Words may go across or back, up or down, and diagonally up or down in the grid.



6. Which of the following features refer to vector data structures and which to raster data structures?

Vector	Raster																																																						
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1. Data are divided into cells, pixels, or elements.
2. Cells are organized in arrays.
3. Data are associated with points, lines, or boundary enclosing areas.
4. Row and Column numbers are used to identify the location of the cell within the array.
5. It stores data as coordinates.
6. It represents geographic data by discretizing it equally spaced and quantizing each cell.
7. A grid system stores data as a string of characters in which each character represents a location.
8. Straight line segments are displayed to indicate line based data (e.g. roads, rivers).
9. Common formats are .jpg, .png, .gif.
10. Common formats are: .svg, .dxf, .shp, .pdf.

7. List the advantages and disadvantages of each data system. For more information go to:

http://bgis.sanbi.org/GIS-primer/page_19.htm

<http://gis.nic.in/gisprimer/data3.html>

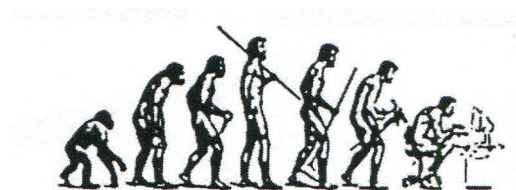
<http://gis.stackexchange.com/questions/7077/what-are-raster-and-vector-data-in-gis-and-when-to-use>

or other GIS-related web-sites.

Vector	
Advantages	Disadvantages
1. _____ 2. _____ 3. _____	1. _____ 2. _____ 3. _____
Raster	
Advantages	Disadvantages
1. _____ 2. _____ 3. _____	1. _____ 2. _____ 3. _____

8. Go to the GIS history page at <http://www.gislounge.com/history-of-gis/>. Fill the timescale with the most important events in the history of GIS development. Include such information as:

- *when?*
- *where?*
- *who?*
- *what?*
- *implications for GIS?*



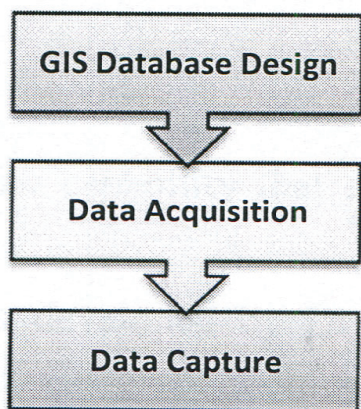
e.g.

- 1964
- Harvard Graduate School of Design (USA)
- Howard T. Fisher
- formed the Laboratory for Computer Graphics and Spatial Analysis
- a number of important theoretical concepts in spatial data handling and software codes and systems were later developed ('SYMAP', 'GRID' and 'ODYSSEY')

Language Focus

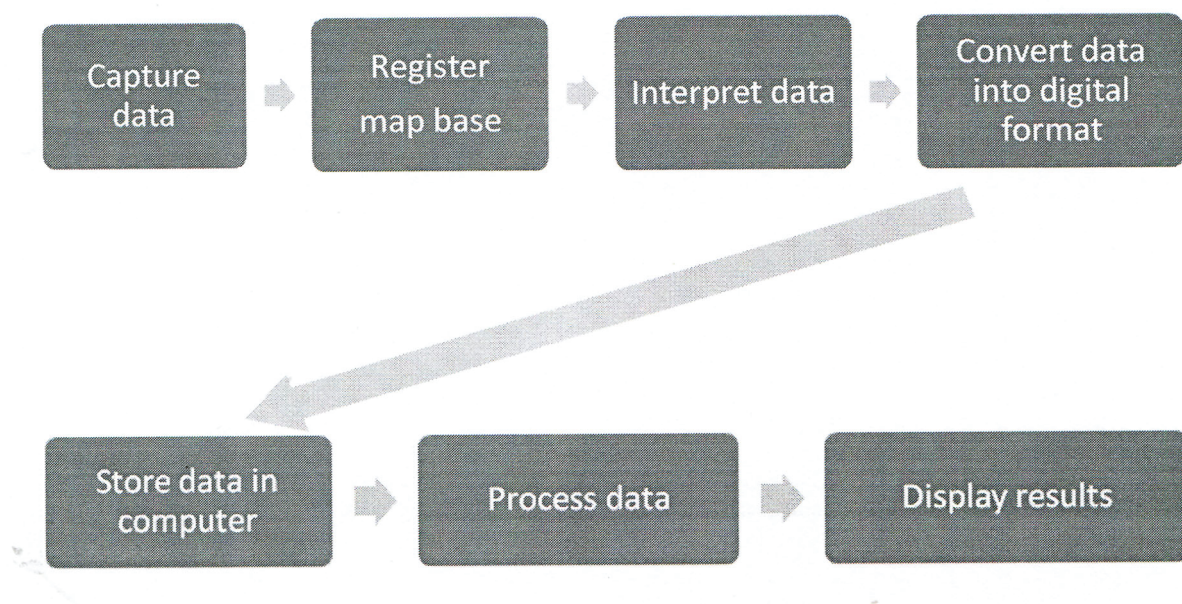
1. To talk about systems, processes and procedures, we often use the passive voice. Rewrite the text by changing the underlined active verb forms into the present simple passive.

GIS must have capabilities for inputting data. There are three distinct phases to the data input process: In the first phase, the design phase, you identify and code all the



features and attributes needed for your project (1) **all the features and attributes needed for your project are identified and coded**. Next is the data acquisition phase, when you acquire the needed data from various agencies, storehouses, and organizations, and convert (2) it into a format that your GIS programme can read (3). Finally, in the data capture phase, you digitize hard-copy maps and data directly into your GIS and transform (4) existing digital data into a format that your GIS reads (5).

2. Using the diagramme below, describe the GIS process putting the verbs into the present simple passive.



e.g. First, the data are captured.
Then,

Listening

1. Watch a video about the GIS history at. <http://www.youtube.com/watch?v=Ls8IuHZQnd4>. What do these figures refer to?

- a) 1960's b) 1900's c) 1854 d) 1994 e) 426

2. Choose the correct from. Check yourself against the video.

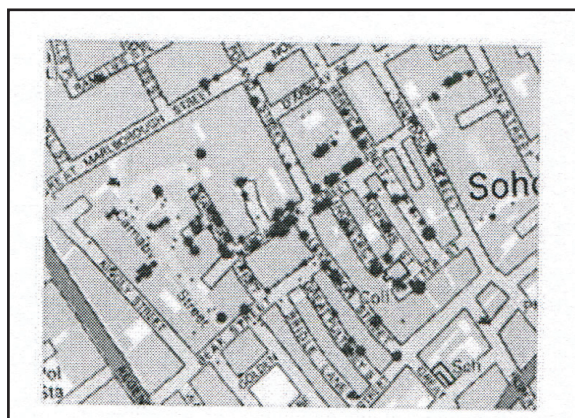
- 1) The early 1990s saw the development of the capability that allowed maps (to be split / to split / are split) into layers.
- 2) The world's first true operational GIS was developed by Dr Roger Tomlinson and (called / call / calling) Canada Geographic Information System – CGIS.
- 3) After the evolution of GIS followed what (could refer to / could be referred to / could referred to) as its revolution.

4) More recently, there (has been / have been / is) the development of a number of free open-source GIS software (running / run / ran) on a range of operating systems.

5) It (has been / have been / was been) timely, as the Internet was a huge leap forward and its affect on GIS has been the concept of (viewed / view / viewing) the GIS data over the Internet.

3. The video presents an early use of GIS describing a massive cholera outbreak in Soho, London.

- 1) When did it take place?
- 2) Who did the first geographical analysis of disease data?
- 3) What did the map show?
- 4) How was the outbreak stopped?



Language Focus

Comparisons

Express similarity and difference

Words for similarity and difference

S i m i l a r i t y	D i f f e r e n c e
Use these comparative words to show similarity.	Use these comparative words to show difference.
These objects are the same .	Those objects are different .
These objects are alike .	Those objects are unlike / not alike .
These objects are similar .	Those objects are dissimilar .
These objects behave similarly .	Those objects behave differently .
This object is like that object.	That object is unlike this object.

Expressions for similarity and differences

S i m i l a r i t y	D i f f e r e n c e
Use these expressions to show similarity .	Use these expressions to show difference .
This object is as big as that object (is).	This object is different from that object.
This object is the same size as that object (is).	This object is not as big as that object.
This object and the other objects are the same .	This object is more transparent than that object.
This object looks like that object.	This object is much more transparent than that object.
This object is similar to that object.	This object is visible unlike that object.
This object is like that object.	This object is more like a square than a triangular.
This object is just the same as that object.	The shape of this object contrasts to the shape of that object.
Both this object and that one are big.	This object in contrast to that object is visible.
Neither this object nor that one is small.	This object is square in contrast to that object which is triangular.

1. Select the word that best completes the sentence.

1. Raster data is different (than/from) vector data.
2. Identity overlay is similar (as/to) intersection overlay.
3. (Both/As well as) animations and flythroughs involve the development of short movie clips.
4. People often mistake GPS for GIS, partly because the two acronyms sound so much (alike/like).
5. Your business might be more successful if you could position it (closer/more close) to your customers.
6. Spatial sampling can give you a much (more better/better) representation of the geography.
7. Perhaps (the most/most) robust and advanced of the object-oriented models is the ESRI new geodatabase model.
8. Because they are (same/similar) data structures, you don't need to do a lot of data conversion to add them to your GIS.
9. Neither Google Maps (or/nor) Google Earth is a true GIS, but they can perform some GIS-like functions.
10. The accuracy of vector is better (than that/that than) of raster.

Linking adverbs for similarity and difference

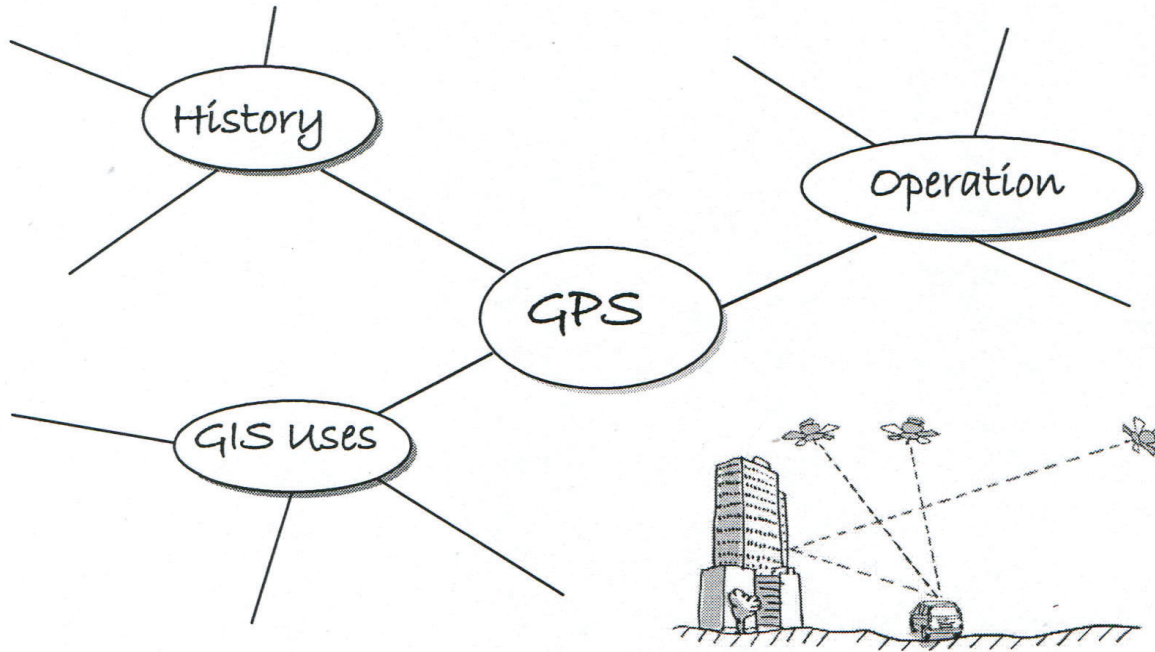
S i m i l a r i t y	D i f f e r e n c e
A transition word (a <i>linking adverb</i>) transitions the reader from the thought in one sentence to a similar thought in the next. The adverbial is an adverb (-ly, -wise) or a prepositional phrase.	These transition words, called linking adverbials, are used to relate the information in two clauses. The adverb relates to the entire clause rather than the verb within the clause.
This object is arched. Similarly , that one is rounded.	This object is arched. In contrast , that object is square.
This object is arched. In the same way , that one is rounded.	It may seem that this object is arched. On the contrary , it is square.
This object is arched. Likewise , that object is rounded.	While / Whereas this object is arched, that one is not.
This object is arched. Equally , that object is rounded.	This object is arched. However , that one is not.
This object is arched. In a similar manner , that object is rounded.	On the one hand this object is square, on the other hand it is has rounded corners.

2. Select the word or the expression that best completes the sentence.

- (In contrast to/On the contrary) traditional GIS, multimedia GIS is not only able to collect, analyze and store the data in traditional formats but also audio, animations and video.
- Technological development comes in distinct bursts, and (does so/so does) the technology drive behind GIS.
- The GIS in this type of application is (neither/both) involved in flood modelling nor in establishing hazard potential.
- Moreover, some maps are designed to be read close-up (as/while) others are displayed on walls and read from a distance.
- The Web continues to grow rapidly, and (so does/too does) the volume of information.
- Times change and (and does Infrastructure too/and infrastructure does too).
- We do not focus exclusively on using only one technology, (in contrast/on the contrary) – we focus on the customer’s needs.
- The more information the map can show, the more likely it is that hidden relationships will come to light. (On the other hand/On the contrary), data may be difficult to find.

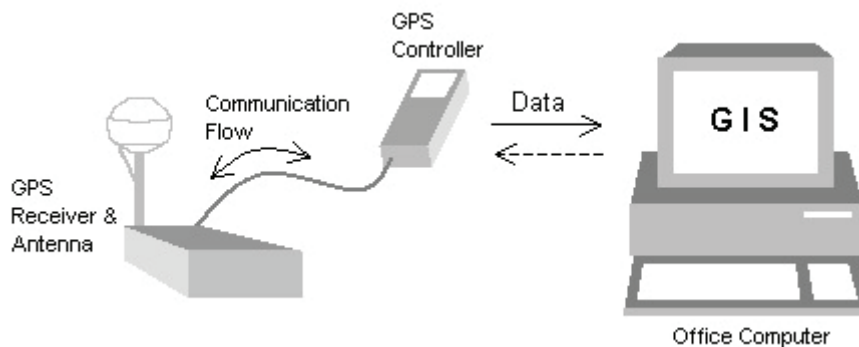
Comprehension Check

1. What do you know about GPS? Add as much information as you can to the ideas map.



2. Read the first sentence of each paragraph in the text. Match headings (1-5) to paragraphs (A-E).

1. 24 GPS satellites (21 active, 3 spare) are in orbit at 10,600 miles above the earth.
2. GPS has always been considered a technology that helps GIS operations.
3. Nowadays GPS is providing new capabilities and efficiencies in GIS.
4. The Global Positioning System (GPS) network that we all use is called Navstar.
5. GPS operations depend on a very accurate time reference, which is provided by atomic clocks on board the satellites.



A _____

It is paid for and operated by the US Department of Defence. Though designed as a military system, it is available (with certain restrictions) to civilians. This Global Navigation Satellite System (GNSS) is currently the only fully operational system but Russia has GLONASS, China has COMPASS and the EU has GALILEO each at varying stages of development or testing. France, India and Japan are in the process of developing regional navigation systems.

B _____

The satellites are spaced so that from any point on earth, four satellites will be above the horizon. Each satellite contains a computer, an atomic clock, and a radio. With an understanding of its own orbit and the clock, the satellite continually broadcasts its changing position and time. On the ground, any GPS receiver contains a computer that «triangulates» its own position by getting bearings from three of the four satellites. The result is provided in the form of a geographic position – longitude and latitude.

C _____

The transmitted data indicates its location and the current time. All GPS satellites synchronize operations so that these repeating signals are transmitted at the same instant. The signals, moving at the speed of light, arrive at a GPS receiver at slightly different times because some satellites are further away than others. The distance to the GPS satellites can be determined by estimating the amount of time it takes for their signals to reach the receiver. When the receiver estimates the distance to at least four GPS satellites, it can calculate its position in three dimensions.

D _____

The integration of GPS technology into GIS activities can be achieved through a variety of means. They include: the transfer of data from GPS systems, building new databases, integrating GPS technology into existing GIS systems, conducting spatial analysis directly in the field.

E _____

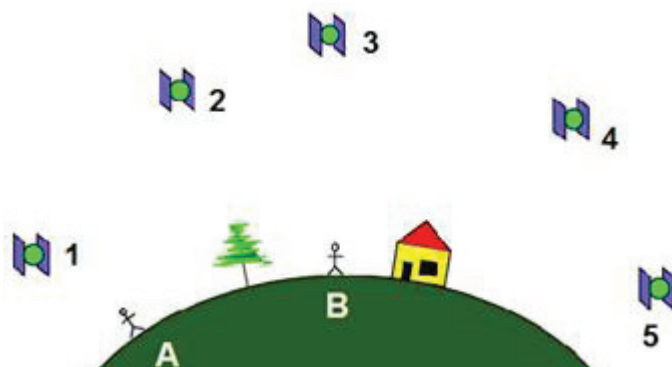
Apart from being used as a GIS data collection tool, GPS can locate precisely objects (called features) which are then mapped and described in terms of a multi-layered database. Accuracy of GPS data is another important consideration. When used autonomously, GPS, is accurate to approximately 12 m. Dual-Frequency receivers are capable of providing sub-centimetre GPS position. The creation of geographic information as user-generated Web content breaks down of the traditional distinction between experts and amateurs. Amateurs began to create “mash-ups”, using the APIs of Web services to produce digital map of the world relying on social networking and GPS (“Neogeography”).

3. Put the paragraphs in the correct order (1-5).

4. Answer the questions.

1. What is GPS?
2. Which GPS network is most widely used nowadays?
3. What is the name of the Russian global navigation satellite system?
4. What is the time reference provided by?
5. When can the receiver calculate its position in three dimensions?
6. How can the distance to the GPS satellites be determined?
7. How are the satellites spaced above the earth?
9. How accurate are GPS data?
10. What is neogeography?

5. One can “see” a GPS satellite if you can draw a straight line connecting the GPS receiver to the GPS satellite that does not go through any objects (including the Earth). In answering the following questions, assume that the observers are holding their GPS receivers near their heads.



1. Which GPS satellites can Observer A see?
2. Which GPS satellites can Observer B see?
3. Which satellites can be seen by both Observers A and B? (This is called «simultaneous visibility.»)
4. Which satellites cannot be seen by either Observer A or Observer B?
5. If the tree were removed, which satellites would now become visible to Observer A? To Observer B?
6. Which satellites does the house prevent Observer A from seeing? Observer B?
7. If the tree and the house were removed, which Observer could detect all the satellites?
8. If the tree and the house were removed, which Observer would not be able to see all the satellites? Why not? (What gets in the way?)
9. Draw an arrow indicating the direction that Satellite 5 would be moving if it were rising from the Observers' viewpoint. Which Observer would see it first?
10. Which satellites are visible more often, satellites directly overhead or satellites near the horizon? Why?

Listening 2

1. Watch a video about how GPS works at. <http://www.youtube.com/watch?v=3zRIbboMvb0#t=35> . Answer the questions.

1. Why do four satellites need to be visible?
2. How does GPS locate itself?
3. What is trilateration?
4. How do GPS receivers know how far they are from the satellite?
5. Do satellites have stop watches?
6. What happens if a satellite malfunctions?
7. What would happen if GPS was only receiving a signal from one or two satellites?

Speaking

1. To make a question more polite, we can begin it with a phrase like *Could you tell me...? Could I ask you...? I'd like to know...?*

There are two important facts about such **Indirect Questions**:

The word order of an indirect question is like a normal statement:

DIRECT: How would GIS software help?

INDIRECT: Could I ask you how GIS software would help?

here there is no question word we use *if* or *whether*:

DIRECT: Does the map look balanced?

INDIRECT: Could you tell me if the map looks balanced?

Look at the questions from **Listening 2**. Make them indirect.

e.g.

1. Why do four satellites need to be visible? – *I'd like to know...*

2. Choose two GIS software packages. Using information from the Internet, compare them in terms of:

- cost,
- functionality,
- usability,
- reliability.

Use words and expressions of comparison from **Language Focus 2**. Work in pairs.

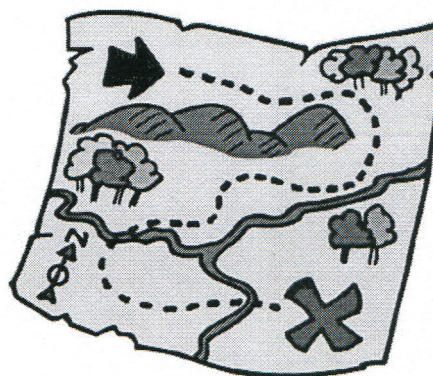
e.g. *QGIS has a faster startup time than ArcGIS. On the other hand, ...*

3. Choose one of geodata usage groups (**Reading 1**) or another area of GIS application and make a presentation.

Writing

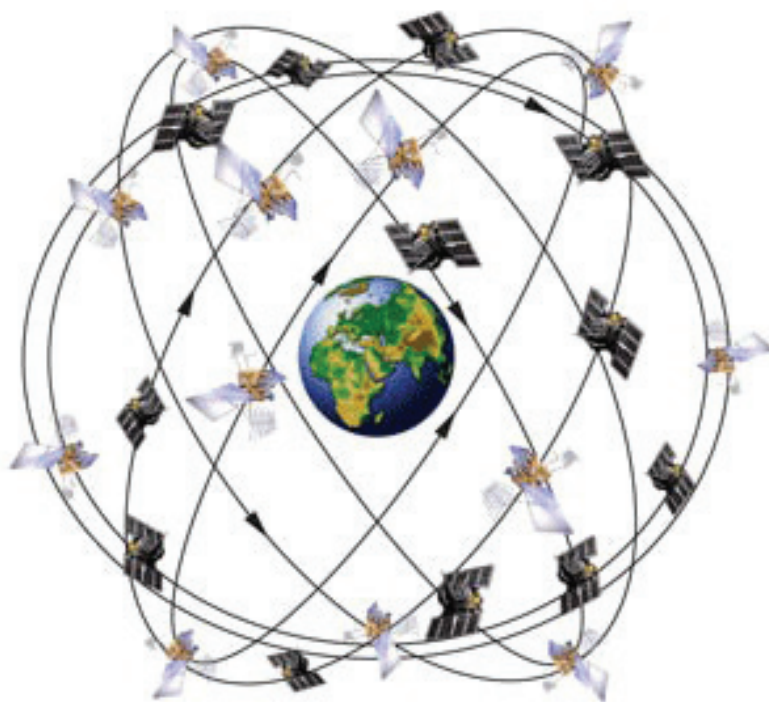
1. Write a short essay (about 250 words) on one of the following topics.

1. GIS history.
2. GIS future trends.
3. Geocaching: Adventure or Sport?
4. Ethical GIS practice.
5. GPS: Global Competition.
6. Neogeography.



UNIT 10

Satellite Navigation Systems: GPS



Lead in

1. “Where am I? How do I get to my destination?” These questions have been asked since ancient times. Various techniques have been tried for centuries to find a solution for the problem of identifying positions.

Work in pairs and brainstorm at least three reasons why people might need to determine their position.

2. Discuss the following questions.

- a) In what areas is identifying location of vital importance?
- b) What technologies, techniques and instruments are used to determine a position?
- c) What techniques do you use to identify your position and find a way? Do you like maps or prefer using a satellite navigation system? Why?

3. Work with another pair. Compare your ideas and agree on the most efficient technology for determining positions. Think of as many arguments as possible to confirm your conclusion.

Vocabulary

1. Satellite navigation systems have revolutionized the area of navigation and proved to be the most efficient and reliable for establishing locations.

These are some basic words used in relation to satellite navigation. Match the terms in the box with the definitions below.

coverage	eccentricity	constellation	inclination	tracking
sidereal hour	Doppler shift (frequency)		semi-major axis	
	sine wave (carrier frequency)			

1. The activity of continuous checking and recording the position and movements of space vehicles and satellites.
2. A parameter that determines the amount by which an astronomical object's orbit around another body deviates from a perfect circle. A value of zero is a circular orbit, values between 0 and 1 form an elliptical orbit.
3. A 24th part of a sidereal day (the time required for a complete rotation of the earth in reference to any star, it is about 4 minutes shorter than a mean solar day).
4. The geographic area where a communications system can operate.
5. One of the six orbital parameters that describes the shape and orientation of a celestial orbit. It is the angular distance of the orbital plane from the plane of reference (for satellite orbits it is usually the equatorial plane, the plane perpendicular to the axis of rotation of the central body), normally measured in degrees.
6. Any periodic oscillation with the waveform of a sine curve, its amplitude, frequency or phase is varied or modulated to transmit a signal.
7. The amount of the change in the frequency of a wave due to the specific effect (it is named after the Austrian scientist who discovered it. It consists in the change in the wavelength (or frequency) of energy in the form of waves, e.g. sound or wave, resulted from motion either the source or the receiver of the waves), usually expressed in hertz.
8. A number of satellites that are part of a system and have a similar orbit.
9. Either of the equal line segments into which the major axis of an ellipse is divided by the center of symmetry.

2. Form derivatives (nouns, adjectives and adverbs) from the verbs below.

navigate

operate

receive

transmit

use

orbit

equip

3. Make up sentences using some of the words you have formed.

Reading

1. You are going to read the article about GPS, the global navigation system. Before you read the text, take a guess and choose the correct option to fill in the spaces in the sentences below.

Then compare your answers with those of your partner and decide whose guesses are more accurate.

1. GPS is a U.S. ... global navigation system.

- a) ground-based b) sea-based c) space-based

2. The system was developed in the early

- a) 1960s b) 1970s c) 1990s

3. GPS comprises ... satellites orbiting the Earth.

- a) 24 b) 38 c) 52

4. GPS consists of ... segments.

- a) 5 b) 4 c) 3

5. Each GPS satellite transmit a ... radio signal.

- a) very-high frequency b) microwave c) ultra-high frequency

6. The transmitted signals are controlled by ... onboard the satellites.

- a) atomic clocks b) computers c) antennas

7. GPS is currently available to

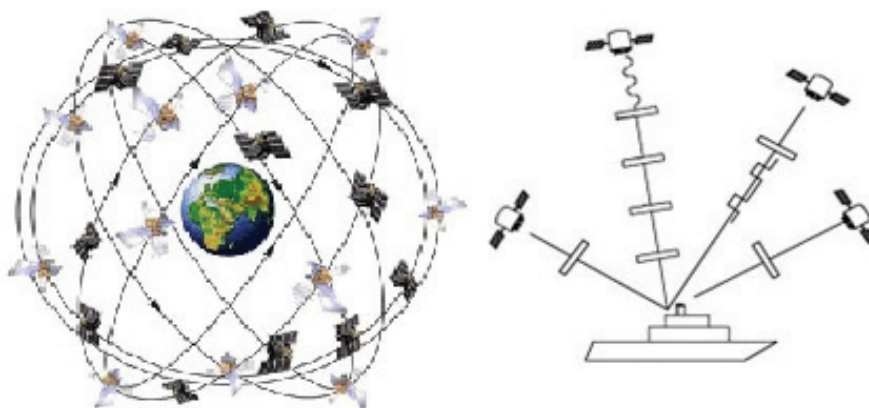
- a) military users b) civilian users c) both military and civilian users

2. Read the text and check whether your guesses were right.

GPS: The Components and Basic Concept

1. The Global Positioning System (GPS) is a satellite-based navigation system that was developed by the U.S. Department of Defense in the early 1970s. GPS was designed as a military system to fulfill U.S. military needs. However, later it became available to civilians, and now it is a dual-use system that can be accessed by both military and civilian users.

2. GPS provides continuous positioning and timing information, anywhere in the world under any weather conditions. Since the system not only serves an unlimited number of users but also is used for security reasons, GPS is a one-way-ranging (passive) system, i.e. users can only receive the satellite signals.



GPS Navigation

3. GPS consists of a constellation of 24 operational satellites. This constellation, known as the initial operational capability (IOC), was completed in July 1993. To ensure continuous worldwide coverage, GPS satellites are arranged so that four satellites are placed in each of six orbital planes. This constellation geometry allows making four to ten GPS satellites visible anywhere in the world at an elevation angle of 10° .

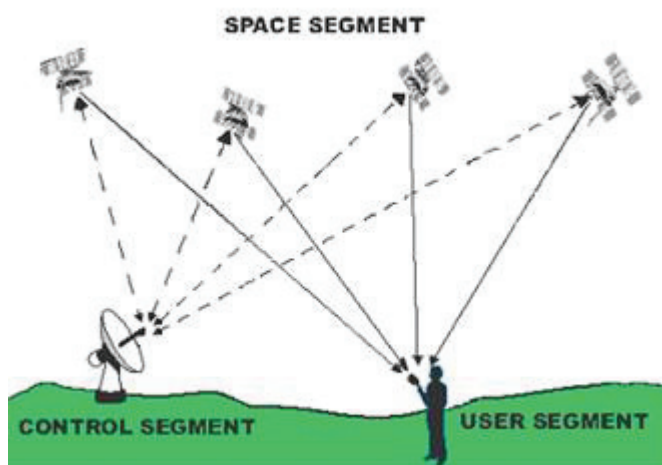
4. GPS satellite orbits are nearly circular (an elliptical shape with a maximum eccentricity is about 0.01), with an inclination of about 55° to the equator. The semi-major axis of a GPS orbit is about 26,560 km (i.e., the satellite altitude of about 20,200 km above the Earth's surface). The corresponding GPS orbital period is about 12 sidereal hours (~ 11 hours, 58 minutes). The GPS system was officially declared to have achieved full operational capability (FOC) on July 17, 1995, ensuring the availability of at least 24 operational GPS satellites. In fact, the number of satellites in the GPS constellation has always been more than 24 operational satellites.

5. GPS consists of three segments: the space segment, the control segment, and the user segment. The space segment includes the 24-satellite constellation. Each GPS satellite transmits a microwave radio signal composed of two sine waves (also known as carrier frequencies) modulated by two digital codes and a navigation message. The two carrier frequencies are generated at 1,575.42 MHz (referred to as the L1 carrier) and 1,227.60 MHz (referred to as the L2 carrier). The corresponding carrier wavelengths are approximately 19 cm and 24.4 cm, respectively, which result from the relation between the carrier frequency and the speed of light in space. The availability of the two carrier frequencies allows for correcting a major GPS error, known as the ionosphere delay. All of the GPS satellites transmit the same L1 and L2 carrier frequencies. The code modulation, however, is different for each satellite, which significantly minimizes the signal interference.

The codes and the navigation message are added to the carriers as binary bi-phase modulations. The carrier and the codes are used to determine the distance from the user's receiver to the GPS satellites. The navigation message contains, along with other information, the coordinates (the location) of the satellites as a function of time. The transmitted signals are controlled by highly accurate atomic clocks onboard the satellites.

The control segment of the GPS system consists of a worldwide network of tracking stations, with a master control station (MCS) located in the United States at Colorado Springs, Colorado. The primary task of the operational control segment is tracking the GPS satellites to determine and predict satellite locations, system integrity, the satellite atomic clock operation, atmospheric data, the satellite almanac (rough orbits and status information for each satellite in the constellation). This information is then packed and uploaded into the GPS satellites through the S-band link.

The user segment includes all military and civilian users.



6. The idea behind GPS is rather simple. A GPS receiver picks up the GPS signal through the antenna and processes it using its built-in software. The outcome of the signal processing is the distances to the GPS satellites in the form of digital codes (known as the pseudo-ranges) and the satellites coordinates through the navigation message.

7. One of the important GPS uses is determining the user's velocity by several methods. The most widely used method is based on estimating the Doppler frequency of the received GPS signal. It is known that the Doppler shift occurs due to the relative satellite-receiver motion. GPS may also be used in determining the attitude of a body, such as an aircraft or a marine vessel. The word «attitude» means the orientation, or the direction, of the body, which can be described by the three rotation angles of the three axes of the body with respect to a reference system. Attitude is determined by equipping the body with a minimum of three GPS receivers (or one special receiver) connected to three antennas, which are arranged in a non-straight line. Data collected at the receivers are then processed to obtain the attitude of the body.

Comprehension Check

1. Find words in the text with the following meaning.

1. to have the right or opportunity to get or use something (e.g. information)
2. happening without stopping or being interrupted
3. to provide something that people need
4. able to be seen
5. the height of an area of land, usually measured from sea level
6. to send data or programs from one computer to a larger system
7. a mistake, e.g. in a calculation or a decision
8. the quality of being in a good condition, without any damage or mistakes
9. the ability to do something in a precise way

2. The text contains a number of important collocations (fixed expressions). Match words in A with words in B to make collocations and use them to complete the sentences given below.

A

1. worldwide
2. navigation
3. weather
4. digital
5. atomic
6. reference
7. built-in
8. carrier
9. tracking
10. signal

B

- a. code
- b. wavelength
- c. software
- d. coverage
- i. interference
- f. conditions
- g. station
- h. clock
- i. system
- j. message

1. The ... result from the relation between the carrier frequency and the speed of light in space.
2. The ... contains, along with other information, the coordinates of the satellites as a function of time.
3. The receiver processes the GPS signal using its
4. GPS provides positioning and timing information worldwide under any
5. The transmitted signals are controlled by highly accurate ... onboard the satellites.
6. Attitude of the body can be described by the three rotation angles of the three axes of the body with respect to
7. To provide continuous ... , GPS satellites are arranged so that four satellites are placed in each of six orbital planes.
8. One of the outcomes of the signal processing includes the distances to the GPS satellites through
9. The control segment of the GPS system consists of a worldwide network of ...
10. The code modulation is different for each satellite to minimize

3. Ask questions to which the following statements could be answers.

- a. To fulfill U.S. military needs.
- b. Because GPS serves an unlimited number of users.
- c. Four to ten GPS satellites.
- d. Two sine waves, two digital codes, and a navigation message.
- e. The availability of the two carrier frequencies.
- f. To all users worldwide.
- g. Because of the relative satellite-receiver motion.
- h. By equipping the body with three GPS receivers.

4. The text can be divided into several logical parts. How many parts can be distinguished? What is the topic of each part? Think of a title for each part and write an outline of the text.

Compare your outline with this of your partner. Do you have the same or different number of parts?

5. Find words in the text with the following meaning.

Language Focus

1. Work in pairs and discuss what experimental satellite navigation systems led to the development of the modern positioning systems.

To find out more about the history of GPS and check your ideas read the passage below. The sentences in the passage have been jumbled. Rearrange the sentences to make up a complete text.

History OF GPS

1. The design of GPS is based partly on similar ground-based radio navigation systems, such as LORAN and the Decca Navigator developed in the early 1940s, and used during the Second World War.
2. The first GPS satellite was launched in 1989 and the 24th was put into orbit in 1994.
3. A team of U.S. scientists led by Dr. Richard B. Kushner was monitoring Sputnik's radio transmissions.

4. In 1967, the U.S. Navy developed the Timation satellite, which proved the feasibility of placing accurate clocks in space, a technology that GPS relies upon.
5. The launch of the first artificial satellite, Sputnik, by the Soviet Union in 1957 inspired another stage in the GPS development.
6. The first satellite navigation system, Transit, used by the United States Navy was successfully tested in 1960.
7. Initially, the highest quality signal was reserved for military use, and the signal available for civilian use intentionally degraded (Selective Availability).
8. In the 1970s, the ground-based Omega Navigation System operating on phase comparison of signal transmission from pairs of stations became the first worldwide radio navigation system.
9. They discovered that, because of the effect, the frequency of the signal being transmitted by Sputnik became higher as the satellite approached and lower as it continued away from them.
10. It used a constellation of five satellites and could provide a navigational fix approximately once per hour.
11. In 1983, President Ronald Reagan issued a directive making GPS freely available for civilian use as soon as it was sufficiently developed.
12. Selective Availability was cancelled in 2000, thus, the precision of civilian GPS was improved from 100 meters to about 20 meters.
13. They realized that since they knew their exact location on the globe, they could pinpoint the satellite position along its orbit by measuring the Doppler distortion.

2. Positioning, or finding the user's location, with GPS requires some understanding of the GPS signal structure and how the measurements can be made.

Read the text about the signal structure and fill in the gaps with appropriate words. You should use auxiliary verbs, articles, prepositions, conjunctions and pronouns. There is an example (0) at the beginning.

GPS Signal Structure

The two GPS codes (0) *are* called coarse acquisition (or C/A-code) and precision (or P-code). Each code consists 1) ...a stream of binary digits known 2) ... bits or chips. The codes are generated using a mathematical algorithm. The C/A-code is modulated onto the L1 carrier only, 3) ... the P-code is modulated onto both the L1

and the L2 carriers. This modulation is called bi-phase modulation, 4) ... the carrier phase is shifted by 180° when the code value changes from zero to one or from one to zero.

The C/A-code is a stream of 1,023 binary digits that repeats 5) ... every millisecond. This means that the chipping rate of the C/A-code is 1.023 Mbps. 6) ..., the duration of one bit is approximately one millisecond that is equivalent to 300m. Each satellite is assigned a unique C/A-code that enables the GPS receivers to identify 7) ... satellite is transmitting a particular code. 8) ... C/A-code range measurement is less precise compared 9) ... that of the P-code. It is, however, less complex and is available to all users.

The P-code is a very long sequence of binary digits that repeats itself after 266 days. It is also ten times faster 10) ... the C/A-code (i.e., its rate is 10.23 Mbps). The 266-day-long code 11) ... divided into 38 segments, each is one week long. 32 segments of these segments are assigned to the various GPS satellites. That is, each satellite transmits 12) ... unique 1-week segment of the P-code, which is initialized every Saturday/Sunday midnight crossing. The remaining six segments are reserved for 13) ... uses. A GPS satellite is usually identified by 14) ... unique 1-week segment of the P-code. The P-code is designed primarily 15) ... military purposes.

The GPS navigation message is a data stream added to both the L1 and the L2 carriers as binary bi-phase modulation 16) ... a low rate of 50 kbps. It includes 25 frames of 1,500 bits each, or 37,500 bits in total. This means that the transmission of the complete navigation message takes 750 seconds, or 12.5 minutes. The navigation message contains the coordinates of the GPS satellites as a function of time, the satellite health status, the satellite clock correction, the satellite almanac, and atmospheric data. Each satellite transmits its own navigation message with information on the other satellites, 17) ... the approximate location and health status.

3. The GPS signal is picked up by a GPS receiver. Therefore, understanding the features and limitations of various types of GPS receivers is essential.

The passage below is about the GPS receiver types. Skim it quickly without paying attention to the gaps in order to find out:

- ✓ what types of GPS receivers are available;
- ✓ what features should be taken into account while choosing a GPS receiver.

4. Read the text and decide which word A, B, C or D best fits each space. There is an example (0) at the beginning.

Types of GPS Receivers



In 1980, only one commercial GPS receiver was available on the market at a price of several hundred thousand U.S. dollars. The situation, however, has changed (0) considerably since more than 500 different GPS receivers are available in the market today. A GPS receiver requires an antenna 1)to it, either internally or externally. The antenna receives the incoming satellite signal and 2)its energy into an electric current, which can be handled by the GPS receiver.

Commercial GPS receivers can be divided into four types, according to their receiving 3) These are single-frequency code receivers, single-frequency carrier-smoothed code receivers, single-frequency code and carrier receivers, and dual-frequency receivers. Single-frequency receivers access the L1 frequency only, while dual-frequency receivers access both the L1 and the L2 frequencies. GPS receivers can also be categorized according to their number of tracking 4), which varies from one to 12. A good GPS receiver would be multichannel, with each channel 5)to continuously tracking a particular satellite. Most GPS receivers have from nine to 12 independent (or parallel) channels. Features such as cost, ease of use, power 6), size and weight, internal and/or external data-storage capabilities, interfacing capabilities, and multipath mitigation are to be considered when choosing a GPS receiver.

The first receiver type, the single-frequency code receiver, measures the pseudo-ranges with the C/A-code only. No other measurements are available. It is the least expensive and the least 7)receiver type, and is mostly used for recreation purposes. The second receiver type, the single-frequency carrier-smoothed code receiver, also

measures the pseudo-ranges with the C/A-code only. However, with this receiver type, the higher-resolution carrier frequency is used internally to 8) ... the resolution of the code pseudo-range, which 9)in high-precision pseudo-range measurements. Single-frequency code and carrier receivers output the raw C/A-code pseudo-ranges, the L1 carrier-phase measurements, and the navigation message. In 10), this receiver type is capable of performing the functions of the other receiver types.

Dual-frequency receivers are the most 11)and expensive receiver type that outputs the key GPS signal components.

- | | | | |
|-------------------------|-----------------------|------------------------------|---------------|
| 0. A <i>importantly</i> | B <i>consistently</i> | <u>C <i>considerably</i></u> | D <i>very</i> |
| 1. A attached | B attendant | C adjacent | D adjoined |
| 2. A circulates | B combines | C converts | D collects |
| 3. A opportunities | B chances | C capabilities | D functions |
| 4. A paths | B channels | C ways | D routes |
| 5. A destined | B derived | C deserved | D dedicated |
| 6. A use | B consumption | C dissipation | D application |
| 7. A popular | B accurate | C available | D widespread |
| 8. A improve | B modify | C upgrade | D change |
| 9. A leads | B indicates | C results | D presents |
| 10. A fact | B conclusion | C general | D addition |
| 11. A sophisticated | B fashionable | C eye-catching | D amazing |

5. Read the extract about measuring the range to the satellites and choose the correct form in each case.

Pseudo-Range Measurements

The pseudo-range is a measure of the range, or distance, between the GPS receiver and the GPS satellite (more precisely, it is the distance between the GPS receiver's antenna and the GPS satellite's antenna). The ranges from the receiver to the satellites are 1) *required* / *requires* for the position computation. Either the P-code or the C/A-code can be used for 2) *measuring* / *measured* the pseudo-range.

The procedure of the GPS range determination can be described as follows. Let us assume that both the satellite and the receiver clocks, which control the signal generation, are perfectly *3) synchronizing / synchronized* with each other. When the code is transmitted from the satellite, the receiver *4) is generated / generates* an exact replica of that code. The transmitted code will *5) be picked up / pick up* by the receiver in a moment equal to the signal travel time in space. Comparing the *6) transmitted / having transmitted* code and its replica, the receiver can compute the signal travel time. Multiplying the travel time *7) to / by* the speed of light *8) gives / is given* the range between the satellite and the receiver.



Unfortunately, the assumption that the receiver and satellite clocks are synchronized *9) are / is* not exactly true. In fact, the measured range is deteriorated, along *10) in / with* other errors and biases, by the *11) synchronize / synchronization* error between the satellite and receiver clocks. For this reason, this quantity is referred *12) on / to* as the pseudo-range, not the range.

GPS was designed so that the range *13) determining / determined* by the civilian C/A-code would be less precise than that of military P-code. This is based *14) on / in* the fact that the resolution of the C/A-code, 300m, is ten times lower than the P-code. Surprisingly, *15) because / due to* the improvements in the receiver technology, the obtained accuracy was almost the same from both codes.

6. Although GPS was originally designed as a military system, its civil applications have grown much faster. Nowadays GPS has numerous land, marine and airborne applications.

Work in groups and brainstorm what benefits people derive from using GPS. Make a list of the most important GPS applications.

Compare your views with those of your group-mates and decide on the most vital and perspective GPS uses.

7. Read the text about GPS applications and check whether your ideas were right. Ten sentences have been removed from the text. While reading, choose from the sentences (A– K) the one, which fits each gap. There is one extra sentence you need not use.

GPS Applications

GPS has found its way into many industrial applications, replacing conventional methods in most cases, because it provides high-accuracy positioning in a cost-effective manner. The GPS technology is indispensable for mapping, surveying, monitoring different structures and activities, automatic machine guidance and control. Vehicle tracking and navigation are among the most rapidly growing applications.

Accurate and up-to-date maps of utilities are essential for utility companies. 1 _____. The GPS system provides a cost-effective, efficient and accurate tool for creating utility maps. With the help of GPS, locations of gas lines can be accurately collected, along with their conditions. Buried utilities such as electric cables or water pipes can also be mapped efficiently using GPS.



GPS has been applied successfully in many areas of the forest industry. Typical applications include fire prevention and control, harvesting operations, insect infestation, boundary determination and aerial spraying. 2 _____ . GPS is a key technology that enables a system operator to identify and monitor the exact location of the resources.

Civil engineering works are often done in a complex and dangerous environment, making it difficult for personnel to operate efficiently. 3 _____ . Construction firms use GPS in many applications such as road construction and fleet management.

Since its early development, GPS has been used for monitoring the stability of structures, an application that requires the highest possible accuracy. The system is used for monitoring the deformation of dams, bridges, TV towers and ground subsidence of oil fields and mining areas. 4 _____ .

Slow-deforming structures such as dams require sub-millimeter– to millimeter-level accuracy to monitor their displacement. Although this accuracy level may be achieved with GPS alone under certain conditions, it is not a cost-effective method. To monitor such structures effectively, GPS should be supplemented with geotechnical sensors and special types of stations. Bridges, in contrast, are subjected to vibrations caused by dynamic traffic loads. 5 _____ .

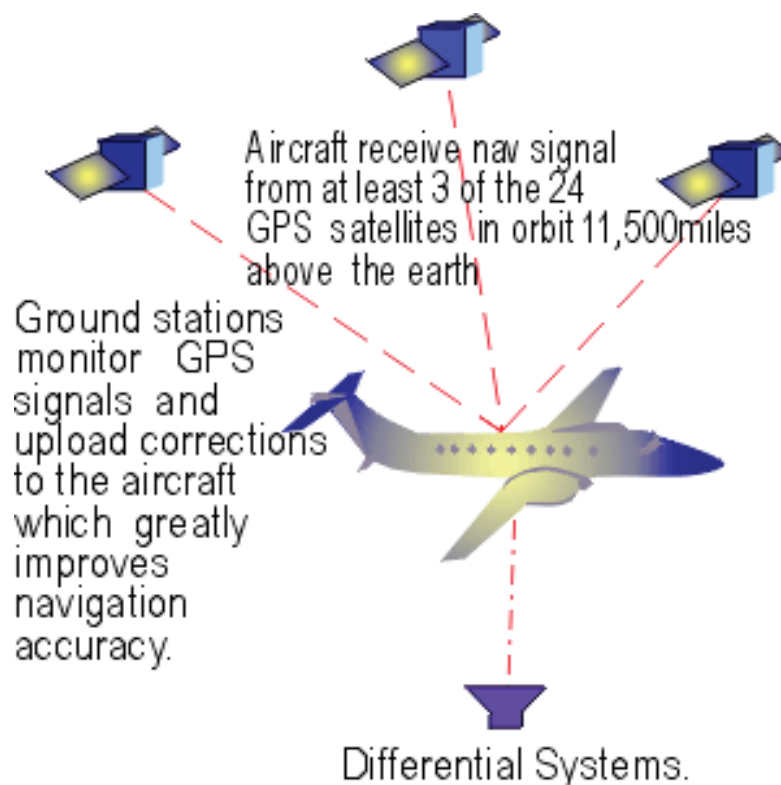
GPS is successfully used for topographic mapping of small-size areas. A user takes positions of the points on the ground where the topography changes for producing the topographic map of that area. However, the use of GPS alone becomes time-consuming and cost-ineffective for mapping large areas, coastal areas, forests and inaccessible areas.

Traditionally, classical airborne photogrammetry was applied for this purpose. 6 _____. For practical use, the captured images must first be related to the geodetic reference system, a process known as geo-referencing the images. In classical airborne photogrammetry, the geo-referencing is done indirectly with the help of a number of ground control stations with known geodetic coordinates and their corresponding image coordinates. 7 _____. The use of GPS in airborne photogrammetry has significantly reduced the required number of ground control points. Direct geo-referencing of the captured images can be achieved when using an integrated GPS/ inertial system onboard the aircraft that allows the captured images to be directly related to the geodetic reference system without using ground control points.

8 _____. LIDAR uses an airborne laser scanner to measure the altitude of the points above the ground level. Combining the GPS/inertial-based position and orientation of the laser with the measured altitude of the points leads to direct acquisition of accurate digital elevation models (DEM). Another advantage of the LIDAR system is

that the data can be collected at night as well as under cloudy and high wind conditions. Moreover, the LIDAR system can be used in mapping featureless areas such as deserts and areas covered by snow and ice and is attractive to the forest industry as well.

The technology incorporating GPS with digital road maps and a computer allows obtaining route guidance electronically with a touch of a button. The vehicle location is superimposed on an electronic digital road map, containing in its database digital information such as street names and directions, airports, attractions, and other related information. 9 _____. Factors such as shortest distance and time to destination, one-way roads, illegal turns, and rush-hour restrictions, are all considered in the path finding. The driver usually gets turn-by-turn instructions, with audio and/or visual indications, to the destination. If the driver misses a turn, the system displays a warning message and finds an alternative best route based on the current location of the vehicle. Some manufacturers add wireless systems to provide weather and traffic information and to locate the vehicles in case of emergency as well as the Internet access from their vehicles.



GPS has become the most valuable method of navigation in the modern aviation world due to its accuracy, reliability and ease of use. The GPS system applies triangulation technique to determine the exact aircraft position and provide pilots with precise location data. 10 _____.

Some high-end GPS receivers even provide turn-by-turn navigation assistance when taxiing an aircraft on the ground.

- A. The GPS ability to provide real-time sub-meter– and centimeter-level accuracy in a cost-effective way has significantly changed the civil engineering industry.
- B. Integrated GPS/GLONASS and GPS/digital barometer systems have been used in situations of poor GPS signal reception.
- C. To monitor effectively such cyclic deforming structures dual GPS receivers should be located at several points with maximum amplitude of cyclic deformation.
- D. The availability of such maps helps electric, gas and water utility companies to plan, build and maintain their assets.
- E. Other applications such as airborne remote sensing and light detection and ranging (LIDAR) benefit greatly from direct geo-referencing using the integrated GPS/inertial system.
- F. Deformation monitoring is done by taking GPS measurements over the same area at different time intervals.
- G. Modern GPS receivers supply real-time air traffic information, weather reports, coloured terrain mapping and airport directory information.
- H. Since the forest service encounters thousands of fires every year, an efficient resource-management system is essential.
- I. In recent years, GPS has been used onboard the aircraft to provide the precise position of the aerial camera and the precise time of each aerial exposure.
- J. Once the driver inputs a destination the built-in computer finds the best route to reach that destination.
- K. With this method, an aircraft-mounted camera captures a sequence of images for the area to be mapped.

Speaking

1. The research laboratory you work for specializes in developing innovative communications systems. Your team is responsible for a concept of an advanced GPS receiver. Hold a meeting with your partners to decide on.

- ✓ performance and technical characteristics of a receiver
- ✓ its purpose and functions it will provide
- ✓ operational principles
- ✓ optional features, upgrading
- ✓ areas of application
- ✓ budget you would need to develop and test a receiver
- ✓ how you are going to promote a receiver

2. Take turns to make a presentation of your concept to the group. Which project is the best?

3. Work in two groups:

Group A. You are designers of a new enhanced GPS receiver.

You have been invited to participate in an international exhibition and present your device. Be prepared to demonstrate your device and answer visitors' questions.

Group B. You are visitors to an international exhibition.

You are interested in innovative satellite systems. Brainstorm questions you could ask about a new GPS receiver you see at the exhibition. You would like to find out about its performance, functions, features, advantages and price.

4. Role-play your conversation.

Writing

1. You have been asked to write a review of GPS receivers currently in the market for a popular website on electronic gadgets.

In your review, you should describe models available in the market at present, express your opinion of them highlighting their advantages and drawbacks and make recommendations which one to choose.

2. Write a plan for your review including:

- Introduction: available models, your opinion of them
- Main body: description of gadgets, analysis of their advantages/drawbacks
- Conclusion: a recommendation

3. Write your review. Write 180-200 words.

UNIT 11

Satellite Navigation Systems: GPS or GLONASS?



Lead in

1. It is undeniable that GPS has become indispensable worldwide. It plays a crucial role in an enormous range of activities. Nevertheless, is GPS the only system available for navigation nowadays?

Work in pairs and brainstorm at least three reasons why people might need to determine their position.

1. What other satellite navigation systems have been developed in the world?
2. What countries are planning to develop satellite-based navigation systems?

2. Try to guess what acronyms GNSS, GLONASS, DORIS stand for.

Compare your ideas with those of other students. Whose guesses are more accurate?

3. To check whether your guesses were correct read the extract below. While reading complete it by filling in the gaps with the words and phrases in the box.

satellites term positioning
satellite navigation systems
Doppler coverage

GPS, GNSS, GLONASS or DORIS?

These acronyms refer to all types of 1) They provide geo-spatial 2) across the earth using a system of 3) A system with global 4) is known as a global navigation satellite system (GNSS). At present, there are only two GNSS in the world. These are the USA's global positioning system (GPS) and the Russian GLONASS (global navigation satellite system). China are expecting their Compass navigation system to be a global system by 2020 and the European Galileo positioning system should go global shortly after this date.

GNSS is therefore a generic 5) for systems such as GPS and GLONASS.

DORIS is the 6) Orbitography and Radio positioning integrated by satellites system, which is a navigation system being developed by France.

Reading

1. The article below is about GLONASS, the Russian navigation system. Before you, read try to predict what issues will be discussed in the text choosing the statements from those given below.

- ✓ Purpose of GLONASS
- ✓ GLONASS architecture
- ✓ History of GLONASS
- ✓ The GLONASS signal components
- ✓ GPS/GLONASS integration
- ✓ Difference between two systems
- ✓ Problems with GPS/GLONASS integration
- ✓ Advantages of GLONASS over GPS
- ✓ GLONASS applications

2. Read the text to check if your predictions were right.

GLONASS Satellite System

GLONASS is an all-weather global navigation satellite system developed by the Russian Federation. The GLONASS satellite system has much in common with the GPS system and provides reliable positioning, navigation, and timing services to users on a continuous worldwide basis freely available to all. It can be considered as an alternative and complementary to other GNSS systems such as the United States' GPS, the Chinese BeiDou navigation system and the planned Galileo system of the European Union.

The first Soviet navigation spacecraft “Cyclone” was launched into orbit in 1967. This was the beginning of the first Soviet low orbit navigation system, called “Cicada”. It consisted of four satellites placed in circular orbits at an altitude of 1000 km and an inclination of 83° and provided positioning data within several hundred meters. Since the requirements to space navigation were constantly increasing, low-orbit systems could not comply with the needs of all potential users. Thus, flight tests of high altitude (20000 km) satellite navigation system, called GLONASS were started in 12 October 1982 with the launch of the Kosmos-1413, Kosmos-1414, and Kosmos-1415. In 1993, the Russian Federation formally declared the system operational, and in 1995, the system was brought to its optimal status of 24 operational satellites.

Similar to GPS, each GLONASS system Space Vehicle (SV) “GLONASS” and “GLONASS-M” transmits a radio signal that has a number of components: two L-band carriers (L1 ~ 1.6 GHz, L2 ~ 1.25 GHz), C/A-code on L1, P-code on both L1 and L2 and a navigation message. GLONASS relies on the Frequency Division Multiple Access (FDMA) technique instead of the CDMA used by other GNSS systems such GPS or GALILEO. Each satellite transmits signals on its own carrier frequency. The satellite pairs, however, are placed on the opposite sides of the Earth (antipodal), which means that a user cannot see them simultaneously. GLONASS codes are the same for all satellites. Therefore, GLONASS receivers use the frequency channel rather than the code to distinguish the satellites. The chipping rates for the P-code and the C/A-code are 5.11 and 0.511 Mbps, respectively. The GLONASS navigation message is a 50-bps data stream, which provides, among other things, the satellite ephemeris (precise orbital information) and the channel allocation.

GLONASS is comprised of three segments: a GLONASS Space Segment (SS), a GLONASS Ground Segment (CS), and a GLONASS User Segment (US).

According to the GLONASS Interface Control Document, the GLONASS Space Segment is composed of 24 satellites. Eight satellites are arranged in each of three orbital planes. The satellites operate in approximately circular orbits at an altitude of 19,100 km, an inclination of 64.8° and with the orbital period of 11 hours 15 minutes. The spacing of the satellites allows providing continuous and global coverage of the terrestrial surface and the near-earth space.

GLONASS Ground Segment includes the System Control Center and the network of the Command and Tracking Stations that are located throughout the territory of Russia. The control segment provides monitoring of GLONASS constellation status, correction to the orbital parameters and navigation data uploading.

GLONASS User Segment consists of the user receivers, which compute coordinates, velocity and time using the GLONASS navigation signals.

Two services are available from GLONASS system:

The Standard Positioning Service (or Standard Accuracy Signal service) is an open service, free of charge for worldwide users. The navigation signal was initially provided only in the frequency band G1, but the GLONASS-M transmits also a second civil signal in G2.

The Precise Positioning Service (or High Accuracy Signal service) is restricted to military and authorized users. Two navigation signals are provided in the two frequency bands G1 and G2.

GPS and GLONASS systems may be integrated to improve geometry and positioning accuracy, particularly under poor visibility such as in urban areas. There are, however, two problems with GPS/GLONASS integration. The first one is that both systems use different coordinate frames to express the position of their satellites. GPS uses the WGS 84 system, while GLONASS applies the Earth Parameter System 1990 (PZ-90). The two systems differ as much as 20 meters on the Earth's surface. The transformation parameters between the two systems may be obtained by observing reference points in both systems simultaneously. The second problem with GPS/GLONASS integration is in using different reference times. The offset between the two time systems changes slowly and reaches several tens of microseconds. One way of determining the time offset is by treating it as an additional variable in the receiver solution.

Comprehension Check

1. Find words in the text with similar meaning to the following words and phrases.

1. contain	.....
2. height	.....
3. roughly	.....
4. at the same time	.....
5. put in an order	.....
6. differentiate	.....
7. enhance	.....
8. making a good combination	.....
9. obey a rule or law	.....
10. discrepancy	.....
11. completely different	.....

2. Match words in A with words in B to make collocations and explain in relation with what these collocations are used in the text.

<i>A</i>	<i>B</i>
1. orbital	a. channel
2. chipping	b. satellite
3. urban	c. stream
4. frequency	d. period
5. operational	e. time
6. satellite	f. side
7. reference	g. area
8. data	h. frame
9. coordinate	i. ephemeris
10. opposite	j. rate

3. According to the text, are the following statements true or false? If they are false, explain why.

1. GLONASS and GPS are completely different systems; they do not have any similar features.
2. The development of high altitude satellite systems began because low-orbit systems could not meet increasing requirements to space navigation.
3. Each GLONASS satellite transmits a signal containing two carriers, two digital codes and a navigation message.
4. GLONASS includes three segments: a space segment, a ground segment and a user segment.
5. GPS/GLONASS integration is hardly feasible.
6. GLONASS receivers use the code rather than the frequency channel to distinguish the satellites.
7. GPS/GLONASS integration allows improving geometry and positioning accuracy.
4. Write a summary of the text in which outline the GLONASS purpose, features and architecture.

Language Focus

1. Any system needs improving and upgrading. Evidently, the GLONASS performance has not achieved the level of the GPS capability yet because of several factors, on-board atomic clock imperfections, the number of satellites in the constellation, ground monitoring and control limitations are among them.

Work in groups and brainstorm features that could improve the GLONASS efficiency. Make a list of feasible solutions.

Compare your ideas with those of other students. Do you have similar or different solutions?

2. To check your ideas read the extract about GLONASS modernization. While reading, choose the correct form in each case. There is an example at the beginning (0).

GLONASS Modernization

GLONASS Space Segment modernization began with the launch of the second generation of satellites, (0) known / knowing as GLONASS-M, in 2003. These satellites had some improvements, including new filters that 1) permitting/permitted the reduction of out-of-band emissions and 2) enhancing / enhanced on-board clock stability.

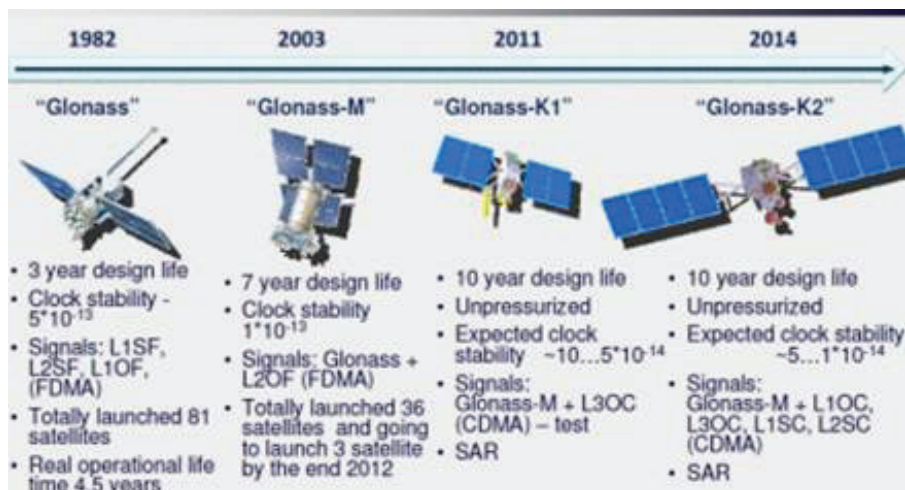
Aiming to provide 3) better / best accuracy, multipath resistance and greater interoperability with GPS and future GALILEO and other GNSS Systems, new GLONASS-K satellites will transmit CDMA (code division multiple access) signals 4) in / with addition to the system's traditional FDMA (frequency division multiple access). The GLONASS L3 signal is 5) centered / centering at 1207.14 MHz, the same frequency as Galileo/BeiDou signal E5b, in the region allocated to the Aeronautical Radio 1 Navigation Service (ARNS). These bands are especially suitable for Safety-of-Life applications because no other users 6) allow / are allowed to interfere 7) on / with their signals.

The first satellite of the third generation, GLONASS-K1, 8) launched / was launched on February 26, 2011. GLONASS-K1 satellites 9) have / are having a ten– 10) year / years design life and transmit a CDMA civil signal at L3 frequency in the 1205 MHz band.

The future GLONASS-K2 satellites to 11) be / being launched in 2014 have a 10-year design life, a higher clock stability and feature four additional CDMA signals as well as the original FDMA signals.

A 12) modernized / modernizing GLONASS-K satellite (GLONASS-KM) could transmit legacy FDMA signals on L1 and L2 and CDMA signals on L1, L2, and L3. It could also transmit CDMA signals on the GPS L5 frequency and Galileo signal E5a at 1176.45 MHz.

By 2020, the system is scheduled to have all satellites transmitting 13) either / both the CDMA and FDMA signals.



Space Segment

As for the ground segment, there are plans to enhance it 14) with / by adding fifteen new reference stations, with six of them located outside the Russian territory.

The development of both the GLONASS tracking capabilities and the steady increase in the number of GLONASS satellites 15) has had / has been having a positive influence on the accuracy of the GLONASS orbits and clocks.

To improve the interoperability with other GNSS systems, GLONASS coordinate system 16) has matched / has been matched with the International Terrestrial Reference System (ITR), an international standard.

3. Another system that is likely to become a global navigation system in the future is the Galileo system being developed by Europe.

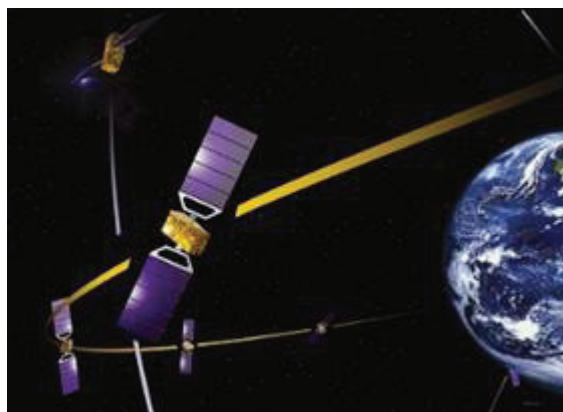
The text below is about the Galileo system. Read the text and choose the best sentence (A-H) given below to fill in the blanks in the text. Two of the suggested options do not fit at all.

Future European Global System

The Galileo system is a European-controlled, satellite-based global navigation system. 1)_____.

Three different constellation types were investigated to ensure the optimum Galileo architecture, namely low Earth orbits (LEO), medium Earth orbits (MEO) and inclined

geo-synchronous orbits (IGSO). Following this study, a constellation of 30 MEO satellites was adopted. 2) _____. This selection ensures that more uniform performance is obtained for all regions (i.e. independent of the region latitude).



Galileo is compatible at the user level with the GPS and GLONASS systems. 3) _____. With positioning accuracy to one meter, the freely accessible Galileo Open Service (OS) provides positioning, timing and synchronization information significant for satellite radio navigation applications. 4) _____.

The Galileo Open Service is accessible through the signals at L1, E5a and E5b frequencies. Several combinations are also possible, such as a dual frequency service based on L1 and E5a or single frequency services (at L1, E5a, E5b or E5a and E5b together), and even triple frequency services using all the signals together (L1, E5a and E5b), which can be exploited for very precise applications.

5) _____. Each navigation frequency will include two ranging code signals (in-phase and quadrature). Data are added to one of the ranging codes while the other “pilot” ranging code does not contain any data for more precise and robust navigation measurements.

The introduction of Galileo operational service is implemented gradually, in a number of phases. 6) _____. At this stage, however, accuracy and availability have not reached their optimum level yet.

	Galileo Open Service (positioning & timing)	
	Single Frequency (SF)	Dual Frequency (DF)
Coverage	Global	
Accuracy (95%)	Horizontal: 15 m	Horizontal: 4m
	Vertical: 35 m	Vertical: 8m
Availability	99.8%	
Timing Accuracy UTC/TAI	N/A	30 ns
Ionosphere Correction	Based on SF Model	Based on DF Measurements
Integrity	No	
Service Performances for Galileo Open Service		

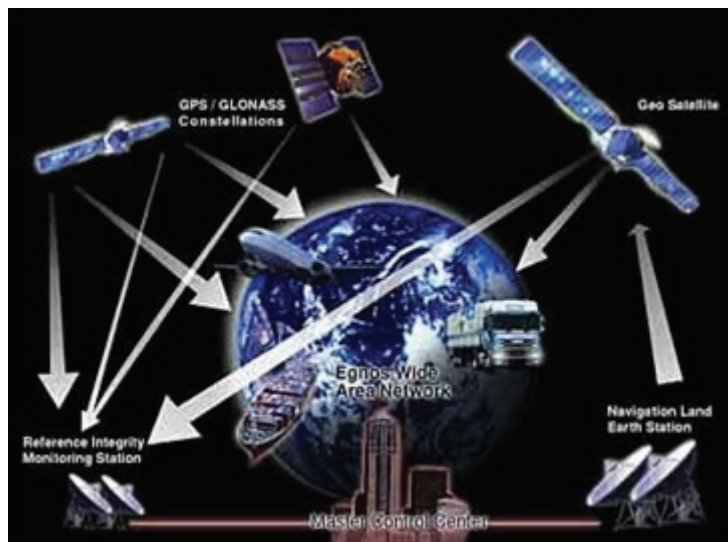
- A. The timing service is synchronized with UTC when used with receivers in fixed locations and can be useful for network synchronization or scientific applications.
- B. During the Initial Operational Capability (IOC) phase, mainly search and rescue services are provided.
- C. As well, it includes determining the signal characteristics.
- D. It will provide a range of guaranteed services to users equipped with Galileo receivers.
- E. The Open Service signals are separated in frequency to permit the correction of errors caused by ionosphere effects by differentiating the ranging measurements made at each frequency.
- F. The satellites will be evenly distributed over three orbital planes at an altitude of about 23,000 km.
- G. However, unlike GPS and GLONASS, Galileo will provide two levels of services: a basic, free-of-direct-charge service and a chargeable service that offers additional features.
- H. A European political body, independent of Galileo management, will have the authority to take the proper measures in the event of a crisis.

4. The current satellite-based global navigation systems, GPS and GLONASS, do not meet all of the civil aviation requirements. To overcome these limitations regional augmentation systems are developed. One of these systems, European Geostationary Navigation Overlay System (EGNOS), is developed by Europe.

Read the extract about EGNOS. Use the words in brackets to form a word that fits in the gap in the sentence.

The European navigation system is intended to augment the two 1) (operate) satellite navigation systems – the American GPS and the Russian GLONASS, and make them 2) (suit) for safety-critical 3) (apply) such as flying aircraft or navigating ships through narrow channels. EGNOS consists of three geo-stationary satellites and a network of ground stations. The system transmits a signal containing 4) (inform) on the 5) (rely) and 6) (accurate) of the positioning signals sent out by GPS and GLONASS. It allows users in European countries to determine their position within 5 meters. EGNOS is a joint venture of ESA (European Space Agency), the European Commission, and the

European Organization for the Safety of Air Navigation. It is Europe's 7) (contribute) to the first stage of creating a global navigation system and is viewed as a precursor to the Galileo satellite navigation system. It was announced on July 28, 2005, that the transfer of EGNOS operations from ESA to the operating company, European Satellite Services Provider, had begun.



Speaking

1. You are going to participate in an international scientific conference dedicated to advances in electronic technologies. One of the issues to be discussed is the satellite communication perspectives. You have been asked to give a ten-minute talk on satellite navigation.

Work with a partner. Do some research on the GLONASS perspectives and prepare your talk. Think of visual aids (e.g. graphs, drawings, photos) to make your talk more informative.

2. Work in groups:

Group A. You are the speakers. Give your talk. Be prepared to answer the audience's questions.

Group B. You are participants at the conference. Brainstorm some questions you could ask about the Russian navigation system.

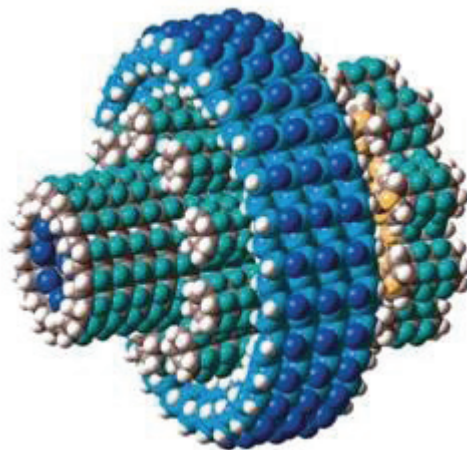
Role-play your sessions.

Writing

1. Write an article for a scientific journal on satellite navigation perspectives.

UNIT 12

Nanotechnology



Lead in

1. The 21st century is sometimes called the century of nanotechnology. List the main applications of nanotechnology.

- 1) _____
- 2) _____
- 3) _____
- 4) _____
- 5) _____

2. Make a list of advantages of using nanotechnology.

- 1) _____
- 2) _____
- 3) _____
- 4) _____

3. Name the advantages of using unmanned flight technology.

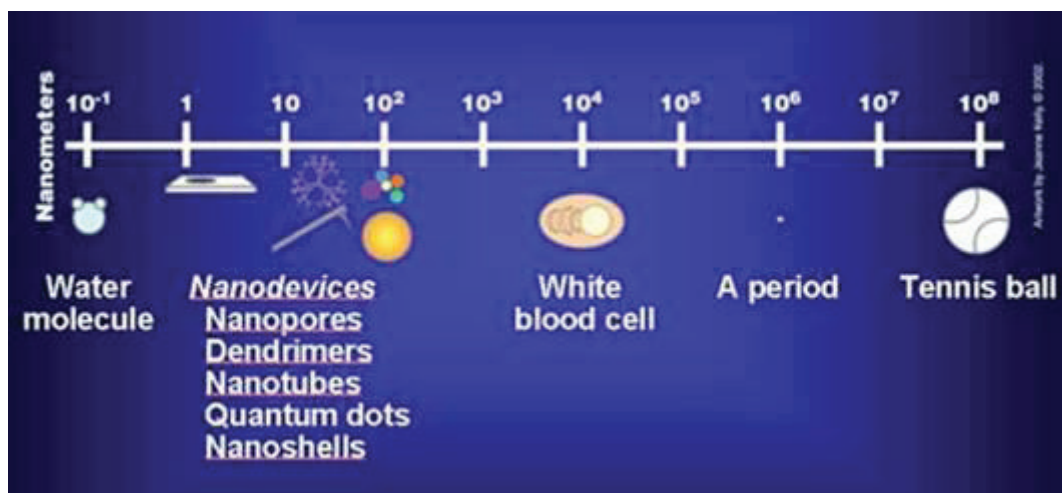
Reading

1. Read the text below focusing on the concept of nanotechnology and its applications.

What is Nanotechnology?

A nanometer is a billionth of a meter. It's difficult to imagine anything so small, but think of something only 1/80,000 the width of a human hair. Ten hydrogen atoms could be laid side-by-side in a single nanometer.

Nanotechnology is the creation of useful materials, devices, and systems through the manipulation of matter on this miniscule scale. The emerging field of nanotechnology involves scientists from many different disciplines, including physicists, chemists, engineers, and biologists. There are many interesting nanodevices being developed that have a potential to improve cancer detection, diagnosis, and treatment.



Real-World Examples

Nanotechnology, in one sense, is the natural continuation of the miniaturization revolution that we have witnessed over the last decade, where millionth of a meter (10^{-6} m) tolerances (microengineering) became commonplace, for example, in the automotive and aerospace industries enabling the construction of higher quality and safer vehicles and planes.

There are many examples of the application of nanotechnology from the simple to the complex. For example, there are nanocoatings which can repel dirt and reduce the need for harmful cleaning agents, or prevent the spread of hospital-borne infections. New-generation hip implants can be made more “body friendly” because they have a nanoscale topography that encourages acceptance by the cells in their vicinity.

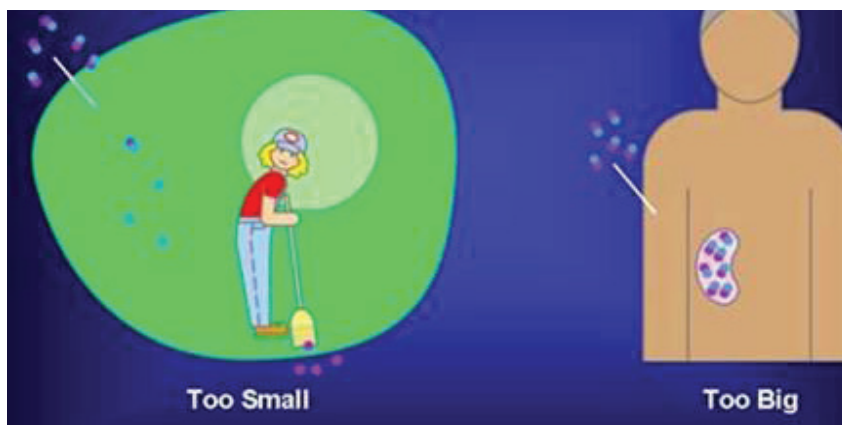
In simple terms, nanotechnology can be defined as “engineering at a very small scale”, and this term can be applied to many areas of research and development – from medicine to manufacturing to computing, and even to textiles and cosmetics. It can be difficult to imagine exactly how this greater understanding of the world of atoms and molecules has and will affect the everyday objects we see around us, but some of the areas where nanotechnologies are set to make a difference are described below.

Nanodevices are Small Enough to Enter Cells

Most animal cells are 10,000 to 20,000 nanometers in diameter. This means that nanoscale devices (less than 100 nanometers) can enter cells and the organelles inside them to interact with DNA and proteins. Tools developed through nanotechnology may be able to detect disease in a very small amount of cells or tissue. They may also be able to enter and monitor cells within a living body.

Designing Nanodevices for Use in the Body

Other challenges apply specifically to the use of nanostructures within biological systems. Nanostructures can be so small that the body may clear them too rapidly for them to be effective in detection or imaging. Larger nanoparticles may accumulate in vital organs, creating a toxicity problem. Scientists will need to consider these factors as they attempt to create nanodevices the body will accept.

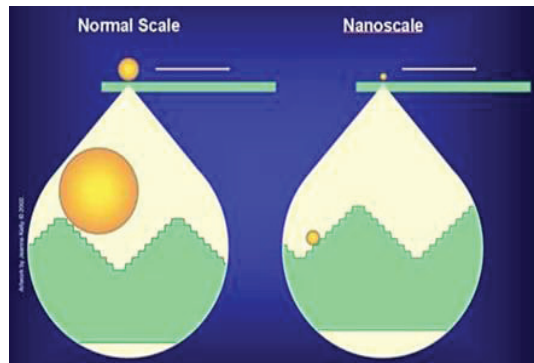


Nanodevices Can Improve Cancer Detection and Diagnosis

Detection of cancer at early stages is a critical step in improving cancer treatment. Currently, detection and diagnosis of cancer usually depend on changes in cells and tissues that are detected by a doctor’s physical touch or imaging expertise. Instead, scientists would like to make it possible to detect the earliest molecular changes, long before a physical exam or imaging technology is effective. To do this, they need a new set of tools.

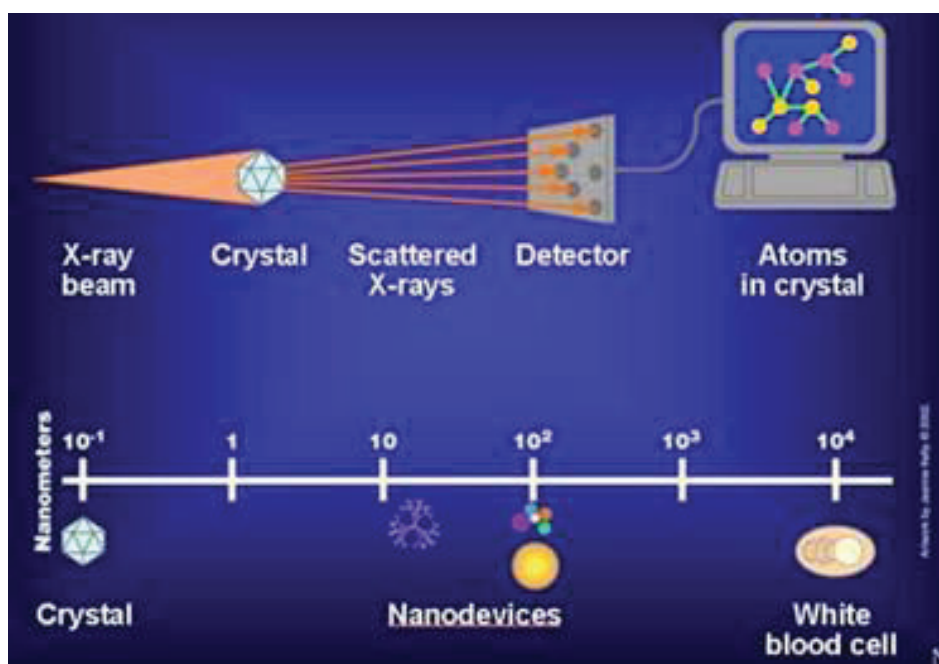
Nanoscale Research

Much of today's nanoscale research is designed to reach a better understanding of how matter behaves on this small scale. The factors that govern larger systems do not necessarily apply at the nanoscale. Because nanomaterials have large surface areas relative to their volumes, phenomena like friction and sticking are more important than they are in larger systems.



Manufacturing Nanodevices

There are two basic approaches for creating nanodevices. Scientists refer to these methods as the top-down approach and the bottom-up approach. The top-down approach involves molding or etching materials into smaller components. This approach has traditionally been used in making parts for computers and electronics. The bottom-up approach involves assembling structures atom-by-atom or molecule-by-molecule, and may prove useful in manufacturing devices used in medicine.



Cooperation

The contribution of nanotechnology to new products and processes cannot be made in isolation and requires a team effort. This may include life scientists – biologists and biochemists – working with physicists, chemists and information technology experts. Consider the development of a new cochlear implant and what that might require – at least a physiologist, an electronic engineer, a mechanical engineer and a biomaterials expert. This kind of teamwork is essential, not only for a cochlear implant, but for any new nano-based product whether it is a scratch-resistant lens or a new soap powder.

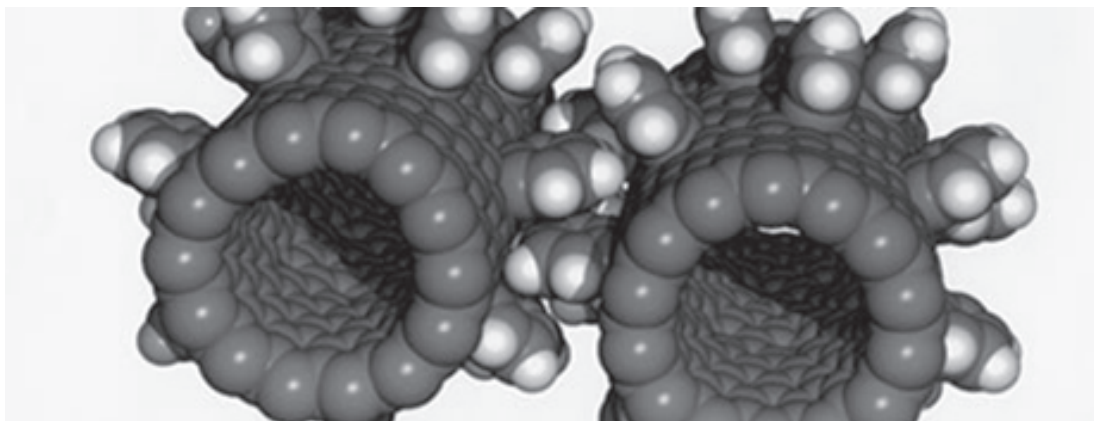
Finding Solutions

Nanoscientists are now enthusiastically examining how the living world “works” in order to find solutions to problems in the “non-living” world. The way marine organisms build strength into their shells has lessons in how to engineer new lightweight, tough materials for cars; the way a leaf photosynthesizes can lead to techniques for efficiently generating renewable energy; even how a nettle delivers its sting can suggest better vaccination techniques.

*(from: <http://www.cancer.gov/cancertopics/understandingcancer/nanodevices/AllPages>
and <http://www.nano.org.uk/what-is-nanotechnology>)*

Comprehension Check

1. Read the text again and write down all the words that you are not familiar with. Guess the meaning of the words. Discuss them with other students.



2. Divide the text into logical parts. Highlight the topic sentence of each part.

3. Match the terms on the left with the definitions and explanations on the right.

- | | |
|--------------|---|
| 1. encourage | a. the basic structural, functional and biological unit of all known living organisms |
| 2. tough | b. the hard protective outer case of a mollusk or crustacean |
| 3. a cell | c. strong enough to withstand adverse conditions or rough handling |
| 4. effort | d. give support, confidence, or hope to someone |
| 5. shell | e. the activities of a group of people with a common purpose |

4. Look at the text again and discuss these questions.

1. How many hydrogen atoms could be laid side-by-side in a single nanometer?
2. In which areas can the term “nanotechnology” be applied?
3. Give some examples of the application of nanotechnology.
4. What tools can enter animal cells?
5. How can we use the nanostructures within biological systems?
6. How can nanodevices improve cancer detection and diagnosis?
7. What basic approaches for creating nanodevices you know?
8. How the living world helps nanoscientists to find solutions to problems in the “non-living” world?

Language Focus

1. a) Give the definitions of the following words:

WORD	DEFINITION
1. vehicle
2. tissue
3. reach, v.
4. friction
5. assemble, v.
6. accumulate, v.
7. relative
8. enthusiastically
9. involve, v.
10. contribution
11. repel, v.

b) Find in text the synonyms for the following words.

WORD	SYNONYM
1. main
2. implement
3. try, v.
4. tiny
5. meaning
6. influence, v.
7. sickness

2. a) Fill in the gaps with a suitable word. Watch out! There's an extra word.

apply	basic	cells	complex	field
materials	nanotechnology	organs	powder	
	team	treatment		

1. _____ can be defined as “engineering at a very small scale”.
2. Most animal _____ are 10,000 to 20,000 nanometers in diameter.
3. Detection of cancer at early stages is a critical step in improving cancer _____.
4. The way marine organisms build strength into their shells has lessons in how to engineer new lightweight _____ for cars.
5. The factors that govern larger systems do not necessarily _____ at the nanoscale.
6. There are many examples of the application of nanotechnology from the simple to the _____.
7. Larger nanoparticles may accumulate in vital _____, creating a toxicity problem.
8. The contribution of nanotechnology to new products and processes cannot be made in isolation and requires a _____ effort.
9. There are two _____ approaches for creating nanodevices.
10. The emerging _____ of nanotechnology involves scientists from many different disciplines.

b) Use the words and expressions from the box in the sentences of your own.

Speaking

1. You are visiting an international exhibition of nanotechnologies. You see a lot of new gadgets, devices, technologies. Sure, you have a lot of questions. Think of the questions you would ask the experts.

Example:

- Please, tell me about the advantages of nanotechnologies.
- Could you tell me, where are the nanotechnologies used?
- What is the underlying principle of nanotechnologies?

The following expressions might be helpful:

- I'd like to know...
- Could you tell me...?
- Excuse me, do you know...?
- Another thing I'd like to know is...

Which question do you think would be the most interesting?

2. Use the text below to prepare a presentation on nanomaterials and their use. Search the Internet for additional information.

Nanomaterials



There are many fascinating examples of nanotechnology applications in new materials. For example, polymer coatings are notoriously easily damaged, and affected by heat. Adding only 2% of nanoparticulate clay minerals to a polymer coating makes a dramatic difference, resulting in coatings that are tough, durable and scratch resistant.

This has implications for situations where a material fits a particular application in terms of its weight and strength, but needs protection from an external, potentially corrosive environment – which a reinforced polymer nanocoating can provide.

Other nanocoatings can prevent the adherence of graffiti, enabling them to be easily removed by hosing with water once the coating has been applied. This has the important knock-on effect of improving urban environments, making them more attractive to bona fide citizens and less encouraging to criminals. These kinds of coatings, invented in Mexico, have been shown to work well in parts of Mexico City. They are currently helping to transform seedy crime-ridden neighbourhoods into increasingly respectable suburbs.

Particles at the nanoscale are below the wavelength of visible light, and therefore cannot be seen. Consequently, they can impart new properties while being invisible themselves! Fluorescent nanoparticles, or quantum dots (mentioned earlier) have a whole range of possible applications. They are invisible until “lit up” by ultraviolet light, and can even be made to exhibit a range of colours, depending on their composition and size.

Such nanoparticles are ideal for crime prevention, where goods can be invisibly “tagged”, preventing counterfeiting; stolen goods can be traced by their invisible “bar code” and illicit drugs by the fact they have no legal identification. In some countries, cheap agricultural fuel is “laced” with harmless nanoparticles, making it easy for police to identify a stolen consignment, merely by using ultraviolet light.

Nanoparticles can seem to be quite strange as they have new and unusual properties that are not obvious in the corresponding bulk material. This is because a nanoparticle has a large surface area in relation to its size, and is consequently highly reactive. This is exemplified by the fine grained materials that we use in our daily lives, such as flour, which can become explosive in some circumstances. Applications of nanoparticles include nanoparticulate titanium dioxide for sunscreens, and it also acts as a photocatalytic agent in coatings that can be applied to stay-clean windows, causing the dirt to be oxidized and easily washed away by rain.

Writing

1. Write an essay (180-200 words) on one of the following topics:

- If I were the inventor of Nanotechnologies...
- The Nanotechnology Revolution.
- Modern applications of Nanotechnologies.

Glossary for Part II

- 3D modelling – трёхмерное моделирование, объёмное моделирование
- 3D printer – 3D-принтер
- 3D printing – 3D-печать, трёхмерная печать
- 3D visualization – трёхмерная визуализация, пространственная визуализация
- accurate – точный
- acquire, v – получать, приобретать
- adjust, v – регулировать, приспособливать
- advantage – преимущество, достоинство
- aeronautics – аэронавтика
- agility – быстрая перестройка, быстрая реакция
- air traffic control – управление воздушным движением, авиадиспетчерская служба
- air traffic controller – авиадиспетчер
- aircraft – летательный аппарат, воздушное судно
- aircraft engineering – самолётостроение, авиастроение, авиационная техника
- aircraft maintenance – техническое обслуживание самолётов
- airline reservation – бронирование авиабилетов
- alerting system – система аварийного оповещения
- alphanumeric – буквенно-цифровой
- altimeter – альтиметр, высотометр
- altitude – высота
- application – применение, использование, приложение
- approach – подход
- arc – дуга
- artificial satellite – искусственный спутник
- astronautics – астронавтика, космонавтика
- atom – атом
- atomic clock – квантовые часы, атомные часы
- attitude control – устройство управления положением
- attribute – атрибут, свойство
- attribute data – атрибутивные данные
- attribute value – значение атрибута
- automotive – автомобильный
- autonomy – автономность, независимость
- avionics – авионика
- bearing – месторасположение
- binary format – двоичный, бинарный формат
- bitstream – поток битов (двоичных разрядов)
- broadcast, v – передавать, вещать, транслировать
- buffer coating – защитная оболочка
- CAD (computer-aided design) – система автоматизированного проектирования, САПР
- CAE (computer-aided engineering) – автоматизированное конструирование
- calculate, v – рассчитывать, высчитывать
- CAM (computer-aided manufacturing) – автоматизированная система производства
- cancer – рак
- carbon dioxide – диоксид углерода, двуокись углерода
- carrier frequency – несущая частота
- cartography – картография
- celestial body – небесное тело
- cell – ячейка
- cityscape – городской ландшафт
- cladding – покрытие
- cloud computing – облачные вычисления, вычисления в удалённой среде
- cockpit – кабина пилотов
- communication – связь, коммуникация
- communication channel – канал связи
- communication network – сеть связи
- compilation – компиляция, объединение
- computation – вычисления, исчисления

computer-aided design (CAD) – CAD (computer-aided design) – система автоматизированного проектирования, САПР	digital – цифровой
computer-aided engineering (CAE) – автоматизированное конструирование	digitize, v – оцифровывать, преобразовывать в цифровую форму
computer-aided manufacturing (CAM) – автоматизированная система производства	dimensions – размеры
constellation – совокупность, группа; созвездие	direction – направление
continuous – непрерывный, постоянный	discrete – дискретный; отдельный
controller – контроллер, устройство управления	discrete boundary – дискретная граница
convert, v – преобразовывать	display, n – дисплей
core – сердцевина	display, v – показывать, демонстрировать
cost – себестоимость, затраты	Doppler shift – доплеровский сдвиг частоты, доплеровская частота
coverage – охват, покрытие, зона действия, рабочая зона	downlink – пересылка данных со спутника на наземную станцию
cruising – крейсерский полёт	drone – простейший небольшой беспилотник, радиоуправляемый наземным пилотом; дрон
customized equipment – оборудование, выполненное по специальному заказу клиента	dual-frequency receiver – двухчастотный приёмник
data – данные	duplex network – дуплексная сеть (схема), позволяющая передавать информацию в двух направлениях одновременно
data acquisition – получение и накопление данных; сбор информации	eccentricity – эксцентриситет
data capture – сбор данных; ввод (собранных) данных в компьютер; загрузка данных	electronic circuit – электронная цепь
data collection – сбор данных	elevation angle – угол возвышения
datalink communication – связь по линии передачи данных	environmental conditions – внешние условия, условия окружающей среды
debris – обломки, осколки, мусор	etching – травление, гравирование
departure – вылет, отправление	e-ticketing – покупка/продажа билетов электронным путём
design analysis – конструкторский анализ	failure – сбой, неудача
design and development – научно- исследовательские и опытно- конструкторские разработки (НИОКР)	feature – объект
destination – пункт назначения	finite element analysis (FEA) – анализ [методом] конечных элементов
deviate, v – отклоняться	fire – огонь, пожар
device – устройство	flight data recorder – бортовой самописец
diagnosis – диагноз	flight management – управление полётом
diffraction – дифракция	flight path control – система управления траектории полётов, траекторное управление
	flight path stabilization – стабилизация траектории полёта

frequency-division multiplexing – уплотнение по частоте	hardware – оборудование, аппаратура, аппаратное обеспечение
fuel – топливо	haul – протяженность линии связи; расстояние, дальность
functionality – функциональность, функциональные возможности, набор функциональных возможностей	hazard – риск, опасность
gauge – измерительный прибор	high-capacity – высокопроизводительный
generic application – стандартное применение, типовое применение	humidity control – регулирование влажности
geocaching – геокешинг, геокладоискательство (игра в «поиск кладов» с использованием GPS-навигаторов)	hydrogen – водород
geodesy – геодезия	illumination – освещённость
geographic information science – геоинформатика	imaging – получение изображения, визуализация, томография
geographic information system (GIS) – геоинформационная система	in-built – встроенный
geoinformatics – геоинформатика	inclination – величина отклонения; наклон, угол наклона
geospatial information – геопространственная информация	increment – возрастание, увеличение; приращение, шаг (приращения)
GIS (geographic information system) – геоинформационная система	install, v – устанавливать
global navigation satellite system – глобальная навигационная спутниковая система	instrument – аппарат, прибор
global positioning system (GPS) – глобальная (спутниковая) система (радио-) определения местоположения, система GPS	interference – интерференция
GPS (global positioning system) – глобальная (спутниковая) система (радио-) определения местоположения, система GPS	land parcel – земельный участок
graphical representation – графическое изображение, графическое представление	landing – приземление
gravitational force – сила тяжести, сила гравитации, гравитационная сила	landscape – (природный) ландшафт
grid – решётка	latitude – широта
ground control station – наземная станция управления	launching – взлёт, запуск
ground station – наземная станция	layer – слой
gyro compass – гирокомпас	light-emitting diode – светодиод
	line – линия
	locate, v – определять место, местонахождение
	location coordinates – координаты местонахождения
	longitude – долгота
	loop – контур, (замкнутая) цепь
	maintenance – техническое обслуживание
	malfunction, v – неисправная работа; неправильное срабатывание
	manned space missions – пилотируемый космический полёт
	map, v – производить съёмку местности; рисовать карту (чего-л.) , изображать в виде карты

mash-up – мэшап (интернет-приложение, объединяющее данные из нескольких интерактивных источников); гибридное веб-приложение	orbit determination – определение параметров орбиты
matter – вопрос, проблема	orbital period – период обращения
measure, v – измерять	overlay – оверлей, надписи на картах
measurement – измерение	oxygen sensor – датчик содержания кислорода
microengineering – микро-инжиниринг	payload – полезная нагрузка;
midair collision – столкновение в воздухе	грузоподъёмность
miniscule – очень маленький	PDM (product data management) – управление данными об изделии
missile – ракетная установка	performance – характеристика (работы машины); эксплуатационные качества; производительность
mock-up – модель в натуральную величину	pertinent – подходящий; имеющий отношение
molecular – молекулярный	perturbation – пертурбация, возмущение
monochromatic light – монохроматический свет	photogrammetry – фотограмметрия
multi-mode fibers – многомодовый оптоволоконный кабель	photosynthesize – фотосинтезировать
multiplex – многократный, множественный, мультиплексный, сложный	point – точка
multiplex, v – мультиплексировать, уплотнять (каналы)	polygon – полигон, многоугольник
nanoengineering – нанотехника, наноинженерия	precipitation – выпадение (осаждение), выпадение осадка
nanometer – нанометр	product data management (PDM) – управление данными об изделии
nanosensor – нанодатчик	productivity – производительность, продуктивность
nanotechnology – нанотехнология	propulsion – продвижение вперёд, движение вперёд; поступательное движение; двигатель, силовая установка
nanounit – наноразмерное устройство, наноустройство	propulsion system – двигательная установка
navigation – навигация, наведение	purifier – очистительная установка
navigation message – сообщение, содержащее навигационные данные	quantization – квантование, дискретизация; разбиение (данных) на подгруппы
neogeography – неогеография	radio frequency identification – радиочастотная идентификация
noise immunity – помехоустойчивость, помехозащищённость	range – диапазон
on-board system – бортовая система	ranging pulse – импульс дальности
open source application – приложение с открытым исходным кодом	rapid prototyping – быстрое прототипирование
operator – оператор, лицо, управляющее полётом	raster model – растровая модель
optical fiber – оптоволокно	receiver – приёмник, получатель, ресивер
optical navigation – оптическая система наведения	re-entry – вход или возвращение в плотные слои атмосферы

reference time – начало отсчета времени; начальный момент времени; опорная точка отсчета времени	sharing – разделение, совместное [коллективное] использование
reference, v – привязывать, давать ссылку	sidereal hour – звездный час
reflection – отражение	simplex network – симплексная, односторонняя сеть (схема), позволяющая передавать данные только в одном направлении
reliability – надёжность	single-mode fibers – одномодовый оптоволоконный кабель
remote control – дистанционное управление, удалённое управление	software – программное обеспечение (ПО), компьютерные программы
remote sensing – дистанционное зондирование, дистанционный сбор данных	solid modelling – объёмное моделирование
rendezvous – сближение, стыковка (космических кораблей)	solid-state device – твердотельный прибор
reservation system – система резервирования, бронирования	space control centre – центр управления космическими полётами
resolution – разрешение, разрешающая способность	space mission – космический полёт
right ascension – прямое восхождение (напр. небесного тела)	space vehicle – космический летательный аппарат
robotics – робототехника	spacecraft guidance – система наведения космического аппарата
routing – маршрутизация, прокладка маршрута	spatial analysis – пространственный анализ
rover – ровер, вездеход, мобильный аппарат	spatial data – пространственные данные
satellite – спутник	storage – хранение
satellite almanac – календарь, альманах спутника	surface model – модель поверхности, двухмерная модель, плоскостная модель
satellite communication – спутниковая связь	surveillance – наблюдение
satellite ephemeris – спутниковые эфемериды, астрономические таблицы	surveillance satellite – спутник наблюдения, разведывательный спутник
search-and-rescue system – поисково- спасательная система	surveying – геодезическая съёмка
security check – проверка на безопасность	switch – выключатель, переключатель, коммутатор
security system – система безопасности	switch, v – переключать, коммутировать
semi-major axis – большая полуось	take-off, n – взлёт
sensor – датчик	technique – способ, приём
serial transmission – последовательная передача (метод передачи информации, при котором биты передаются последовательно, вместо одновременной (параллельной) передачи по нескольким линиям)	telescope – телескоп
	terrain – местность, территория, топография
	thematic map – тематическая карта
	three-dimensional – трёхмерный
	time reference – временная ссылка; привязка ко времени

time-division multiplexing – временное уплотнение	uplink – линия связи Земля-ЛА
tolerance – допустимое отклонение	usability – удобство работы, простота использования
tool – инструмент	vehicle – транспортное средство
topography – топография, геометрические особенности	velocity – скорость
tracking – слежение, сопровождение; прокладка маршрута	vernal equinox – весеннее равноденствие
traffic – транспорт, движение	very long baseline interferometry (VLBI) – интерферометрия со сверхдлинной базой
trajectory – траектория	vicinity – близость, соседство, окрестности
transmission – передача, трансмиссия	vigilance – бдительность, внимательность
transponder – ретранслятор	vital – жизненный, жизненно важный
treatment – обработка, лечение	VLBI (very long baseline interferometry) – интерферометрия со сверхдлинной базой
triangulate, v – триангулировать, производить триангуляцию, делать тригонометрическую съёмку	warning lights – световая предупредительная сигнализация
trilateration – трилатерация	wavefront – волновой фронт
trim – балансировка	wavelength – длина волны
trunk – магистральная линия, магистраль (базовый канал, соединяющий два пункта, каждый из которых является коммутационным центром или точкой распределения)	web mapping – использование карт, предоставленных ГИС (геоинформационными системами)
turbulence – турбулентность	wind shear – сдвиг ветра, градиент скорости ветра
UAV (unmanned aerial vehicle) – беспилотный летательный аппарат (общее определение);	wire-frame modelling – каркасное моделирование
	withstand, v – выдерживать, противостоять

ANSWER KEY

Part I

Section 1. Aircraft Structure

Unit 1. A Short History of Flying

Comprehension Check

2. – c.

Language Focus

2. a) danger – safety; lose – find; slower – faster; the newest – the oldest; impossible – possible; irregular – regular; moveless – movable; impractical – practical.

3. 1 – d; 2 – b; 3 – b; 4 – b.

Unit 2. Types of Aircraft

Lead in

1. A – helicopter; B – airplane; C – kite; D – supersonic fighter/ military airplane ; E – rocket/ launch vehicle/ spaceship; F – glider; G – airplane/ flying wing/ military airplane; H – supersonic fighter/ military airplane; I – free balloon.

2. 1 – d; 2 – f; 3 – j; 4 – h; 5 – g; 6 – c; 7 – a; 8 – i; 9 – b; 10 – e.

Comprehension Check

2. a – E; b – C ; c – G.

3. 1 – T; 2 – F; 3 – F; 4 – T; 5 – F; 6 – T; 7 – F; 8 – T.

Language Focus

1. advance – progress; produce – create; subdivide – classify; propel – move; airfoil – wing; attach – mount; aircraft – vehicle.

5. 1 – up and down airstreams; 2 – the wing itself; 3 – wing position; 4 – the parasol wing; 5 – flying boat; 6 – seaplanes; 7 – a rotor; 8 – the autogiro; 9 – ballistic rockets; 10 – engines.

6. 1 – heavier-than-air aircraft; 2 – glider; 3 – to take off, land; 4 – VTOL, STOL; 5 – fuselage, conventional propeller; 6 – disadvantages; 7 – by means of; 8 – engine, transmitted; airscrew.

Unit 3. Airplane Components

Comprehension Check

2.	Component	Function
	wing	to develop the necessary supporting force
	fuselage	to house crew, passenger and cargo compartments
	flight controls	to change the attitude of flight
	power plant	to produce power for flying
	aileron	to control motion of the plane about the longitudinal axis
	elevator	to control the airplane's movement up and down about the lateral axis
	cockpit	to house the crew, the flight controls and flight instrument panels
	cargo room	to house luggage and cargo
	rudder	to control the movement of the airplane around the vertical axis
	nacelle	to house the power plant or engine and its accessories
	landing gear	to carry the wheels on which the aircraft moves on the ground
	tail unit	to provide stability of flight

3. 1 – F; 2 – F; 3 – T; 4 – T; 5 – F; 6 – F.

Language Focus

2. air flow – air stream; engine – power plant; surface – wing; to locate – to situate; to hinge – to attach; energy – power; usual – conventional; to manage – to control; form shape; compartment – cabin; wing – lifting surface.

Unit 4. The Wing

Comprehension Check

1. Light weight is very important in an airplane structure because every pound of structural weight replaces a pound of payload.

2. 1 – b; 2 – c; 3 – b; 4 – a; 5 – c.

3. 1 – c; 2 – e; 3 – f; 4 – a; 5 – b; 6 – g; 7 – d.

4. 1 – T; 2 – F; 3 – T; 4 – F; 5 – F; 6 – T; 7 – T.

5. Possible questions:

- 1 – What component of an airplane produces lifting force?
- 2 – What sections is the wing divided into?
- 3 – Where are the movable parts of the wing located?
- 4 – What is the distance from the leading edge to the trailing edge?
- 5 – What does the wing structure consist of?

Language Focus

1. wing – airfoil; front edge – leading edge; shape – form; covering – skin; section – bay; trailing edge – rear edge; power plant – engine.
2. leading – trailing; take off – landing; primary – secondary; root – tip; different – similar; reinforce – weaken; transverse – longitudinal; movable – fixed.
3. 1 – transverse; 2 – spars, stringers and beams; 3 – bending, shear and torsion; 4 – fuel tanks, engines, bays.
4. stressed skin; landing gear bay/nacelle; low-wing monoplane; mid-wing monoplane; high-wing monoplane; bending load; wing root; flap; bay; control mechanism; spanwise stiffener; wing shape; stress.
5. 1 – into; 2 – on; 3 – in; 4 – from, to; 5 – with; 6 – of.

Unit 5. The Tail Group

Reading

1. 1 – c; 2 – e; 3 – a; 4 – g; 5 – f; 6 – d; 7 – h; 8 – b.

Comprehension Check

1. 1 – g; 2 – a; 3 – c; 4 – h; 5 – b; 6 – f; 7 – d; 9 – e.
2. 2.
3. 1 – tail unit; 2 – spars, ribs; 3 – dynamic balancing; 4 – trimmers; 5 – rudder; 6 – fin; 7 – trimmer; 8 – fin; 9 – elevator; 10 – dorsal fin; 11 – elevators; 12 – balance area.
4. Flutter is a violent vibration of a wing or control surface.
5. 1 – stability; 2 – hinged, rear; 3 – altitude; 4 – rudder; 5 – auxiliary, trailing edges; 6 – dynamic balancing.

Language Focus

2. fixed – movable; to increase – to reduce; main – auxiliary; to promote – to avoid; irregular – constant; weak – violent.

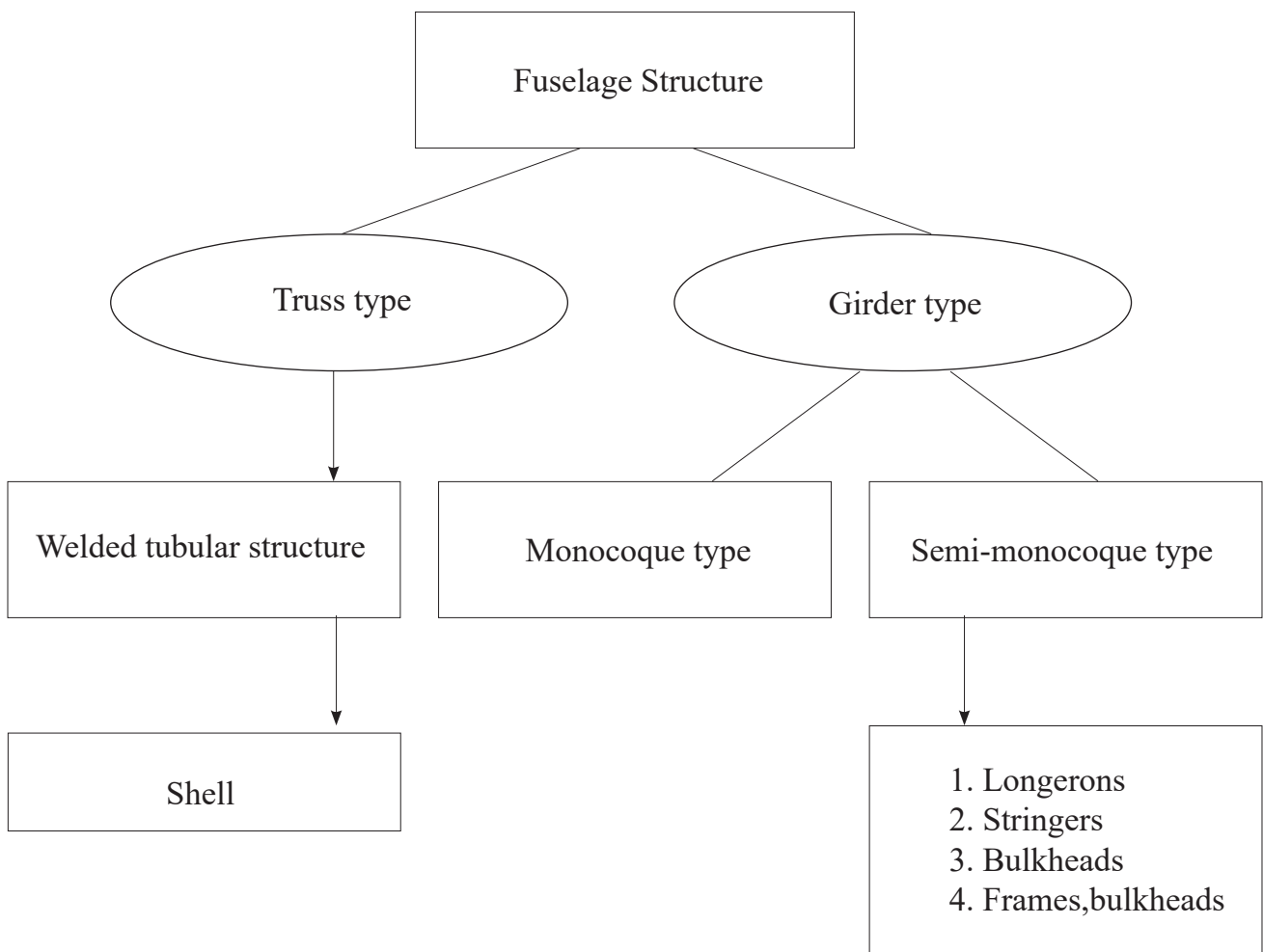
4. 1 – in, of; 2 – along, of; 3 –with; 4 – at; 5 – from.

Unit 6. The Fuselage Structure

Comprehension Check

2. – longerons provide the basis of the necessary strength to resist bending; bulkheads give the fuselage its shape.
– the semi-monocoque type incorporates longerons or stringers carrying the main portion of the load;
monocoque type of construction uses a single shell providing necessary structural strength.

4.



Language Focus

3. cover – shield; derive – obtain; divide – split; reinforce – strengthen; resist – withstand; bulkhead – frame; bay – compartment; assembly – unit; stress – pressure; house – contain.
4. started – completed; flexible – solid; different – similar; broken – joined; insufficient – sufficient; weak – reinforce; weak – strong; simplify – complicate; inner – outer.
5. 1 – b; 2 – c; 3 – a; 4 – c; 5 – b; 6 – c.

Unit 7. The Landing Gear

Lead in

2. 1 – f; 2 – h; 3 – e; 4 – d; 5 – b; 6 – g; 7 – c; 8 – a.

Comprehension Check

1.	UNIT	FUNCTION
	landing gear	to support the airplane in proper location for take-off and landing, to provide shock absorption
	pneumatic tyres	to allow the airplane to taxi over rough ground and to assist in absorbing the shock of landing.
	shock-absorbing struts	to absorb the shock of landing, to mount wheels
	tail skid	to support the rear of an airplane, to provide an electrical earth contact and to prevent the aircraft and crew from damage through static electrical charges
	wheel well	to house landing gear in flight

2. Possible answers:

D – Tricycle gear has many advantages. It simplifies landing, eliminates the danger of nosing over and carries the airplane in normal take-off position.

H – When the tail wheel rests on the ground it provides an electrical earth contact and so prevents the aircraft and crew from damage through static electrical charges.

3. 1 – to support, to provide; 2 – nose leg, main legs; 3 – nacelles; 4 – oleo unit; 5 – skid.

4. Possible questions:

- What are the main types of landing gear?
- What are the advantages of tricycle landing gear?
- When is the landing gear retracted?
- Where are the landing gear wheels retracted?
- What are the landing gear wheels fitted with?
- Why is the tail wheel designed of conductor type?
- How are the landing gear wheels attached to the fuselage?

Language Focus

1. fit – equip; strut – leg; rear – back; landing gear – undercarriage; intend – design; support – maintain; tail wheel – skid; conventional – usual.
2. fixed – swiveling; similar – different; add – eliminate; complicate – simplify; straight – rough; different – similar; result in – prevent; repair – damage.

Section 2. Aircraft Engine

Unit 8. Engine Designing

Reading

b)	1) performance (e)	a) совершать, выполнять
	2) payload (k)	b) режим работы двигателя
	3) drag (f)	c) загрязнять
	4) to create (l)	d) оказывать влияние
	5) power output (g)	e) летные характеристики
	6) to accomplish (a)	f) лобовое сопротивление
	7) strength (m)	g) выходная мощность
	8) loss (o)	h) вспомогательные средства
	9) facilities (h)	i) цель
	10) to influence (d)	j) достигать
	11) goal (i)	k) грузоподъемность; нагрузка
	12) power setting (b)	l) создавать
	13) to reduce (n)	m) прочность
	14) to achieve (j)	n) снижать
	15) to contaminate (c)	o) потери

Comprehension Check

1. Basic things for engine design. (B)
2. Innovations in engine design. (E)
3. A machine for generating mechanical power. (A)
4. Experts involved in the process of engine construction. (D)
5. Factors, providing good engine operation and its reliability. (C)

2. 1. This is a machine that produces mechanical power necessary for propulsion of a vehicle.
2. To convert the fuel energy into propulsion one and to propel a vehicle.
3. Experts in the field of automatic control, measuring and information systems and other specialists are involved in this process.
4. Aircraft engine designers must be well educated and able to solve the most difficult problems by using all modern knowledge, techniques and facilities.
5. It is necessary to create plasma, ion and other exotic engines. Moreover, it is necessary to have “clean” aircraft power plants, that is, aviation engines which do not contaminate the environment due to usage of hydrogen as the main fuel.

3. требования к конструкции – design requirements

область применения – application

площадь поверхности – surface area

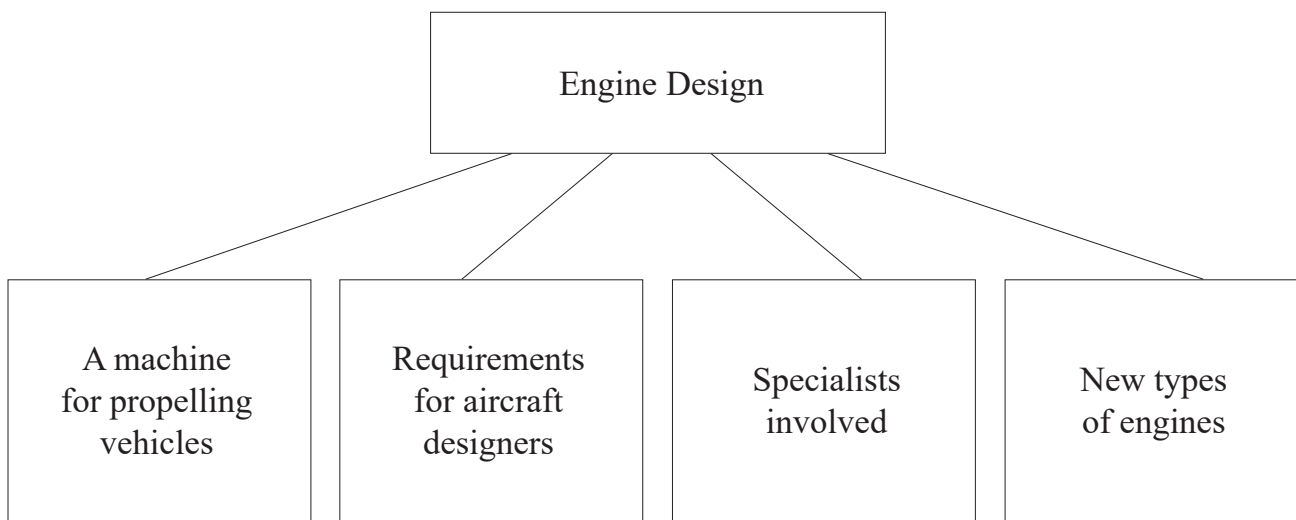
авиационные силовые установки – aircraft power plants

длительный срок эксплуатации – long life

определение оптимальных параметров – determination of optimal parameters

быстро развивающаяся отрасль промышленности – fast developing branch of industry

4. a)



Language Focus

1. a)
- | | | |
|----------------|-----|---|
| 1. aircraft | (g) | a. something successfully finished |
| 2. advancement | (d) | b. the use of physical strength or power of the mind |
| 3. achievement | (a) | c. a method of doing something that needs skill |
| 4. effort | (b) | d. improvement, development or movement to a higher rank facility |
| 5. facility | (e) | e. a system that makes a particular activity possible |
| 6. loss | (f) | f. inability to keep something |
| 7. techniques | (c) | g. a flying machine of any type, with or without an engine |

2. a)	high	higher	the highest
	small great simple cheap strong	smaller greater simpler cheaper stronger	(the) smallest (the) greatest (the) simplest (the) cheapest (the) strongest
b)	modern	more modern	the most modern
	efficient lightweight attractive popular significant	more efficient more lightweight more attractive more popular more significant	(the) most efficient (the) most lightweight (the) most attractive (the) most popular (the) most significant

3. larger lighter more
wider colder easier
heavier lower further

4. stronger; more lightweight; smaller; larger; higher; better; most bothersome; faster; less; further; higher; greatest.

5. (Suggested answers)

1. Thanks to its performance, this type of engine is capable of competing with the best world's engines of similar class.
2. This design is more efficient but it is more costly.
3. The cooler air then mixes with the hot air at the engine exit area.
4. The frontal area of the turbine is much smaller than that of the compressor and combustion chamber assembly.
5. The result of this increased volume is a greater velocity.
6. The F100 is the safest and most reliable engine produced for bombers.
7. Since the J 73 engine is equipped with variable inlet guide vanes, it may accelerate much faster than before.
8. The freighter has been more popular lately, especially among Asian carriers.
9. The more energy the turbine produces, the lower the rate of the turbofan exhaust gases becomes.
10. In some cases, the planes are not so effective as helicopters.

6. a)

verb	noun	both verb and noun
invent	performance	steam
melt	combustion	exhaust
	blade	demand
	degree	influence
		fix
		heat
		result
		power
		burn
		change
		export
		process

7. a) Any engine can be called a propulsion unit.
- b) Steam units were the first power plants.
- c) Turbojet is the most suitable engine for high forward speeds.
- d) The number of stages in an axial compressor varies with an engine design.
- e) Fuel must be burnt in the combustion chamber.
- f) There are some methods of increasing the thrust for a turbojet engine.
- g) Thrust is an applied force tending to produce motion in a body.

Speaking

- a) Fig. 1 – turbine. Fig. 2 – twin-cylinder in-line. Fig. 3 – radial.

Unit 9. Jet Engine

Reading

1 – f; 2 – j; 3 – a; 4 – l; 5 – c; 6 – k; 7 – h; 8 – g; 9 – i; 10 – e; 11 – d; 12 – b.

Comprehension Check

1. 1 – T, 2 – T, 3 – F, 4 – T, 5 – T.
2. 1 ... turbojets, turbofans, rockets, ramjets, pulse and pump-jets.
2 ... to produce the high pressure and high temperature gas jet.
3 ...any jet propulsion device which utilizes air from the atmosphere together with the combustion of a fuel and produces the jet for propulsion purposes.
4. ... the reaction of the jet of hot gases ejected from the rear.
5. ... also industrial systems and equipment.
4. A – J79 Turbojet engine – b.
B – T58 Turboshift engine – d.
C – T64 Turboprop engine – c.
D – CF34 Turbofan engine – a.

Language Focus

1. 1 – e, 2 – c, 3 – d, 4 – b, 5 – a.
2. 1 – e, 2 – d, 3 – a, 4 – b, 5 – c.

4. engine exit area – площадь выходного сечения сопла двигателя
reaction principle – принцип реактивного движения
easy maintenance – неприхотливость в обслуживании
the speed of sound – скорость звука
high temperature gas jet – струя газа высокой температуры
extreme advantage – главное преимущество
compressed air – сжатый воздух
atmospheric air – атмосферный воздух
front opening – фронтальное отверстие
extensive use – широкое применение
the speed of sound – скорость звука
jet propulsion device – реактивный двигатель

5. 1. Is being discussed – Present Continuous (PV)
2. Will be increased – Future Simple (PV)
3. Has had – Present Perfect (AV)
4. Am working – Present Continuous (AV)
5. Have – Present Simple (AV)
6. Has been provided – Present Perfect (PV)
7. Had equipped – Past Perfect (AV)
8. Was subjected to – Past Simple (PV)
9. Left – Past Simple (PV)
10. Had been overcome – Past Perfect (PV)

6.	1. will be designed	(b)
	were designed	(c)
	are being designed	(a)
2.	were being created	(c)
	had been created	(b)
	will be created	(a)
3.	was changed	(b)
	is being changed	(c)
	has been changed	(a)
4.	is achieved	(b)
	were achieved	(c)
	will be achieved	(a)
5.	will be discussed	(b)
	has been discussed	(a)
	was discussed	(c)

7. 1 – about; 2 – by; 3 – to; 4 – with; 5 – on/upon; 6 – at/on; 7 – for.

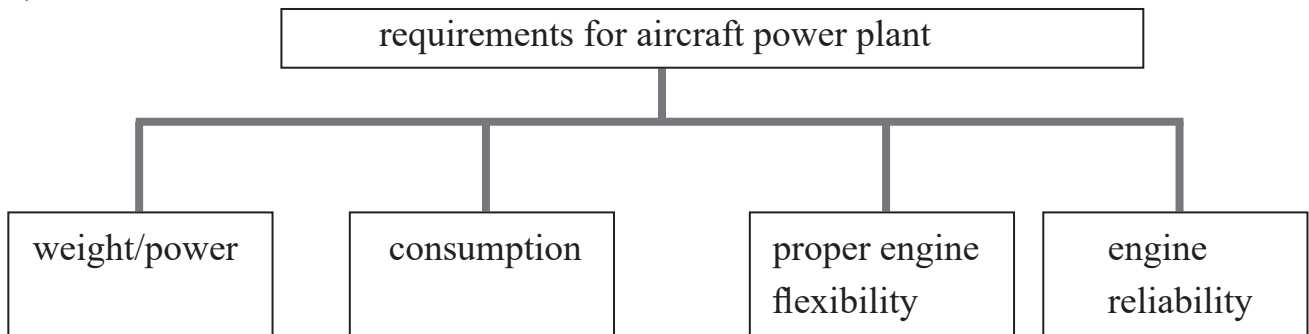
8. (Suggested answers)

1. The reporters were listed to with great attention.
2. Many issues were affected by practical requirements and restrictions imposed on the market today.
3. I have never been asked about it.
4. You will be asked some questions after the report.
5. These data have already been referred to.
6. Is the equipment being installed? Do you think it will have been installed by the noon?
7. The project of this device have been worked at for 2 years.
8. The difficulties were overcome by better analysis of vibration problems.
9. This work will be completed in time.
10. A new type of nozzle has been recently developed by a group of engineers.

Unit 10. Power Plant

Reading

b)



Comprehension Check

1. a) силовая установка – power plant
аппарат для движения – means of propulsion
величина – amount
способность – ability
требование – requirement
двигатель – engine
вес – weight
коэффициент – ratio
определять – define
выход – output
цель – purpose
топливо – fuel
потребление – consumption
существовать – exist
надежность – reliability
излишек – excess
ремонт – overhaul
приспособляемость – flexibility

2. 1 – d, 2 – e, 3 – a, 4 – b, 5 – c.

3. 1. The engine.
2. The weight of any engine must be as low as possible.
3. Flexibility is the ability to run smoothly and perform properly at all speeds and through all variations of atmospheric conditions.
4. Maximum.
5. The necessity of carrying away excess heat.
6. It is a means of propulsion that should meet a number of requirements to work effectively.
7. There are gasoline engines, diesel engines, gas turbines, jet engines and rocket engines.

Language Focus

1. 1 – e; 2 – g; 3 – a; 4 – b; 5 – c; 6 – f; 7 – d.

2. a) power
b) requirements
c) excess
d) engine
e) output
f) overhaul
g) flexibility

3. (Suggested answers)

1. mechanical	power
2. reduced	weight
3. fuel	consumption
4. engine	flexibility
5. atmospheric	conditions
6. important	requirement
7. overhaul	period

4.
 1. must have
 2. had to be developed
 3. may be
 4. could be used
 5. should check

5. (Suggested answers)

1. The power plant is an important part of the aircraft.
2. Piston and turboprop engines consist of two main parts: the engine and the propeller.
3. The aircraft engine serves as a means of propulsion.
4. If there are some engines on board of the plane, they are located in nacelles.
5. Normally, the propeller is located on the engine shaft.

Writing

1. The machine that produces power is called an engine.
2. A power plant is a means of propulsion.
3. The designers want to solve the problem of fuel consumption.
4. Today's modern airplanes are powered by turbofan engines.
5. Do you know what was the first engine like?

Unit 11. Gas Turbine Engine Components

Comprehension Check

1. а) роторный компрессор – rotary air compressor
воздухозаборник компрессора – air intake
центробежный компрессор – centrifugal flow compressor
осевой компрессор – axial flow compressor
рабочее колесо – impeller
диффузор – diffuser
переменные ряды – alternate rows
результатирующая тяга – resultant thrust
кольцевая камера сгорания – annular combustion chamber
вспомогательные агрегаты двигателя – accessories
выхлопные газы – discharge gases

2.	Part	Function
	compressor	centrifugal – to accelerate the air and to produce the required pressure rise; axial – to accelerate and diffuse the air
	combustion chamber	to expand the air, passing through the engine, by burning fuel in the air stream
	turbine	provides the power to drive the compressor and accessories
	exhaust system	passes the turbine discharge gases to atmosphere at a velocity, and in the required direction, to provide the resultant thrust

3. a)
1. The gas turbine engine consists of a rotary air compressor with an air intake, one or more combustion chambers, a turbine and an exhaust outlet.
 2. There are two basic types of rotary air compressors: a centrifugal flow compressor and an axial flow one.
 3. To produce the required pressure rise.
 4. It has rotating and stationary blades.
 5. In the air stream.

Language Focus

1. a) 1 – e; 2 – g; 3 – a; 4 – b; 5 – f; 6 – d; 7 – c.

2. The gas turbine engine takes air from the atmosphere and, after compressing and heating, it uses some of its power to drive the turbine. The mechanical geometry of the gas turbine engine is simple. It consists of two main rotating components, a compressor, a turbine and a combustion chamber. The turbojet engine is most appropriate for high forward speeds. At aircraft speeds below 450 miles per hour the jet engine is less powerful than a propeller-type engine.

3. (Suggested answers)

1. This engine may be installed on a new airliner.
2. The proposals of this design team should be taken into consideration.
3. It is necessary to conduct a thorough inspection of the compressor of this power plant.
4. Moreover, the performance measures of this plant should be checked.
5. We were assured the report would be completed in time.

Speaking

- a) A – LM6000 gas turbines (used for industrial equipment).
C – CF34 turbofan engine (used for aircraft).
D – IM400 TRI-FLECS gas turbine co-generation system (used for industrial systems).
FLEXS – (Flexible Electric Cogeneration System).

Unit 12. Compressors

Reading

1. *compressor efficiency* – maximum compression with minimum temperature rise;
axial flow compressor – a compressor that is made up of a series of rotating airfoils called rotor blades and a stationary set of airfoils called stator vanes;
stage – a row of rotating and stationary blades is called a stage;
rotor blades – a series of rotating airfoils called rotor blades;
stator vanes – a stationary set of airfoils called stator vanes.

Comprehension Check

1. a) *Role*: provide a maximum of high-pressure air and then expand it through the turbine.

Efficiency: determine the power necessary to create the pressure rise of a given airflow and affect the temperature change.

Characteristics: *compression ratio is 15:1;

*efficiency is about 90%;

*airflow is up to 350lb/s;

*total pressure ratio is 25:1 (if fan is added);

*mass airflows is 1000lb/s (if fan is added).

Types of compressors: axial, centrifugal, centrifugal-axial.

2. a) степень сжатия – compression ratio
осевой компрессор – axial/axial flow compressor
центробежный компрессор – centrifugal-flow compressor
аэродинамическая поверхность – airfoil

лопасть – blade, vane
комплект лопаток – blading
насос – pump
каскад (компрессора) – spool
фронтальная поверхность – frontal area
ступень – stage
нагнетание – pumping
повреждение – damage
диапазон – range
приспособляемость – flexibility
плотная посадка деталей – close fit

- b)** влиять на изменение температуры – affect the temperature change
снижать стоимость – bring down the cost

3. 1... a maximum of high-pressure air which can be heated in the limited volume of the combustion chamber and then expanded through the turbine.
2... the power necessary to create the pressure rise of a given airflow and affects the temperature change which can take place in the combustion chamber.
3... parallel to the axis of the engine.
4... a series of rotating airfoils called rotor blades and a stationary set of airfoils called stator vanes.
5... some axial-flow designs have two or more compressors or spools which are driven by separate turbines.
6... it is capable to very high compression ratios with relatively high efficiencies.
7... this type of pump being highly susceptible to damages of foreign objects.
8... the demands of efficiency and output predominate considerations of cost, simplicity, flexibility of operation.

4. (Suggested answers)

1. Its efficient operation (maximum compression with minimum temperature rise) is the key to high overall engine performance.
2. The compressor efficiency determines the power necessary to create the pressure rise of a given airflow and will affect the temperature change which can take place in the combustion chamber.
3. A row of rotating and stationary blades is called a stage.

4. It is made up of a series of alternating rotor and stator vane stages.
5. Axial compressors are capable to very high compression ratios with relatively high efficiencies. They have small frontal area. Unfortunately the delicate blading, especially toward the rear, makes this type of air pump especially susceptible to foreign object damage.
6. The number of compressor blades and stator vanes (which can exceed 1000 in a large jet engine), the close fits required for efficient air pumping, and the much narrower range of possible operating conditions, make this type of compressor very complex and very expensive to manufacture.
7. Where the demands of efficiency and output predominate considerations of cost, simplicity, flexibility of operation, etc. Most manufacturers utilize several dodges to increase flexibility and to improve the operating characteristics of the axial-flow compressor.

Language Focus

1. since – поскольку; key – ключ; affect – влиять; approximately – приблизительно; addition – добавление; entire – весь; alternating – чередующийся; design – конструкция; therefore – поэтому; advantage – преимущество; relatively – сравнительно; unfortunately – к сожалению; especially – особенно; furthermore – более того.
2. a) to set free – to release; to use – to consume; whole – overall; modern – present-day; besides – in addition to
3. arrays of; a requirement for; arrays of; set in; flow for; blades of; with the cross-sectional area; of the gas passage.
4. a) maximum – minimum; under – over; expansion – compression; rotating – stationary; front – rear; wide – narrow; input – output; complexity – simplicity
5. spinning; stalled; violently; associated; rotational; operating; variable.
6. a) 1 – i; 2 – o; 3 – l; 4 – a; 5 – s; 6 – b; 7 – r; 8 – c; 9 – q; 10 – d; 11 – e; 12 – f; 13 – g; 14 – j; 15 – m; 16 – n; 17 – h; 18 – k; 19 – p.

Unit 13. Centrifugal-Flow Compressor

Lead in

Construction	Characteristics
impeller	chief
manifold	multiple
rim	single
stage	ruggedness
plenum chamber	shock wave
diffuser	acceleration
gas turbine	gas turbine
	excessively
	double-entry
	rapid
	attribute
	inefficient
	flexibility
	massive
	centrifugal
	simplicity

Reading

2. *Components:* impeller, diffuser manifold, compressor manifold.

Types: single-stage, multiple-stage, double-sided.

Characteristics: high compression ratio per stage, simplicity, ruggedness and low cost.

Advantages: flexibility.

Disadvantages: massive construction, large air chamber, lost of efficiency.

Application: on small engines.

Comprehension Check

1. a) 1. It consists of an impeller and a diffuser manifold.
 2. Centrifugal force provides high acceleration to this air and causes it to move outward from the axis of rotation toward the rim of the rotor where it is ejected at high velocity and high kinetic energy.

3. The pressure rise is produced in part by expansion of the air in the diffuser manifold by conversion of the kinetic energy of motion into static pressure energy.
 4. The centrifugal compressors can be manufactured in a variety of designs including single-stage, multiple-stage, and double-sided types.
 5. They are simplicity, ruggedness and low cost.
 6. Because of its massive construction.
 7. Above a compression ratio of 6 or 7 to 1 efficiency drops off at a rapid rate.
 8. Through the use of multistage compressors.
- 2.**
1. ...an impeller and a diffuser manifold.
 2. ...by expansion of the air in the diffuser manifold.
 3. ... single-stage, multiple-stage, and double-sided types.
 - 4...damage from the injection of foreign objects.
 5. ...above 80% efficiency of a compressor.
 6. ...low fuel consumption.
 7. ... the difficulty in turning the air as it passes from one stage to another.
 8. Double-entry compressors...
 9. ... a diffuser by which means the rear impeller can receive its air.
 10. ... on the smaller engines, where simplicity, flexibility of operation and ruggedness are the principle requirements rather than small frontal area, and ability to handle high air flows and pressures with low loss of efficiency.
- 3. a)**
- a) impeller – рабочее колесо; manifold – трубопровод; rim – кромка; ruggedness – прочность; tip – кончик; ingestion – засасывание; stage – ступень; plenum chamber – камера сгорания; conversion – превращение; eye – отверстие; in turn – в свою очередь; feature – признак; damage – повреждение; expansion – расширение
- b) to draw in – втягивать; to direct – направлять; to revolve – вращать; to cause – вызывать; to drop off – снижать; to rule out – исключать; to obtain – достигать; to offset – компенсировать; to handle – управлять
- c) susceptible – подверженный; capable – способный; chief – главный; attending – сопутствующий; partially – частично; inherent – присущий; single – единственный; multiple – множественный; outward – извне

4. a) add; manufacture; drop off; offset; rule out.

Language Focus

1. 1 – c, 2 – b, 3 – a, 4 – e, 5 – d, 6 – h, 7 – f, 8 – g.

2. 1 – h, 2 – b, 3 – d, 4 – f, 5 – a, 6 – e, 7 – c, 8 – g.

3. a) 1 – c; 2 – f; 3 – h; 4 – a; 5 – b; 6 – d; 7 – e; 8 – g.

4. 1 – includes; 2 – forms; 3 – incompressible; 4 – deal; 5 – greater; 6 – experience; 7 – contrast; 8 – through; 9 – an increase. The extra word is CONVERT.

5. are used throughout; reciprocating compressors without; more suited to; high volume with; in contrast; 8,000 to; one example of; an application of; their use in; back into.

6. operating; allowable; equipment; typically; location; detrimental; resistance; occurrence; occasional; catastrophic.

Unit 14. Operation of the Combustion Chamber

Reading

2. Combustion system: air and fuel mixture; burning; cooling.

Comprehension Check

1. 1 – f; 2 – e; 3 – a; 4 – b; 5 – c; 6 – d.

3. 1 – F (Fuel is introduced at **the front end** of the burner in either a highly atomized spray from specially designed nozzles.).

2 – F (Air flows in around the fuel nozzle and through **the first row** of combustion air holes in the liner.).

3 – F (**Additional air** is introduced through the remaining air holes in the liner.).

4 – F (During combustion this action permits **rapid** mixing and prevents flame blowout by forming a low-velocity stabilization zone.).

5 – T.

6 – F (Since there **are only two** igniter plugs in an engine, cross ignition tubes **are necessary** in the can-annular types of burners in order that burning may be initiated in the other cans or inner liners.).

- 7 – F (The igniter plug is usually located in the **upstream** reverse-flow region of the burner.).
- 8 – F (If all the air flowing through the engine were mixed with the fuel at this point, the mixture would be **outside** the combustible limits for the fuels normally used.).
- 9 – F (Before entering the turbine the gases must be cooled to approximately **half of** this value.).
- 10 – T.

4. a) 1. Fuel is introduced at the front end of the burner in either a highly atomized spray from specially designed nozzles, or in a prevaporized form from devices called vaporizing tubes.
2. The burner geometry is such that the air near the nozzle stays close to the front wall of the liner for cooling and cleaning purposes.
3. The air entering through opposing liner holes mixes rapidly with the fuel and forms a combustible mixture.
4. It is prevented by forming a low-velocity stabilization zone which acts as a continuous pilot for the rest of the burner.
5. The intense turbulence is necessary for mixing the fuel and air and for transferring energy from the burned to the unburned gases.
6. There are only two igniter plugs.
7. In the upstream reverse-flow region of the burner.
8. After ignition, the flame quickly spreads to the primary or combustion zone where there is approximately the correct proportion of air to completely burn the fuel. If all the air flowing through the engine were mixed with the fuel at this point, the mixture would be outside the combustible limits for the fuels normally used.

Language Focus

1. a) 1 – a, 2 – g, 3 – c, 4 – f, 5 – e, 6 – d, 7 – b.

b) 1 – b, 2 – c, 3 – a, 4 – f, 5 – h, 6 – e, 7 – i, 8 – d, 9 – g.

2. a) 1 – nozzle; 2 – blowout; 3 – turbulence; 4 – diluting; 5 – blanket.

4. travel at; air flows through; burning in; some of; mixture ratio of; air used for combustion; air used for cooling; ported through; small holes in; a blanket of; combustion can from; subjected to.

5. a) (Suggested answers).

1 – f; 2 – d; 3 – k; 4 – i; 5 – a; 6 – b; 7 – c; 8 – e; 9 – g; 10 – h; 11 – j; 12 – l.

6. engine nozzle; complex manifold; flow streams; via the injector; through an atomizer; an electric spark. The extra word is LINER.

7. Incomplete combustion (a state in which not all the fuel in the combustion burns) may result from inadequate chamber design, or it may be deliberately designed into the system so that the unburned fuel acts as a chamber coolant. Generally, incomplete combustion is indicative of a system not functioning efficiently.

Combustion chamber is a space over, or in front of, a boiler furnace where the gases from the fire become more thoroughly mixed and burnt. The clearance space in the cylinder of an internal combustion engine is compressed and ignited.

Unit 15. Supersonic Ducts

Lead in

2. 1 – l; 2 – m; 3 – e; 4 – g; 5 – d; 6 – a; 7 – h; 8 – n; 9 – f; 10 – k; 11 – i; 12 – j; 13 – o; 14 – c; 15 – b.

Comprehension Check

1. будут создавать вибрационные условия – will set up vibrating conditions; точка восстановления давления в канале – the duct recovery point; ударная волна попеременно заглатывается или выталкивается на входе в канал – the shock wave being alternately swallowed and expelled at the inlet of the duct; удерживать ударную волну вне сопла – keep the shock wave out of the duct.

3. 1 – F (The supersonic duct problems start when the aircraft begins to fly **at or near the speed of sound.**)
 2 – F (The normal shock wave will produce a pressure rise and a velocity decrease to subsonic velocities **before** the air strikes the inlet duct.)
 3 – F (At low supersonic Mach numbers, the strength of the normal shock wave is not too great).
 4 – T.
 5 – T.
4. a) 1. The supersonic inlet duct must operate in three speed zones: subsonic, transonic, supersonic.
 2. At the sonic speeds.
 3. Buzz.
 4. At higher Mach numbers.
 5. There are some reasons. It is due to: 1) an oblique shock pressure rise; 2) a normal shock pressure rise; 3) a subsonic diverging section pressure rise.

Language Focus

2. a) Distribute them into the columns according to the meaning they contain in parts A-H.
 b) Think of an additional column and entitle it. Fill it in with the necessary prepositions.

Parts	Direction	Phrasal verbs	Time	Merely grammatical relations	? (Place)
A					in
B				by, with	
C		up		in, by, of	at, in
D	to			of, by, with	at
E	to, out of		before	of, by, in	behind, at, above, in front of, behind, inside
F	into, out of	up (set up), to (due to)		of, to	at, behind

3. 1 – of, at, to, by. 2 – to, until. 3 – before, with, out, of. 4 – into. 5 – in.

Unit 16. Inlet Ducts

Reading

a) the duct pressure efficiency ratio is the ability of the duct to convert the kinetic or dynamic pressure energy at the inlet of the duct into static pressure energy at the inlet of the compressor without a loss in total pressure;

the ram recovery point is an aircraft speed at which the ram pressure rise is equal to the friction pressure losses, or the airspeed at which the compressor inlet total pressure is equal to the outside ambient air pressure;

a bellmouth inlet is a bell-shaped funnel having carefully rounded shoulders, which offer practically no air resistance.

Comprehension Check

1. b)

Inlet Ducts: 1 – operation, 2 – configuration, 3 – role, 4 – characteristics, 5 – types.

Role: a) convert the kinetic energy into a ram pressure rise; b) supply the engine with air.

Characteristics: a) duct pressure efficiency; b) ram recovery point.

Types: a) subsonic; b) supersonic.

2. a)

a) уязвимый – critical; ровный – straight; внешний – outside; неподвижный – dead; плавно – smoothly;

b) число Маха – Mach number; положение – attitude; распределение – distribution; срыв компрессора – compressor stall; основная задача – primary task; скоростной поток – ram; сопротивление – resistance; трение – friction; точка восстановления скоростного потока – ram recovery point; потери – losses, inefficiencies; граничный слой воздуха – boundary, layer air; в допустимых пределах – within limits;

c) для того чтобы – in order to; таким образом – in such a way; по существу – essentially;

d) сводиться к – be held to; доставлять – deliver; обеспечивать – supply; привести к – result in; удерживать – keep; происходить (случаться) – occur; определять(ся) – determine.

3. a) (Suggested answers)

1. It supplies the engine with the air at the highest possible pressure.
2. The inlet duct must operate from static ground run up to high aircraft Mach numbers with a high duct efficiency at all altitudes, attitudes, and flight speeds.
3. Inlet Ducts should be as straight and smooth as possible, and should be designed in such a way that the boundary layer air (a layer of still, dead air lying next to the surface) be held to the minimum.
4. It delivers the air to the front of the compressor.
5. Not only must the duct be large to supply the proper airflow, but it must be shaped correctly to deliver the air to the front of the compressor with an even pressure distribution. Poor air pressure and velocity distribution at the front of the compressor may result in compressor stall.
6. They are rated due to the use of a bellmouth inlet.
7. Inlet Ducts may be divided into two broad categories: subsonic ducts and supersonic ducts.

Language Focus

1. 1 – b; 2 – c; 3 – f; 4 – h; 5 – d; 6 – j; 7 – i; 8 – k; 9 – e; 10 – a; 11 – g.
2. a) 1 – c; 2 – d; 3 – e; 4 – f; 5 – k; 6 – i; 7 – g; 8 – h; 9 – b; 10 – a.
b) 1 – f; 2 – e; 3 – a; 4 – b; 5 – c; 6 – d; 7 – g.
3. a) 1 – e; 2 – f; 3 – a; 4 – b; 5 – c; 6 – d.
b) 1 – convert; 2 – causes; 3 – accomplished; 4 – supplied; 5 – rated; 6 – influenced.
4. for subsonic aircraft; minimize drag; even for supersonic; shockwaves form; to increase. The extra word is DECREASE.
5. 1 – perpendicular **to** the direction **of** the flow; the flow **to** subsonic speeds; crowd **of** molecules; Mach number **to**
2 – bow wave **on** and radiate **from**; **for** a given inlet; supersonic **throughout**; **until** another flow.

6. b)

1	ADVANCE	<i>advanced</i>	adjective
2	COMPRESS	<i>compressor</i>	noun
3	REDUCE	<i>reduction</i>	noun
4	CORRECT	corrected	adjective
5	DISCONTINUE	<i>discontinuity</i>	noun
6	WEAK	<i>weaken</i>	verb
7	RECOVER	<i>recovery</i>	noun
8	HIGH	<i>higher</i>	adjective
9	NORM	<i>normal</i>	adjective

Unit 17. Turbine

Lead in

2. Turbine Construction

Reading (Part I)

1 – D; 2 – F; 4 – C; 5 – A; 6 – B; 7 – E.

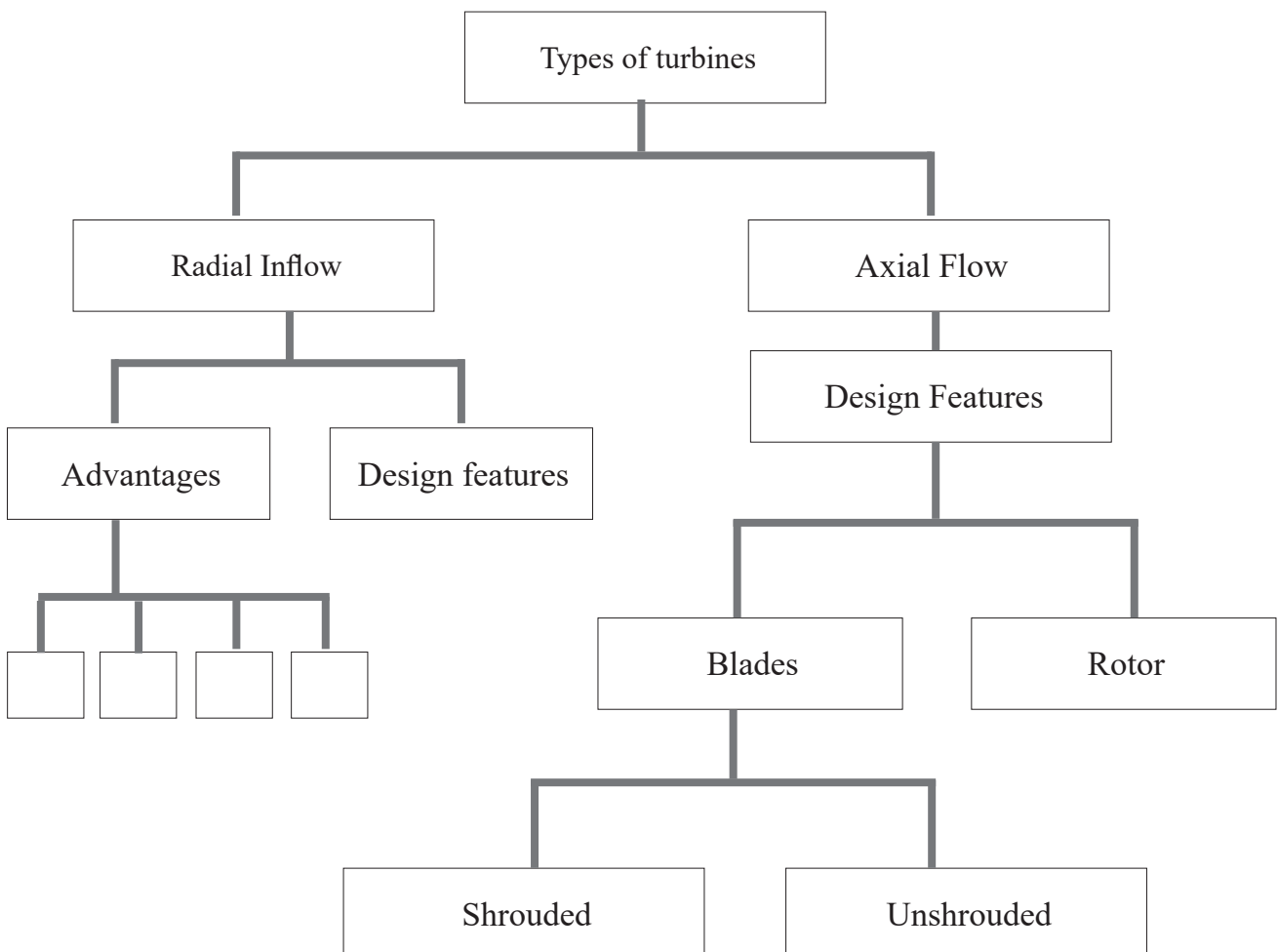
Comprehension Check

1. в пределах – within limits; процентное соотношение – percentage; соответствующее увеличение – corresponding increase; равномерное распределение нагрузки – equitable load distribution; оставшиеся турбины – remaining turbines; экстремальные условия – extreme conditions; наиболее напряжённые части – the most highly stressed parts; при сильных центробежных нагрузках – under sever centrifugal loads; в пределах безопасных эксплуатационных режимов – within safe operating limits; для обеспечения структурной целостности – to assure structural integrity.
2. Fig. 1 – a turbine rotor assembly; Fig 2. – “fir-tree” attachment for turbine blades; Fig. 3 – shrouded and unshrouded turbine buckets.
 - a) 1 – turbine wheel; 2 – buckets; 3, 5 – bearing journals; 4, 6 – bearings; 7 – turbine shaft; 8 – main drive spline.
 - c) It corresponds to part C.

3. 1... to keep the turbine within safe operating limits.
- 2... X-rays, sound waves, and other inspection methods to assure structural integrity.
- 3... highly alloyed steel and are passed through a carefully controlled series of machining and inspection operations before being certified for use.
- 4... within limits by passing relatively cool air bled from the compressor over the face of the turbine...
- 5... the power required to drive the compressor...
- 6... When two or more turbine wheels are used...
- 7... more blade area is needed in the rear stage to assure an equitable load distribution between stages.

Reading (Part II)

1. a) radial-inflow type; b) axial-inflow type.
3. a) The second graph better reflects the content of the text. But it needs some changes.



Language Focus

1. a) (Suggested answers): controllable, shrouded, proportional, rotational, excessive, careful/careless, alloyed, advantageous.
2. a) (Suggested answers): keep to/from/up/within; attach to; tend to; convert to/into; forge from; subject to; achieve by; change into; set up/by; depend on/upon.
3. the most seriously; stream of hot; which raise; introduce vibratory; of the wheel; by the combustion; not uncommon; the rim of; one turbine disk; do not encounter; through various; to flow around. The extra word is CAUSE.
4. a) (Suggested answers)

Verb	Translation	Noun	Translation
1. to flow	протекать	flow	поток
2. to force	заставлять	force	сила
3. to exhaust	выпускать	exhaust	выхлоп
4. to use	использовать	use	польза
5. to work	работать	work	работа
6. to set	устанавливать	set	комплект
7. to assemble	собирать	assembly	агрегат
8. to form	формировать	form	форма
9. to discharge	разряжать	discharge	разряд
10. to sound	звучать	sound	звук

Part II

Unit 1. IT for Aviation

Reading

2. IT in aviation: aircraft engineering, flight management, airline operation.

Aircraft engineering: design and development, testing, training.

Flight management: communication, navigation, aircraft maintenance, surveillance.

Airline operation: airline reservation, air traffic control, e-ticketing, security check, self-service kiosks, airport management.

3. Sirena Travel.

5. wire frame, solid, surface.

6. CIM=Computer Integrated Manufacturing, CAPPS=Computer Aided Process Planning and Control, CAQA= Computer Aided Quality Assurance, CAMH=Computer Aided Material Handling, CAMM=Computer Aided Maintenance Management, CADD=Computer Aided Design and Drafting.

Language Focus

1.	Verb	Noun	Adjective
	apply	application	applied
	develop	development, developer	developed, developing
	produce	production, producer	productive
	compute	computer	computing
	manage	management	managing
	execute	execution, executor	executive
	increase	increase	increasing
	provide	provision, provider	providing
	operate	operation	operating

2. 1 – C, 2 – D, 3 – A, 4 – B, 5 – C, 6 – D, 7 – C, 8 – D, 9 – B, 10 – C.

Listening

5. 1 – F, 2 – T, 3 – T, 4 – F, 5 – T.

Unit 2. IT for Cosmonautics

Reading

3. heliocentric=sun-centred, movement=motion, obtaining=acquiring speed=velocity, place=position, give=provide, precise=accurate, at the same time=simultaneously, fast=high-rate, change=alter.

Language Focus

1. propulsion system, high precision, mathematical model, navigation system, radial component, ranging pulse, precise data, wave front.
2. 1 – E, 2 – G, 3 – D, 4 – B, 5 – F, 6 – A, 7 – C.
3. 1 – position, 2 – vehicle, 3 – circle, 4 – target, 5 – rocket, 6 – use, 7 – data, 8 – together.
4. 1. Satellites are used for a large number of purposes.
2. Robotic spacecraft is a spacecraft with no humans on board.
3. Before the invention of the telescope, people has few tools to explore space.
4. Sir Isaac Newton was searching for a way to reduce the length of a telescope.
5. Karl Jansky in the 1930's discovered that galaxies emitted radio waves.
6. Computers have led to major advancements and breakthroughs in space research.
7. How does the Hubble Space Telescope work?
8. What are supercomputers used for?
9. What plays a critical role in space exploration.
5. **Across:** 1 trajectory, 2 mission, 3 sputnik, 7 alien, 8 astronomy, 11 shuttle, 12 crew, 13 meteorite, 15 destination 16 navigation.

Down: 2 constellation, 4 simulation 5 telescope 9 moon 10 Star Wars, 14 orbit.

6.

be	was/were	been
become	became	become
begin	began	begun
do	did	done
draw	drew	drawn
find	found	found
fly	flew	flown
get	got	got
give	gave	given
grow	grew	grown
have	had	had
keep	kept	kept
know	knew	known
lie	lay	lain
lead	led	led
make	made	made
mean	meant	meant
see	saw	seen
take	took	taken

Comprehension Check

2. 1 – T, 2 – T, 3 – F, 4 – F, 5 – F, 6 – T, 7 – F, 8 – F.

Listening

1. 1. nano-satellite ... earth-like ... planets
2. Exo-Planet Sat ... loaf of bread ... powerful optics ... control and stabilisation technology
3. transiting planet ... stars ... brightness ... in front of
4. 3 litres ... 10 cm ... 10 cm ... 30 cm
5. three segments
6. imaging ... electronics ... computer systems ... power systems ... reaction wheel
7. images ... moving ... direction ... compensating ... six ... freedom ... locked

Unit 3. Digital versus Analog

Vocabulary

1. 1 – c; 2 – f; 3 – g; 4 – h; 5 – a; 6 – d; 7 – e; 8 – b.

- 2.
- | | |
|------------------|-------------------------|
| 1) amplitude | 6) communication medium |
| 2) binary format | 7) distortion |
| 3) continuous | 8) networking |
| 4) discrete | 9) data exchange |
| 5) bit streams | 10) multiplexers |

Reading

1. Arguments in favour: digital technology allows conveying vast amounts of data over a limited number of channels and provides increased noise immunity.

Comprehension Check

1.

1. performance	7. a delay
2. a bottleneck	8. to acquire
3. the advent	9. immunity
4. to overcome	10. negligible
5. to convey	11. to distinguish
6. to restrict	12. substantial

2. 1 – c; 2 – d; 3 – a; 4 – f; 5 – g; 6 – e; 7 – b.

4.

System	Channel capacity	Speed	Noise immunity	Resolution
Analog	Only one signal per channel	Instantaneous	Corrupted by any amount of noise	Unlimited resolution
Digital	Many signals per channel	Time-delayed	Immune to certain amounts of noise	Limited resolution

Language Focus

3. 1 – into; 2 – the; 3 – with; 4 – be; 5 – as; 6 – for instance; 7 – which; 8 – such as; 9 – between; 10 – on; 11 – while; 12 – is; 13 – both; 14 – it; 15 – as...as.

4. 3 – 6 – 1 – 5 – 9 – 12 – 2 – 10 – 15 – 4 – 16 – 7 – 14 – 11 – 13 – 8.

6. 1 – C; 2 – E; 3 – H; 4 – A; 5 – D; 6 – G; 7 – B; 8 – F – extra.

Unit 4. Digital Carrier Systems

Lead in

2. All of the words can be used in an introductory text except for, probably, level, power supply and spectrum.

Reading

1. C – A – D – B.

2. The words *level*, *interference*, *modulation*, *power supply*, *bandwidth*, *spectrum* and *range* are not used in the text.

Comprehension Check

1. 3.

3. 1c), 2b), 3c), 4a), 5b).

4. 1 – F, 2 – T, 3 – F, 4 – T, 5 – F, 6 – T, 7 – F.

Language Focus

1. 1. a) transmitted b) transmitting. 2. obtaining. 3. making.

4. a) transmitting b) receiving. 5. being. 6. a) developed b) applying.

7. a) proposed b) based. 8. a) spaced b) linked.

2. 1A, 2D, 3A, 4C, 5B, 6C, 7D, 8A, 9B, 10D, 11C, 12B, 13A, 14C, 15B.
3. 1 sensors, 2 crash-proof container, 3 similar circumstances, 4 a crucial component, 5 an applied load force, 6 a sonar transmitter, 7 the recording media, 8 moving parts, 9 an analog format, 10 a binary signal, 11 filtration, 12 to determine.

Unit 5. Avionics: On-Board Electronic Devices

Vocabulary

1. 1 – e; 2 – k; 3 – a; 4 – h; 5 – j; 6 – g; 7 – c; 8 – f; 9 – i; 10 – o; 11 – b; 12 – n; 13 – d; 14 – m; 15 – p; 16 – l.

Comprehensive Check

Position of the vehicle (distance departure point, distance to destination, altitude).

Outboard conditions (local traffic, wind/ground speed, weather conditions).

The aircraft performance (fuel supply, trip, range, air speed).

Extraordinary situation (collisions, fire, electrical system failure).

Language Focus

3. (1 – 5; 2 – 1; 3 – 6; 4 – 3; 5 – 2; 6 – 4).

4. (1 – a; 2 – e; 3 – c; 4 – f; 5 – b; 6 – d).

5. (1 – b; 2 – c; 3 – a; 4 – b; 5 – a).

6. a) ADF – Automatic Direction Finder, DME – Distance Measuring Equipment, GPS – Global Positioning System, HIS – Horizontal Situation Indicator, Comm-Communication, RADAR – Radio Detection and Ranging, RMI – Radio Magnetic Indicator, VHF – Very High Frequency, AC – Alternating Current, ATC – Air Traffic Control, HF – High Frequency, VOR – Visual Omnidirectional Range, AM – Amplitude Modulation

- b) 1 – c; 2 – e; 3 – g; 4 – f; 5 – a; 6 – b; 7 – d; 8 – m; 9 – k; 10 – i; 11 – j; 12 – h; 13 – l.

7. (1 – B; 2 – A; 3 – B; 4 – A; 5 – C; 6 – B; 7 – A; 8 – B; 9 – C; 10 – B).

Headings: 1 – Aircraft avionics; 2 – Communications; 3 – Navigation

Unit 6. Avionics: On-Board Equipment

Comprehension Check

1. § 1 – Automated flight control reduces pilot error and workload at key times and increases safety.

§ 2 – Collision – avoidance systems are able to detect the location of nearby aircraft and provide instruments for avoiding a midair collision.

§ 3 – Weather systems such as weather radar, lighting detectors, wind shear and turbulence detection and terrain and traffic warning systems are important for aircraft flying in instrument meteorological conditions.

2. TRAS – Traffic alerting system

CFIT – Controlled flight into terrain

GPWS – Ground– proximity warning systems

TAWS – Terrain awareness warning system

3. alerting system – quick to notice any unusual and potentially dangerous or difficult circumstances; vigilant

transponder – a device for receiving a radio signal and automatically transmitting a different signal

turbulence – violent or unsteady movement of air or water, or of some other fluid

terrain – a stretch of land especially with regard to its features

convective activity – activity in which upward motion of warmer fluid in the center is balanced by downward motion of cooler fluid at the periphery

precipitation – the fact or quality of acting suddenly and rashly

wind share – variations in wind velocity occurring along a direction at right angles to the wind's direction and tending to exert a turning force

deviate – depart from an established course

Language Focus

– Present Simple Active/Passive (have, use, do not provide/include, is tested)

– Past Simple Passive (were used)

– Present / Past Perfect Active (has increased, had limited)

– Modal verbs (can detect, can provide, may use)

1. avoid midair collisions, detect location, supplement air traffic control, overcome weakness, provide instructions, use systems

2. use-usage-usable-user, avoid-avoidance-avoidable-unavoidable, allow-allowance-allowable-unallowable, divide-division-divisible, detect-detection-detective

Reading

1.

1. Yes, there are some. A glass cockpit uses several displays driven by flight management systems that can be adjusted to display flight information as needed, they eliminate the need for a flight engineer, saving costs.
2. As aircraft displays have modernized, the sensors that feed aircraft displays have been modernized as well. Gyroscopic flight instruments have been replaced by electronic AHRS and ADCs, GPS receivers are integrated into glass cockpit.
3. Modern glass cockpits include Synthetic Vision (SVS) or Enhanced Vision systems (EVS).
4. All new airlines such as the Airbus A380, Boeing 787, Bombardier Global Express and Learjet use glass cockpits.

Unit 7. Unmanned Aerial Vehicles

Lead in

1. Post service, Geoinformation, Landscape research, Goods delivery, Green Peace Activities.
2. Economy, environment friendly, low operational costs, no need of special runways.

Comprehension Check

3. b) 1 – c, 2 – f, 3 – d, 4 – e, 5 – b, 6 – a.
4. 1 – T, 2 – F, 3 – F, 4 – F, 5 – F, 6 – T.

Language Focus

2. a) 1 – remotely, 2 – pilotless, 3 – unlawful, 4 – outfitted, 5 – sharing, 6 – privacy.
3. 1 – invasion, 2 – task, 3 – artificial intelligence, 4 – neural networks, 5 – achievements, 6 – expansion, 7 – visual, 8 – to a greater extent

Unit 8. Computer Optics

Lead in

1. Blu-ray, CD, DVD, Holography, Fiber Optics.
2. 1. a technique which enables three-dimensional images (holograms) to be made.
2. a flexible, transparent fiber made of high quality extruded glass or plastic.
3. A CD can hold 783 megabytes of data.
4. DVD can hold 15,9GB of data.
5. Blue-ray is an advanced storage device.
3. 1 – f, 2 – c, 3 – h, 4 – b, 5 – e, 6 – g, 7 – i, 8 – a, 9 – b.

Comprehension Check

4. 1 – T, 2 – T, 3 – F, 4 – T, 5 – F, 6 – F, 7 – T.

Language Focus

1. **b)** 1. holography, 2. core, 3. buffer coating, 4. cladding, 5. ray.
2. 1. technique, 2. laser light, white light, 3. device, 4. task, 5. Blu-ray, 6. of a human hair, 7. in bundles, 8. single-mode fibers and multi-mode fibers, 9. single-mode fibers, 10. infrared light.
3. 1. as you walk past them and look at them from different angles 2. transmission holograms, 3. CDs and DVDs are the primary data storage methods, 4. today's storage needs, 5. to increase the output, 6. Outer optical material.

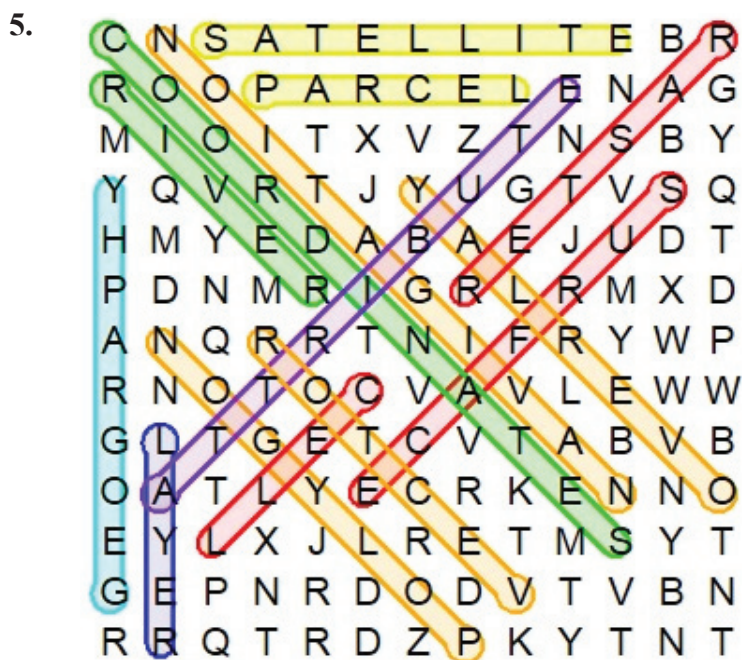
Unit 9. Geoinformatics

Lead in

3. 1 – b, 2 – f, 3 – h, 4 – a, 5 – g, 6 – e, 7 – c, 8 – d.

Reading

2. 1 – vector model, 2 – points, 3 – attributive information, 4 – lines, 5 – spatial information, 6 – raster model, 7 – polygons, 8 – volume, 9 – real world.
3. 1 – e, 2 – c, 3 – h, 4 – j, 5 – d, 6 – b, 7 – k, 8 – i, 9 – g, 10 – f, 11 – a.



6. **Vector:** 1, 3, 5, 8, 10. **Raster:** 2, 4, 6, 7, 9.

Language Focus

2. *First, the data are captured.* Secondly, the map base is registered. Then the data is interpreted. The data is converted into digital format. Then the data is stored in the computer. After that the data is processed. Finally, the results are displayed.

Listening

1. **1960's** – computer mapping applications appeared, **1900's** – capabilities to split maps into layers appeared, **1854** – cholera outbreak in London, **1994** – the Open Geospatial Consortium was established, **426** – the number of organisations involved in the open geospatial services.

2. 1) to be split, 2) called, 3) could be referred to, 4) has been, run, 5) has been, viewing.

3. 1) 1854, 2) John Snow, 3) the wells and the places of cholera cases, 4) the contaminated well was stopped.

Language Focus

1. from, 2. to, 3. Both, 4. alike, 5. closer, 6. better, 7. the most, 8. similar, 9. not, 10. than that.
1. In contrast to, 2. so does, 3. neither, 4. while, 5. so does, 6. and infrastructure does too, 7. on the contrary, 8. On the other hand.

Comprehension Check

- 1 – B, 2 – D, 3 – E, 4 – A, 5 – C.
- D, A, C, B, E.
- 1:1, 2, 3. 2:2, 3, 4. 3: 2, 3. 4: 5. 5: 4, 1. 6: 5. 7: 3. 8: A, horizon. 9: B. 10: directly overhead (the vision is not blocked).

Listening 2

1. The GPS receiver needs four satellites to determine its own location.
 2. By using a mathematical principle called trilateration.
 3. Use of three-dimensional spheres.
 4. They analyse high radio frequency low-powered radio signals from the GPS satellites and calculate the time signals travel.
 5. No. They have a very accurate atomic clock.
 6. Extra satellites are used (there are 29 satellites when only four are needed).
 7. Your GPS device will let you know that it doesn't have enough satellites to calculate an accurate position.

Speaking

1. I'd like to know why four satellite need to be visible.
 2. Could I ask you how GPS locates itself?
 3. Could you tell me what trilateration is?
 4. Could you tell me how GPS receivers know how far they are from the satellite?
 5. I'd like to know if satellites have stop watches.
 6. Could you tell me what happens if a satellite malfunctions.
 7. Could I ask you what would happen if GPS was only receiving a signal from one or two satellites?

Unit 10. Satellite Navigation Systems: GPS

Vocabulary

1. tracking, 2. eccentricity, 3. sidereal hour, 4. coverage, 5. inclination, 6. sine wave, 7. Doppler shift (frequency), 8. constellation, 9. semimajor axis.

Reading

1. 1c), 2b), 3a), 4c), 5b), 6a), 7c).

Comprehension Check

1.

1. to access
2. continuous
3. to fulfill
4. visible
5. elevation
6. to upload
7. error
8. integrity
9. accuracy

2.

1. carrier wavelengths
2. navigation message
3. built-in software
4. weather conditions
5. atomic clocks
6. a reference system
7. worldwide coverage
8. the digital codes
9. tracking stations
10. the signal interference

4. 1. The purpose of GPS (paragraphs 1, 2).

2. Overview of GPS (paragraphs 3, 4).

3. GPS segments (paragraph 5).

4. GPS: the basic concept (paragraph 6).

5. Important GPS applications (paragraph 7).

Language Focus

1. 6 – 10 – 4 – 8 – 1 – 5 – 3 – 9 – 13 – 11 – 2 – 7 – 12.
2. 1) of, 2) as, 3) while, 4) because, 5) itself, 6) In other words, 7) which, 8) The, 9) with, 10) than, 11) is, 12) a, 13) other, 14) its, 15) for, 16) at, 17) such as.
4. 1A, 2C, 3C, 4B, 5D, 6B, 7B, 8A, 9C, 10D, 11A.
5. 1) required, 2) measuring, 3) synchronized, 4) generates, 5) be picked up, 6) transmitted, 7) by, 8) gives, 9) is, 10) with, 11) synchronization, 12) to, 13) determined, 14) on, 15) due to.
7. 1 – D, 2 – H, 3 – A, 4 – F, 5 – C, 6 – K, 7 – I, 8 – E, 9 – J, 10 – G, B – extra.

Unit 11. Satellite Navigation Systems: GPS or GLONASS?

Lead in

3. 1) satellite navigation systems 2) positioning 3) satellites 4) coverage 5) term 6) Doppler

Reading

1. All issues are discussed except for two points– difference between two systems and advantages of GLONASS over GPS.

Comprehension Check

1. 1. consist of
2. altitude
3. approximately
4. simultaneously
5. arrange
6. distinguish
7. improve
8. complementary
9. comply
10. offset
11. opposite

2. 1 – d, 2 – j, 3 – g, 4 – a, 5 – b, 6 – i, 7 – e, 8 – c, 9 – h, 10 – f.

3. 1 – F, 2 – T, 3 – T, 4 – T, 5 – F, 6 – F, 7 – T.

Language Focus

2. 1) permitted 2) enhanced 3) better 4) in 5) centered 6) are allowed 7) with 8) was launched 9) have 10) -year 11) be 12) modernized 13) both 14) by 15) has had 16) has been matched

3. 1 – D; 2 – F; 3 – G; 4 – A; 5 – E; 6 – B; C, H – extra.

4. 1. operational
2. suitable
3. applications
4. information
5. reliability
6. accuracy
7. contribution

Unit 12. Nanotechnology

Lead in

1. 1) computing, 2) medicine, 3) science, 4) communication, 5) space exploration.

2. 1) high quality of production, 2) is able to detect disease, 3) generate renewable energy, 4) high rate data transfer.

Comprehension Check

3. 1 – d, 2 – c, 3 – a, 4 – e, 5 – b.

Language Focus

1. b) 1. essential, 2. appliance, 3. trial, 4. very small, 5. sense, 6. impact, 7. disease.

2. a) 1. nanotechnology, 2. cells, 3. treatment, 4. materials, 5. apply, 6. complex, 7. organs, 8. team, 9. basic, 10. field.

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