МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
НАЦІОНАЛЬНИЙ ТЕХНІЧНИЙ УНІВЕРСИТЕТ УКРАЇНИ
«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ
ІМЕНІ ІГОРЯ СІКОРСЬКОГО»
Факультет лінгвістики
Кафедра англійської мови технічного спрямування №2

АНГЛІЙСЬКА МОВА ЗАГАЛЬНОТЕХНІЧНОГО СПРЯМУВАННЯ

SENSORS AND CONTROL

Практикум

для студентів факультету авіаційних і космічних систем

Рекомендовано вченою радою факультету лінгвістики
КПІ ім. Ігоря Сікорського

Київ
КПІ ім. Ігоря Сікорського
2017

Англійська мова загальнотехнічного спрямування: Sensors and control [Електронний ресурс]: Практикум для студентів факультету авіаційних і космічних систем / Уклад. С.В.Вадаська, Н.Ю. Дроздович. – К.: КПІ ім. Ігоря Сікорського, 2017. – 158 с.

Гриф надано вченою радою
ФЛ КПІ ім. Ігоря Сікорського
(протокол № 9 від 24.04.2017 р.)

Ухвалено на засіданні кафедри АМТС
№2 ФЛ КПІ ім. Ігоря Сікорського
(протокол № 7 від 28.03.2017 р.)

Електронне навчальне видання

АНГЛІЙСЬКА МОВА ЗАГАЛЬНОТЕХНІЧНОГО СПРЯМУВАННЯ

SENSORS AND CONTROL

Практикум

для студентів факультету авіаційних і космічних систем

Укладачі Вадаська Світлана Валеріївна, старший викладач
Дроздович Наталія Юріївна, старший викладач

Відповідальний редактор Лавриш Ю.Е., к.пед.н , доцент

Рецензенти Прохорчук О. В., к.техн.н., доцент
Голуб Т. П., к.пед.н., доцент
Волкова О.А., ст. викладач
Цепкало О. В., ст. викладач

CONTENTS

ПЕРЕДМОВА

Практикум укладено відповідно до чинної програми підготовки студентів з освітнього ступеня “бакалавр” факультету авіаційних і космічних систем з дисципліни “Іноземна мова”, яка передбачає формування у студентів комунікативної компетенції, необхідної для ефективної участі в навчальному процесі та в різноманітних ситуаціях професійного спілкування. Ця робота призначена для навчання студентів у четвертому семестрі і є продовженням матеріалу викладеного у методичних вказівках до практичних занять для студентів 2 курсу факультету авіаційних і космічних систем «Англійська мова загальнотехнічного спрямування» (укладачів В.В. Лук’яненко, С.В. Вадаської).

У практикумі представлено шість уроків, які містять дванадцять англомовних оригінальних текстів з розробленим методичним забезпеченням у рамках загальнотехнічної тематики, пов’язаної з спеціальностями факультету авіаційних і космічних систем .

Мета практикуму - розширення та закріплення студентами загальнотехнічної термінологічної лексики та опанування граматичними конструкціями, що дозволяють розуміти автентичні тексти, пов’язані з навчанням та спеціальністю. Розроблений практикум сприятиме систематизації знань студентів, формуванню навичок, розвитку та удосконаленню вмінь у читанні, говорінні, письмі, аудіюванні та перекладі; підвищенню ефективності організації навчання іноземної мови в аудиторний та позааудиторний час, а також поглибленню знань студениів у рамках загальнотехнічних дисциплін.

UNIT 1

METROLOGY

PART I

I. Look at the pictures. What do they have in common? Do you know the functions and the structure of the following devices: tuning fork, oscilloscope, electric meter, and anemometer?

II. Many decisions in life are based on measurements. Measurements are an integral part of our daily lives. Read the saying of Lord Kelvin and explain how you understand it.

"When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind. It may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of science."

Reading

III. Read the following words and expressions and give their Ukrainian equivalents. Memorize them.

auspices	to verify	approximate
traceability	to measure	decimal
additive	to expand	interchangeable
evolution	to require	reliable
implementation	to deposit	large-scale

IV. Read and translate the text. Define the main reasons for metrology appearance.

World Metrology Day

From the primitive population who lived in caves to modern man, the need has always been there to measure and know. Of course, all these measurements were approximate. With the development of civilization the need for more acceptable measurement grew. This led to the evolution of the standards of measures. The origin of today's metrology can be traced to two events that took place over a period straddling the end of the eighteenth and beginning of the nineteenth centuries: the first was the creation and implementation of the decimal metric system in France; the second was the development of mass production using interchangeable parts.

World Metrology Day is an international annual event that marks the signing of the Metre Convention by seventeen nations on 20 May 1875. It was proposed to create an International Bureau of Weights and Measures, where the new international prototypes of the metre and kilogram would be deposited for the use of all member governments of the proposed Metre Convention. The range of metrological activity carried out under the auspices of the Metre Convention has greatly expanded since 1875. The first attempts to move beyond the metre and the kilogram and temperature were not long in coming. In 1881 at the first international Congress of Electricians that took place in Paris, it was proposed that the Metre Convention should take responsibility for electrical standards. Since then, nearly every nation in the world has adopted the measurement standards accepted by the convention, known as the International System of Units, or more generally, the Metric system.

Metrology is a science of measurements which covers definitions of units of measurements, realization of standards of units of measurements, development of measuring instruments and field of its implementation, establishing the unbroken chain of traceability of measuring results, as well as other theoretical and practical aspects concerning measurements. Metrology is represented in all areas of human's life, and thereby it is one of the most important supports of scientific and technical progress of each country.

The economic success of most manufactured products is critically dependent on how well they are made, a requirement in which measurement plays a key role. Telecommunications, transport and navigation are highly dependent on the most accurate frequency and time services. Human health and safety depend on reliable measurements in medical diagnosis and therapy. Food and agriculture are closely regulated in terms of the use of pesticides and food additives and it is essential to have reliable means of measuring their presence in the human food chain. Protection of the environment and large-scale studies related to global climate change depend critically on accurate measurements, often extending over long periods of time. These require accurate and stable measurement standards. Physical theory, upon which all of our high-technology activities are based, is reliable only to the extent that its predictions can be tested and verified quantitatively. This calls for measurements of the highest accuracy.

Modern metrology is based on the standards form the International System of Units, more commonly called SI Units. There are seven SI Units.

(Adopted from: http://www.millimess.com)

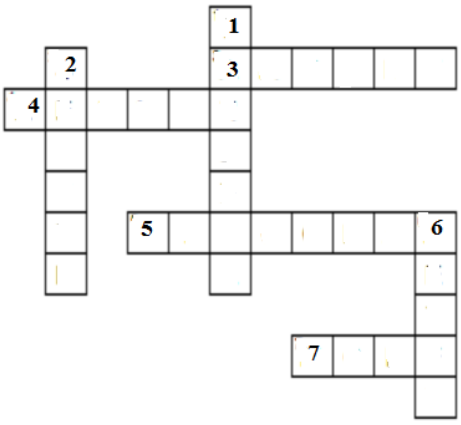
V. Answer the questions to the text.

1. What is metrology?
2. What is modern metrology based on?
3. How many SI Units are there?
4. Where is metrology represented?
5. When did the Metre Convention take responsibility for electrical standards?
6. What does World Metrology Day mark?
7. Why do human health and safety depend on reliable measurements?
8. What event took place in 1881?

VI. Complete the crossword with the names of SI Units using the following descriptions.

Across	Down
3. The constant current that produce a force	1. The luminous intensity that emits

equal to 2 x 10-7 Newton per meter of length. 4. The unit of thermodynamic temperature, it is 1/273.16 of the thermodynamic temperature of the triple point of water. 5. The unit of mass. The weight of a body is the product of its mass and the acceleration due to gravity. 7. The amount of substance of a system that contains as many elementary entities as there are atoms in 0.012 kilogram of carbon 12.	monochromatic radiation of frequency 5,401,012 hertz. 2. The duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium 133 atom. 6. The length of the path traveled by light in a vacuum during a time interval of 1/299,792,458 of a second.



VII. Make up the list of the terms dealing with metrology. Translate these terms and make up your own sentences about metrology.

Standards, peripherals, accuracy, equation, uncertainty, benefit, metric system, collaboration, unit, domestic, error, deviation, ability, airflow, calibration, hardware, tolerances, wing, frame.

VIII. Complete the sentences using information from the text "World Metrology Day".

1. The Metre Convention carried out...
2. New international prototypes of the metre and kilogram were proposed …

3. The reliability of physical theory depends on …

4. Metre Convention introduced …

5. Early measurements were approximate because of …

6. …. led to the evolution of the standards of measures.

7. … were the origins of today's metrology.

8. The creation and implementation of the decimal metric system …

IX. Taylor Hobson is a high precision technology company, operating at the highest levels of accuracy. Read the text "The Taylor Hobson Story" and fill in the gaps with the words given in the box.

Equipment, methods, leader, quality, world, reliability, company, demand, creation, industry, responsible, entrepreneur

The Taylor Hobson Story

Taylor Hobson is proud of its position as a world 1)____ in the design, development and supply of precision metrology 2)____. Taylor Hobson's story begins with the vision of the Victorian 3)____, William Taylor, who founded a lens making company with his brother in Leicester in 1886. He was 4)____ for developing the world's highest 5)____ cinema lenses which helped to develop the film 6)____ in the early twentieth century. The 7)____ and reputation of Taylor Hobson products were achieved through rigorous quality control 8)____. This led to the 9)____ of a new product group for the 10)____ - component inspection – and in doing so began the 11)____ for the metrology instruments that make Taylor Hobson the 12)____ renowned company it is today.

Complete the table using the text "The Taylor Hobson Story"and use your notes to summarize the information about the company.

Foundation of the company	Reasons for company's success	Original products of Taylor Hobson	Company's activity

X. Match the words to make up collocations. Use some of the collocations for the short introduction of metrology.

1. metrology	a. system
2. mass	b. evolution
3. measurement	c. means
4. metric	d. standard
5. key	e. origin
6. reliable	f. chain
7. unbroken	g. role
8. standard	h. production

XI. Fill in the gaps with the appropriate form of the words given in brackets.

1. GPS was _____ designed as a purely military system. (origin)
2. In recent years _____ efforts have been made to quantify the benefits from metrology. (consider)
3. The protection of the environment from the short-term and long-term destructive effects of industrial activity can only be assured on the basis of accurate and _____ measurements. (rely)
4. Human health and safety depend on accurate measurements in diagnosis and medical _____, and in the production and trade in food and food products. (treat)
5. Whereas _____ metrology is essential to all those engaged in the various chains of measurement, calibration and accreditation, legal metrology's primary focus is on measurements that directly affect consumers. (science)
6. The _____ who calibrate weighing scales in shops and markets are directly concerned with legal metrology, and are of course also metrologists. (technique)
7. Basic _____ which refers to this kind of metrology is calibration process. (act)
8. Metrology is now considered an _____ part of the technological infrastructure. (essence)
9. Measurement provides the foundation for progress and _____ of human society. (advance)

XII. Choose the correct option.

1. The SI is a globally agreed system of units based on the _____.

a) metric system b) derived unit c) measurement standard

2. There are seven base measurement _____ from which all other units are derived.

a) standards b) tools c) units

3. Today, reliable _____ are required over a much wider range of activities.

a) measurements b) standard c) products

4. As industry _____ major new developments with new materials, techniques and the miniaturization of products, measurements become more critical.

a) overcomes b) undergoes c) supports

5. Measurement implies _____ of quantities or counting of entities.

a) benefit b) accuracy c) comparison

6. A measurement procedure is usually documented in sufficient detail to enable an operator to _____ measurement.

a) make b) produce c) perform

7. The _____ with which measurements are made depends on the application.

a) precision b) quality c) standard

8. The appearance of _____ and measures systems goes far back into time.

a) scales b) weights c) units

9. The way we measure time is based on the sexagesimal system developed in Mesopotamia, and our calendar is _____ the original 365 days Egyptian calendar.

a) resulted in b) derived from c) differed from

10. The _____ of the metric system sprang from attempts to unify and bring some order to the confusion created by the multitude of units used in France in local trade.

a) origin b) creation c) foundation

XIII. Translate into English.

Здавна людям часто доводилось мати справу з різними вимірюваннями: при будівництві споруд, визначенні напрямку руху морем, в торгівлі. В стародавні

часи частини людського тіла використовувались як міра довжини. В Англії в XVII ст. була прийнята одиниця міри довжини – фут, яка дорівнювала 30,5 см. Різні народи перебували на неоднакових стадіях розвитку, то й міри були різноманітні. Зміцнення культурних і економічних зв'язків вимагало подальшого впорядкування системи мір з розробленням єдиної міжнародної системи мір. 20 травня 1875 року 17 держав підписали міжнародну Метричну конвенцію.

Speaking

XIV. Legal, Industrial and Scientific Metrology has been internationally accepted to cover all the technical and practical aspects of measurements.

a) Work in pairs. Decide what aspects each type of metrology relates to. Complete the table with the given information:

- the guaranteeing correct measurements in the interest of the public such as commerce, health, the atmosphere and safety;
- procedures of calibration;
- production/manufacturing and quality control;
- the definition of internationally accepted units of measurement;
- the structure of a system of units;
- the control of measurement processes and equipment;
- the control of measurement processes and equipment;
- compulsory technical requirements of measurements;
- metrological properties of measuring instruments;
- developing new systems of measurement and standardizing existing ones
- regulating measurements and measuring instruments related to public policy issues

Legal Metrology	Industrial Metrology	Scientific Metrology

b) Compare the types of metrology using the information from the table. The list of the phrases given below helps you to express comparison and contrast.

On the other hand…
In contrast to…
There are a number of important differences between…
At the same time…
… is similar to…in terms of
Nevertheless…

Grammar

Indirect questions

The indirect questions are not normal questions. They have the same word order as statements. They usually come after introductory phrases:

- *Could you tell me…*
- *Do you know…*
- *I was wondering…*
- *Do you have any idea…*
- *I'd like to know…*
- *Would you mind telling me…*

Compare the following direct and indirect questions:

Direct	Indirect
What did she calculate?	Do you know what she calculated?
Where was this material discovered?	Do you remember where this material was discovered?
Will they find the solution to the problem?	I wonder if they will find the solution to the problem.

XV. Choose the correct option.

1. Where's the technical report?

Can you tell me _____ ?

a. where the technical report is
b. where be the technical report
c. where is the technical report

2. How does it work?

Can you explain _____ ?

a. how can it work
b. b.how it works
c. c. does it work

3. Has she made a decision yet?

Has she told you whether _____ ?

a. has she made a decision yet
b. she's made a decision yet
c. have made a decision yet

4. What are you measuring?

Do you have any idea _____ ?

a. what you measure
b. what are you measuring
c. what you are measuring

5. Why are metrology and measurement important?

I'd like to know _____.

a. why are metrology and measurement important
b. if metrology and measurement are important
c. why metrology and measurement are important

6. How does measurement advance the state of the economy?

Do you know _____?

a. what does measurement advance the state of the economy

b. how measurement advances the state of the economy

c. whether measurement advances the state of the economy

XVI. Make up questions to the following sentences. Then rewrite them to make up indirect questions beginning with the phrases given.

1. Standards vary from country to country.

a) Why _____?

b) Do you know _____?

2. Galileo's measurements of pendulum swings were crucial to the development of Newtonian mechanics.

a) What _____?

b) Please tell me _____.

3. One of the earliest records of precise measurement is from Egypt.

a) Where_____?

b) I wonder_____.

4. The ingredients, composition and dimensions of building materials are carefully measured and standardized.

a) Are _____?

b) I'd like to know _____.

5. Self-measurement of blood pressure first started in the 1930s.

a) When _____?

b) Do you have any idea _____?

6. Measurement plays a key role in testing equipment.

a) Does _____?

b) I want to know_____.

7. Modern metrology is based on seven SI Units.

a) How many _____?

b) I don't exactly remember _____.

XVII. Arrange the words in the correct order to make up questions.

1. What/ expect/ we/ changes/ may/ in the future?
2. Why/ today/ is/ complex /metrology/ so/ and expensive?
3. Could/ many/ are/ you/ SI Units/ how/ tell me/ there/?
4. Who/ to/ has/ technical /assistance/ the right/?
5. How important/ to provide resources/ is it/ metrology and measurement/ to support/?
6. In 1878/ table/ was published/ European/ it/ food composition/ was/ not/ the first/?
7. Who/ for Physics/ the 2002/ Nobel prizewinner/ remembers/?
8. Do you know/ metrology/ whether/ an ancient science/ is/?

Speaking

XVIII. Work in small groups. Ask each other indirect questions about the main events in the field of Metrology.

- 1585 - Simon Stevin suggested that a decimal system should be used for weights and measures, coinage and divisions of the degree of an arc.
- 1670 - The French vicar, Gabriel Mouton proposed the universal system of measurements based on the length of the arc of the meridian corresponding to one minute of an angle.
- 1747 - The scientist La Condamine made a new proposal in which he considered as unit of length “the pendulum that swings by the second in the equator".
- 1795 - France officially adopted the metric system.
- 1799 - First Standards, the meter and kilogram, were constructed.
- 1810 - Napoleon Bonaparte, during a session of the Assembly, legalized the decimal metric system as established by the French Revolution.
- 1866 - The use of the metric system made legal (but not compulsory) in the United States by the (Kasson) Metric Act of 1866. This law also made it unlawful to refuse to trade or deal in metric quantities.

- 20/05/1875 - The Convention of the Meter signed in Paris by 48 nations.
- 1889 - First General Conference of Weights and Measures.
- 1937 - First International Conference of Practical Metrology.

XIX. Find out more information about one of the events mentioned in the previous exercise and present it to the class. Complete the following information for the event:

Person_____

Place_____

Reasons_____

Importance _____

Advantages _____

Writing

Email

Email writing has become a large part of modern communication, particularly in business. The world has become much smaller now that we have the ability to send and receive email messages over great distances at an incredible speed. Due to the ease of use it has the potential to be abused and you should try to keep the following points from Ex. XX in mind when writing email.

XX. There are no universally accepted rules for writing e-mails, but here are some useful quidelines. Match each rule (1-5) to the reason (a-e) why it is useful.

1. Create a subject line with impact.
2. Write short sentences.
3. Keep paragraphs short.
4. Put your signature on the message.
5. Proofread the message before sending it.

a. It is more likely that someone will read your E-mail.

b. It creates more proffessional image if there are no silly errors.

c. You don’t need complex grammar or punctuation.

d. There is less chance the reader will miss anything.

e. It saves people scrolling down to see if there is more text.

XXI. The phrases given in the exercise can be used for writing formal or informal e-mails. Complete the table with the phrases

Could your give me some information about...
I am interested in receiving/ finding out...
In reply to your e-mail, here are...
We can confirm that...
Good news!
Here's the ...you wanted.
Looking forward to ...(+ing)
We are able to confirm that...
We regret to inform you that...
Yours faithfully,
I am writing in connection with...
I am delighted to tell you that...
Unfortunately,...
Please find attached my report.
Please send me...
I'd appreciate you help in this.
I'm writing about...
I've attached...
I am looking forward to ...(+ing)
Yours sincerely,
Can you tell me a little more information about...
Thank you in advance for your help in this matter.

Part of e-mail	Formal	Informal
1. Greeting	Dear...	Hello/Hi...
2. Reason for writing		
3. Giving information		
4. Attachments		
5. Asking for information		
6. Requests		
7. Close		

XXII. Fill in the gaps in the email with the appropriate words.

1)_____ Mr. Higgins

It was very nice to speak with you today about the engineer position at the ABC

Organization. The 2) _____ seems to be an excellent match for my skills and interests. The self-confident and aggressive characteristic requirements you described needed for this position confirmed my desire 3) _____ with you.

In 4) _____ to my experience, I will bring to the position assertiveness and the skills to motivate others to work cooperatively as a 5) _____.

I 6) _____ the time you took to interview me. I am very 7) _____ in working for you and look forward to 8) _____ from you regarding this position.

9) _____,

Robert Taylor

XXIII. In the newspaper you saw the advertisement of English Learning Centre. Write the email asking about details of a course.

***Ideas*: ask about cost, dates, time etc and ask to send you the prospect of the centre.**

PART II

I. Work with a partner and make up a list of the fields which are highly dependent on the reliable measurements and measuring devices.

II. Look at the following phrases and decide what industries they can be referred to:

fabrication, genetically modified organisms, assembly processes, geometric

dimensions, water supply, electromagnetic environment, quality control, safety, aircraft maintenance, foodstuff, flame-retardant products, structural durability

Listening

III. Metrology is of increasing importance to the biotechnology community and is in increasing demand. Listen to the conversation and answer the questions.

1. What controls does genetically modified food pass?
2. Who is against genetically modified food?
3. What things does Ann worry about?
4. What are the possibilities for GM food?
5. Why does Frank think that non-GM foods are safer than GM foods?
6. What is the relation between Global warming and genetically modified food?

IV. Listen again and complete the summary to the conversation.

Frank is in favour of genetically modified food because he believes it can help to _____. He also thinks it should be used to make more _____ vegetables and to change the habitats of species that are in danger of losing their habitats and becoming extinct. Ann _____. She thinks GM foods are unnatural and potentially _____. She is worried about rich countries dominating poor countries when they _____. Ann thinks that GM food is responsible for the fall in the numbers _____.

Reading and Speaking

V. Skim through the text fairly quickly and define the number of paragraphs which deal with the topics listed below. Not all of them are metioned in the text.

Topic	**Paragraph(s)**
1. Long-term investigation	_____
2. Standards of measurement	_____
3. Precision improvement	_____
4. Measurement device	_____
5. Human activity in space	_____

6. Theory prediction _____

7. Metrology meets the human needs _____

VI. Read and translate the text. Summarize each paragraph of the text in one sentence.

APPLICATIONS OF METROLOGY

1. _____

Engineering tolerances have tightened in practically all industrial production by a factor of three every 10 years since 1960. There are two reasons for this improvement of precision in manufacturing industries over the past 30 years. The first is that in traditional mechanical engineering, gains in performance and reliability have only been possible through improved precision in manufacture. The second is that many of the new technologies, often based upon the practical applications of recent discoveries in physics, simply do not work at all unless high-precision manufacturing is available.

2. _____

The difference in longitude between any two places on the surface of the Earth is proportional to the difference between the local times at the two places. This was known to Hipparcus in the second century BC, but it was not until the middle of the 18th century AD, when sufficiently accurate sea-going clocks were made by John Harrison, that it became possible to make a useful estimate of longitude in this way. Accurate timekeeping remains the key to precise navigation. In 1989, Norman Ramsay received the Nobel Prize for physics for his key contribution to the development of atomic clocks, which are now the timekeepers of today's most precise navigation system, the global positioning system.

3. _____

Metrology has a much more direct influence on our lives, however, when it involves medical diagnosis or therapy or when we consume food and drink whose purity and freedom from contamination with heavy metals or pesticide residues rely on

measurements. Nevertheless, the reliability of these measurements related to human health and safety must be beyond reproach, because errors can kill. The economic impact of measurements related to medical diagnosis and treatment is very large.

4. _____

Global climate studies have been under way for many years in an attempt to find out whether there is clear evidence of climate change and whether human activities are influencing the climate. Climate studies are based on the combination of data from a wide range of disciplines such as oceanography, solar physics, atmospheric physics, vulcanology, and so on. It is first necessary that the data and measurements in all these areas be made using instruments all calibrated in the same units. It is also evident that in any long-term programme to observe small changes in critical climate parameters, the measurements made at the beginning of the study must be compatible with those made at the end, i.e. the measurement standards used to calibrate them must have long-term stability. An example of such a requirement for long-term stability of standards is in the measurement of changes in the amount of ozone in the upper atmosphere.

5. _____

Einstein suddenly became world famous when in 1919 accurate measurements of the precession of the perihelion of the planet Mercury confirmed one of the predictions of his general theory of relativity. Accurate metrology ever since has been at the frontiers of science in confirming or otherwise the predictions of theory. In modern science, the predictions of theory often call for metrology of the highest accuracy either to set increasingly fine limits on the deviation of observations from theoretical predictions.

(Adopted from: Thompson A., Taylor B. Guide for the Use of the International System of Units)

VII. Read the following sentences and find out what information is not mentioned in the text.

1. The Nobel Prize was awarded to Chu, Cohen-Tannoudji and Phillips for their work on the production and manipulation of cold atoms leading to a new generation of

cold-atom clocks.

2. The aim is to find out the rate at which the amount of ozone is changing over decades.

3. Protection of the environment and large-scale studies related to global climate change depend critically on accurate measurements, often extending over long periods of time.

4. Food and agriculture are closely regulated in terms of the use of pesticides and food additives and it is essential to have reliable means of measuring their presence in the human food chain.

5. GPS is another example of how improvements in accuracy of measurement can suddenly lead to completely new industries of enormous magnitude and potential.

6. Some major manufacturers of digital multimeters installed systems which provide measurements on the production line with an accuracy at least 100 times better than the final specification of the instruments.

7. Climate studies are based on the combination of data from a wide range of disciplines.

8. In medical therapy, permissible errors must not be much greater than the smallest physiological effect that can be detected, usually a few percent.

9. A basic input parameter to all climate studies is the radiation reaching the Earth from the Sun.

10. Production engineers in the large-scale manufacture of automotive and electronic products are now required to work at tolerances previously attempted only in fine, small-scale work.

VIII. Correct the following statements to the text where it is necessary.

1. Climate studies combine information from a wide range of disciplines.

2. Precise navigation is based on mathematical calculation of the distance between objects.

3. Engineering tolerances is the amount by which dimensions are permitted to depart from specification.

4. John Harrison determined that the difference in longitude between any two places on the surface of the Earth is proportional to the difference between the local times at the two places.

5. The climate changing is caused by the emissions of hydrogen.

6. Two reasons for long-term stability of precision in manufacturing are mentioned in the text.

IX. Metrology is critical to the success of many different industries. Work in groups of three. Use the given words and phrases to help you tell the partners about the industries that rely on the science of measurement.

Student A

1. clinicians/ hospitals or general practice/ depend on/ precise measurement of doses/ efficacy and safety/

2. make extensive use/ measurement instruments/ check patient health

3. patients/the proper functioning/ devices/ matter of life and death

4. fine tuning machinery/ ensure/ accuracy of medical tests/ the best possible diagnoses

Student B

1. building/ meter/ display/ energy consumption

2. consumption measurements/ the energy companies/ to charge/ customers by use

3. power plant/ necessary/ verify/ gauges and measurements

4. critical/ measuring/ the power consumption/ new energy-efficient/ household appliances

Student C

1. airplanes/ precise measurements/ to consider/ function and safety

2. manufacturing of planes/ accurate calculations and testing/ components/ turbines and landing gear

3. to check regularly/ the assembly process/ to ensure/ machinery/ function/ correctly

4. cockpit instruments/ navigation system and altimeter/ subject to/ calibration

5. metrology/ to ensure/ the safety/ passengers/ inside the plane

X. Modern metrology is the result of more than 200 years of development. Metrology has become a necessity for trade, technical cooperation, scientific comparison or even simple exchange of information. Discuss the following topics about metrology in class.

- Applications of metrology today
- Benefits of Metrology
- International System of units (SI)
- Metrology carrers

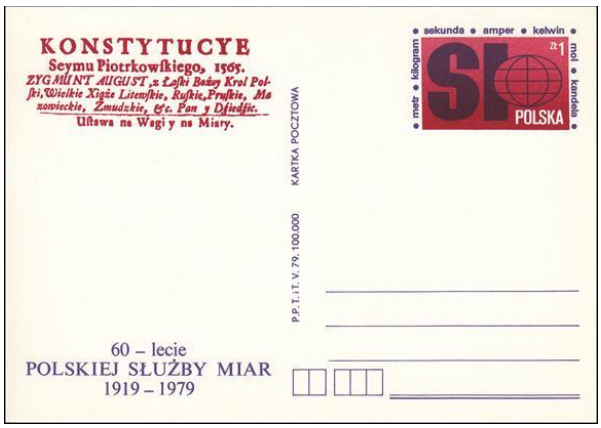
XI. Work in small groups. Study carefully all details on the postcards and stamps. Make your suggestions about the event, country, and date. Use the following phrases:

As far as I can see…
As far as I am aware…
I suppose…/
I guess…
There might be…
I am quite sure that …
I am certain that …
In my view…

A.

B.

C.



XII. Imagine that you are going to take part in the international conference devoted to Metrology development and its applications. What topic would you like to present? Write a short plan for your report and present it to the group.

UNIT 2

MEASUREMENT AND STANDARDS

PART I

I. Each of the words given in the box is used with the word "measurement". Separate them into two columns (the words which go before and words which come after the word "measurement"). Make up the sentences with the formed collocations.

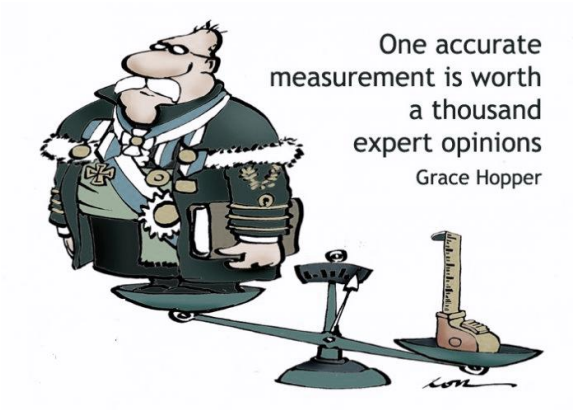
Standard, metric, accurate, altitude, reliable, science, system, error, unit, technology, consumption, result, uncertainty, precise, activity,

II. Discuss the following topics:

- The necessity of measurements
- The main purpose of standards
- Measurement advances the state of human existence.

III. Look at the picture. Do you agree or disagree with the Grace Hopper's saying? Explain your point of view.

Rear Admiral Grace Murray Hopper (9 December 1906 – 1 January 1992) was a U.S. Naval officer. She was a legendary figure in the development of programming languages. In 1991, President George Bush presented her with the National Medal of Technology "for her pioneering accomplishments" in the field of data processing.



Reading

IV. Translate the following words into Ukrainian and memorize them.

reference	assembly	fraud
infinite	enforcement	forensics

traceable	prerequisite	charge
calibration	up-to-date	dissemination

V. Read the first underlined sentences in each paragraph to get an overview of the text. Decide which of the points in the table will be included in the text.

	Yes	**No**	**Perhaps**
1) reliability of measurement standard			
2) how the units of measurements appeared			
3) the earliest units of measurement			
4) the development of new branches of industry			
5) units of measurement			
6) state metrology institutions			
7) measurement standards and their dependence on science advances			

Measurement and Standards

The measurements have been necessary since human beings first began trading with their neighbours. Whenever we buy, sell or exchange, we use a broad array of units. Each of these units is determined according to measurement standard. Due to the existence of measurement standards, we can carry out an infinite array of activities and transactions. A measurement standard is a material measure, measuring instrument, reference material or measuring system intended to define, realize, conserve or reproduce a unit or one or more values of quantity to serve as a reference.

Length and mass were the earliest measurements made by mankind. The oldest standard of measurement of mass that can be traced is the bega, a unit of mass used in Egypt in 7000 to 8000 B.C. The death penalty faced those who forgot or neglected their duty to calibrate the standard unit of length at each full moon. Such was the peril courted by the royal site architects responsible for building the temples and pyramids in ancient Egypt, 3000 years BC. The first royal cubit was defined as the length from elbow to tip of the extended middle finger of the ruling Pharaoh, plus the width of his

hand. The original measurement was transferred to and carved in black granite.

As industry undergoes major developments with new materials, techniques and the miniaturization of products, measurements become more critical. The increasing trend to sub-contract assembly or sub-systems means that each location needs to have the same measurement system; otherwise the various parts would not fit together. New areas in metrology, such as nanotechnology, optical techniques, material sciences, and metrology in chemistry, food safety and testing have developed rapidly. Today the requirements of law enforcement, fraud, forensics and environmental sciences need accurate and traceable measurements to function properly.

Measurement standards are not static. They evolve continually to reflect advances in science and in response to changing industrial and other needs. It is necessary to maintain an active research base in measurement science, so that the nation can obtain the most advanced and accurate calibrations and the most up-to-date expertise and advice on measurement are available to industry, society and government.

Today all industrialized countries of the world have a national institute charged with maintaining and disseminating national standards. National and international representation is one of the important responsibilities of national metrology institutes (NMIs). As global industrial and trade activities are increasingly regulated at a technical level, metrological requirements play an increasingly important part. Such an example of a new activity is global emissions trading under the Kyoto Protocol. A prerequisite for such trading is worldwide agreement related to the measurements of emissions of greenhouse gases.

(Adopted from: Bennett G.I., Austin M. S. Innovative Economics Limited)

VI. Answer the questions to the text.

1. Why are measurements standards not stable?
2. What is National Metrology Institute responsible for?
3. What are the main categories of measurement activity?
4. When is it possible to obtain the most advanced and accurate calibrations?

5. What is a measurement standard?

6. When was the earliest unit of mass measurement introduced?

7. What is the function of measurement standard?

8. Why is it important to have the same measurement system?

VII. Find in the text the words with the similar meaning.

precondition	current	reject
execution	endless	duty
fabrication	risk	fake
recommendation	spread	match

VIII. **Find the appropriate missing word to make a noun + noun collocation common to metrology. There are two items you don't need. Translate the sentences into Ukrainian.**

1. The rapidly developing field of biotechnology will also require **measurement ____**. 2. Marks of conformity play a major role in **consumer ___** and international trade. 3. An underlying principle of **materials ___** is that the properties (or characteristics) of materials are generally understood in terms of the microscopic or atomic structures of the materials. 4. The report shows that metrology and measurement are important for their contribution to **productivity ____.** 5. **Technology ____** depends on accurate measurements. 6. A **reference ____** is a **____**, sufficiently homogeneous and stable with respect to one or more specified properties, which has been established to be fit for its intended use in a measurement process.	innovation meter material safety standard growth science value

IX. Choose the best completion of the sentence and translate them into Ukrainian.

1. Weights and measures…
   a) were among the earliest tools invented by man.
   b) to trade and commerce, land division, taxation, and scientific research.
2. As societies evolved,…
   a) it is possible to create systems of measurement units.
   b) measurements became more complex.
3. The need for a single worldwide coordinated measurement system…
   a) was necessary to do them accurately time after time and in different places.
   b) was recognized over 300 years ago.
4. Standards are instruments used by the Government…
   a) to strengthen its grip over society.
   b) keen to structure the notions of time, temperature, distance, weight and other variables that appear to be measurable.
5. Legal metrology comprises all activities…
   a) for which legal requirements are prescribed on measurement, units of measurement.
   b) makes use of scientific metrology to obtain appropriate references and traceability.
6. The importance of measurement results is ever increasing…
   a) which affect their economic and personal well being.
   b) due to rapid technological development and the emergence of information technology.
7. The role of the government in metrology is…
   a) to the traditional issues of legal metrology.
   b) to provide society with the necessary means to establish confidence in measurement results.
8. The national measurement standards shall…

a) be the most accurate measurement standards of the country.
b) are traceable to the realization of the definition of units through primary standards maintained by another country.

X. Match the verbs with the nouns to make up collocations. Use some of these expressions to complete the dialogue.

Verbs	***Nouns***
To carry out; to obtain; to provide; to solve; to make	Advances; results; standards; measurement; basis; problem; calibrations; test; decision

A: I haven't seen this machine before. What's it used for?

B: _____

A: It is quite complex machine. I'd like to know _____

B: _____. We have some problems with this machine.

A: _____

B: We need to _____. It's important _____

XI. Fill in the gaps with the correct form of the words given in brackets. Translate the sentences into Ukrainian.

1. To make ____ (nation) standards available throughout society, a system of ____ (trace) must be established.

2. As ____ (industry) technology and business ____ (operate) become ____ (increase) global in nature, the importance of ____ (interact) with other countries is rising dramatically.

3. These depend on the ____ (able) to trust ____ (measure) standards used by each country; one country's unit must be ____ (interchange) with all others'.

4. The instruments we use on a ____ (day) basis were not produced with direct ____ (compare) with national standard.

5. Measuring instruments for commercial ____ (transact) and ____ (certify) that have a ____ (remarkable) pervasive influence on private ____ (consume) are under strict legal control.

6. Concerning the ____ (contaminate) of air, soil and water, measuring instruments to determine minute quantities of ____ (pollute) such as dioxin, which have drawn public attention, are also subject to ____ (verify).

XII. Work in pairs. Read the text and then tell your partner about measurement standards described in your text. The following questions help you to present the most important facts described in your text.

- What field is the standard applied in?
- What is the role of the standard?
- What standard technique is used?
- When was the standard adopted?

Student A

Essential oils are used in aromatherapy to improve physical and emotional well being. Essential oils are the aromatic substances extracted from a single botanical source and have been utilized in fragrances, flavours and medicines for thousands of years. But there is general agreement amongst aromatherapists that if these essential oils are to have the desired effects, essential oils need to be of the highest quality – pure, unadulterated and natural. To protect the market for high quality oils, reputable traders need accurate and impartial measurement techniques to demonstrate to customers that their products are pure and genuine. The method of analysis by gas chromatography emerged as a standard technique for measuring the product characteristics of essential oils in the 1970s. This technique provides a “fingerprint" which can be used to assess the identity and purity of oil.

Student B

Most building materials are supplied in standard forms, where the ingredients, composition and dimensions are carefully measured and standardized, so that the builder and architect can be confident of the physical properties of the materials. While the raw material may come from a variety of locations and this gives some regional differentiation to the appearance of bricks, the composition is kept within

standard limits to ensure the physical properties of the end result. BS3921 defines a performance specification in terms of size, frost resistance, salt content, compressive strength and appearance. Careful measurement of such standard bricks gives typical data on the physical properties of the brick in use. Similar standards and measurements are made for other building materials, including: blocks, cement, concrete, timber, metals, roofing materials, plastics, glass-fiber, etc. In the absence of such standards and the careful measurements of the properties of materials, the architect or builder would have to measure the properties of each material.

XIII. Translate into English.

Стандартизація - це діяльність, яка полягає в знаходженні рішень для повторюваних задач в сфері науки, техніки і економіки. Сучасний розвиток стандартизації пов'язаний з ростом міжнародного співробітництва і обміном технічними знаннями між державами. Стандартизація спрямована на підвищення якості продукції, підвищення технічного рівня і раціональне використання ресурсів. Забезпечення єдності вимірювань – головне завдання метрології. Єдність вимірювань забезпечується метрологічними службами в Україні.

Grammar

Modals

Modal verbs are a special kind of auxiliary verbs. Like other auxiliary verbs, they are always used with a main verb but modal verbs express an attitude to what we say. They can express how certain or uncertain we are about an event, or how willing or unwilling we are to do something. (See Appendix 1 p.136)

XIV. Complete the sentences with the suitable modal verb.

1. Before designing aircraft components, engineers ____ take into account the physical principles that govern the complex, turbulent flows of air over surfaces.

2. A computer ____ track millions, even billions of parameters that human ____.

3. In Britain you ____ buy a TV license every year.

4. Recyclable materials ____ to be further developed.

5. The term smart ____ be applied to rather sophisticated systems.

6. Students ____ waste their time.

7. I ____ to visit the laboratory more often next week.

8. ____ I borrow your calculator for a moment?

9. It ____ be weeks before the building is actually finished.

10. No variance _____ be tolerated, even though the same engines _____ be produced at different plants.

XV. Rewrite the following sentences using the modal verbs. There may be more than one possibility.

1. It is not necessary for you to evaluate components without building and testing them before. Computers can fulfill all calculations.

2. Perhaps the designers need more sophisticated software.

3. There is a possibility that new equipment will be tested by our laboratory.

4. Do you mind if I use your laptop?

5. Students are not allowed to use their phones in class.

6. I am sure that he is a highly qualified specialist.

7. It is impossible that the results come out soon.

XVI. Choose the function of the modal verb from the following options:

obligation, prohibition, permission, ability, certainty, probability, advice, request

1. Even before humans could read or write, they needed to count. First they used their fingers, but when they had to deal with figures over ten, a counting device became necessary. The abacus was the earliest counting device. The abacus may seem

obsolete in the world of modern computers, but it is still in use in many countries around the world.

2. A: I can't open this email attachment our Berlin office has sent us. Could you help me?

B: Are you sure you are using the right program?

A: It's definitely the same program but I might have the wrong version. Their system is newer than ours.

B: That's why you can't open it. You should upgrade then you will be able to read the file.

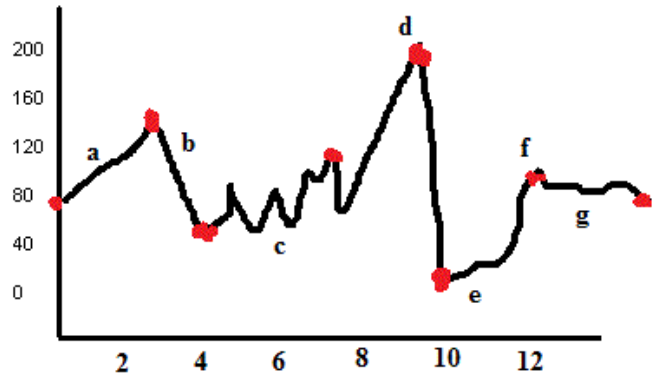
3. This is the machine hall. Do you notice that sign over there? It means you mustn't smoke here. In this area you must wear goggles to protect your eyes. It's quite a hazardous environment so you have to take care. You should put your ear plugs in.

XVII. To each picture write the problem and the suggested solution. Use the appropriate modal verbs in each situation.

Writing

Graph Description

XVIII. Which part of the graph do the following verbs refer to?



rise; fluctuate; peak; fall; recover; level off; bottom out;

XIX. Your team tried to solve the problem with the company's website. The graph in Ex. XVIII presents the number of trades per week. Using the verbs from the previous exercise, complete the description.

Have a look at this. It's a graph showing the number ___ on our website. As you can see ___. For a company of our size, that wasn't too impressive. But look ___. Improvements in our website have led ___. The slow access speed to the website meant people were getting bored waiting for pages to load and simply going somewhere else. The result ___.

XX. Write a short description of the graph given below. Answering the following questions will help you. Use the phrases from the box.

rise considerably; increase dramatically; make no progress; start climbing steadily; to be more than double the number for that year; peaking at; decline gradually; remain stable; drop from … to…; fall to …; reach a bottom; a sharp decrease in;

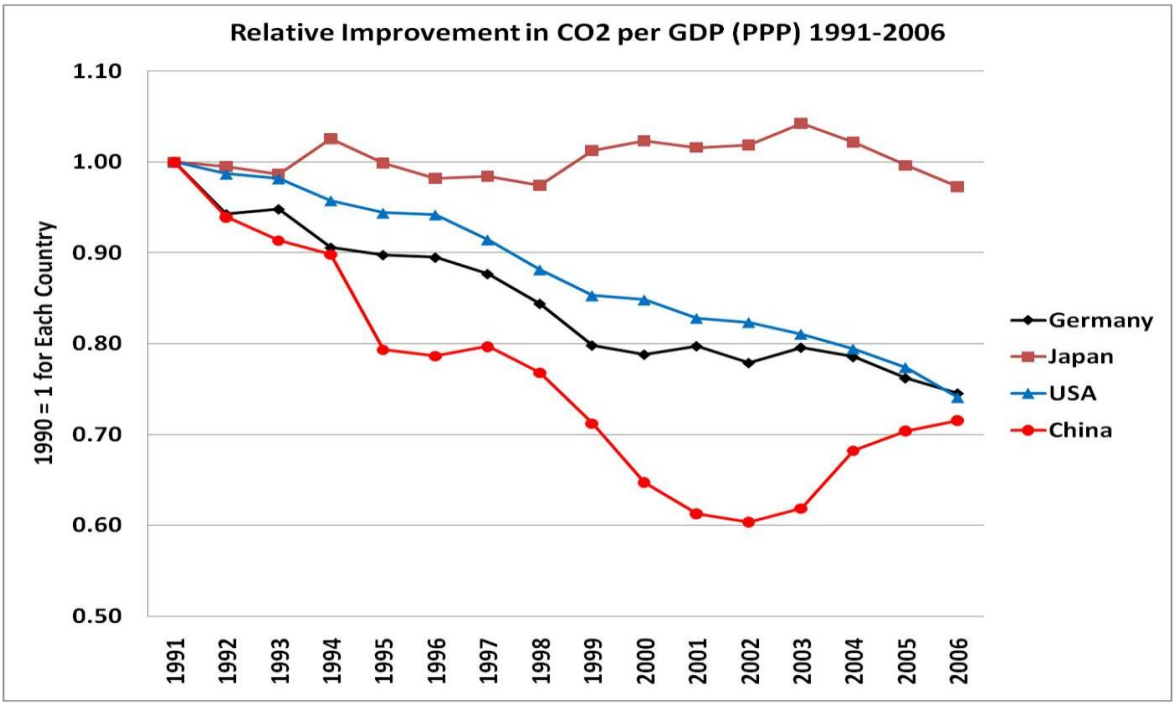
What exactly does the graph show? (Use the chart title)

What period of time does the horizontal axis show?

What information does the vertical axis show?

What do the lines represent?

What main changes does the graph illustrate?



PART II

I. During the course of time more and more precise measuring instruments have been developed. Work in small groups to complete the table. Share your knowledge.

Instrument	History (inventor, country, date)	Purpose and the field of application	Principle of operation
1. 2.			

II. Read the following paragraphs and discuss the questions.

- How can people avoid confusion over units in everyday life?
- Why do countries use different metric systems?
- What are the consequences of using different systems?
- Would it be simpler to use the similar units all over the world?

Some time ago, the Mars Climate Orbiter crashed into the surface of Mars. One reason cited was a discrepancy over the units used. The navigation software expected data in newton second; the company who built the orbiter provided data in pound-force seconds.

Another, less expensive, disappointment occurs when people used to British pints order a pint in the USA, only to be served what they consider a short measure. Again the reason is confusion over units; this time due to the fact that American units, although bearing the same names as British Imperial units, often refer to very different measures.

One of the challenges of international flying is handling different units of measure in different countries. Because of the proliferation of American and British aircraft during the early years of aviation, the imperial foot became standard for altitude measurement. China, North Korea, and Russia, however, use meters for altitude measurement. When reporting weather, airports in China and Russia state the surface winds in meters per second (m/s). The rest of the world reports wind in knots (nautical miles / hour). Pilots flying international routes deal with the assortment of units daily.

(Adopted from: http://www.aerosavvy.com)

Listening

III. Listen to the conversation and answer the following questions.

1. What two systems are mentioned in the conversation?
2. How is the temperature measured in different systems?
3. What does Dr. Pamela Gay do when it hits 32 degrees Fahrenheit?
4. Where is Fraser Cain from?
5. What measurement units are mentioned in the conversation?
6. What problem does Fraser Cain have?
7. What question do the speakers discuss?
8. What problems do Dr. Pamela Gay and Fraser Cain have?

IV. Listen again and put the names Pamela and Fraser into the appropriate place to complete the sentences.

1. _____ thinks that measurement tools are purely objective.
2. _____ brain automatically switches to Celsius when it hits 32 degrees Fahrenheit and zero Celsius.
3. _____ has some difficulties with the imperial system of units.
4. For _____ the weather temperature comes in imperial system.
5. _____ admits that temperature is one of those things that the brain gets broken with.

Reading and Speaking

V. Read and translate the text. Find the terms which define the main principles in metrology.

1. ____ closeness of a measured value to a known reference value
2. ____ a material, device, or instrument whose assigned value is known relative to national standards or nationally accepted measurement systems
3. ____ a quantity or number expressed by an algebraic term
4. ____ comparison of two measurement devices or systems
5. ____ an estimate of the limits, at a given confidence level, which contain the true value
6. ____ the property of a measurement or the value of a standard whereby it can be related to stated references, usually national or international standards
7. ____ a metrological characteristic of a measurement procedures that give qualitative information about its capacity of produce true values
8. ____ the ability of a measurement to be reproduced consistently

KEY PRINCIPLES IN METROLOGY

Measurement today is more valuable than ever. Since measurement plays such a fundamental part in our lives, it is important that the accuracy of the measurement is fit for purpose, i.e. it fully meets the requirements of the application.

Uncertainty Uncertainty of measurement is the doubt that exists about the result of any measurement. It does not matter how accurate a measuring instrument is considered to be, the measurements will always be subject to a certain amount of uncertainty. In order to express the uncertainty of a measurement, we need to evaluate as accurately as possible the errors associated with that particular measurement. For example we may want to determine whether the diameter of a lawn mower shaft is too big, too small or just right. Our aim is to balance the cost of rejecting good shafts and of customer complaints if we were to accept faulty shafts, against the cost of an accurate but over engineered measurement system. When making these decisions the uncertainty in the measurement is as important as the measurement itself.

Calibration It is very important that we are all using the same standards of measurement around the world. When parts are manufactured the machines are set and the finished parts are checked using measurements. By using the same standards of measurement we know that a nut made in China will fit to a bolt made in the USA. Calibration is the way that the standards are transferred from one country to another, and from one instrument to another. The primary reference standards for the SI units of measurement are held in France and each country compares their national standards against these.

Traceability Traceability is a method of ensuring that a measurement is an accurate representation of what it is trying to measure. Many quantities of practical interest such as colour, loudness and comfort are difficult to define because they relate to human attributes. Others such as viscosity, flammability, and thermal conductivity are sensitive to the conditions under which the measurement is made, and it may not be possible to trace these measurements to the SI units. For these reasons the international measurement community establishes documentary standards (procedures) that define how such quantities are to be measured so as to provide the means for comparing the quality of goods or ensuring that safety and health requirements are satisfied.

Accuracy Trueness Precision Accuracy as an umbrella term characterises the closeness of agreement between a measurement result and the true value. If several measurement results are available for the same measurand from a series of measurements, accuracy may be split up into trueness and precision, where trueness accounts for the closeness of agreement between the mean value and the true value, while precision accounts for the closeness of agreement between the individual values among themselves.

(Adopted from: Hofmann D. Theoretical, physical and metrological problems)

VI. Answer the questions to the text.

1. Why is it necessary to use the same standards of measurement around the world?
2. What quantities are difficult to define? Why?
3. What are the measurements subject to?
4. What categories is accuracy split up into?
5. Why does the international measurement community establish documentary standards?
6. What is the difference between precision and trueness?

VII. In the text find the phrases with the similar meanings:

1. appropriate and of a necessary standard
2. to feel uncertain about something
3. to separate into parts or portions
4. covering several specific things in the same category
5. to provide an explanation or justification for
6. it needs something to happen before it can take place
7. do not concern

VIII. Define the principles of metrology described below:

1. Temperature indicator ____ consists of creating a stable temperature through a heating source and comparing the temperature reading of the unit under _____ and a standard thermometer.

2. When the _____ of a micrometer with a range of 0-25 mm and the least count of 1 μ is ± 4 μ, it means that if this micrometer gives a reading of 20.255 mm, the true value of the measurand can be 20.255 mm ± 4 μ, i.e. between 20.251 and 20.259 mm.
3. When the diameter of a pin is 12.53 mm ± 0.04 mm, it means that the actual or true value of the pin diameter lies anywhere between 11.49 and 12.58 mm. In other words, the measured diameter of the pin is 12.53 with an associated _____ of ± 0.04 mm.
4. _____ is a concept applicable to many business sectors including chemicals, pharmaceuticals, automotive, research, testing laboratories, etc. ___ is a tool intended to enable tracking of a product throughout a production and distribution chain, from raw materials supplier to end-consumer.

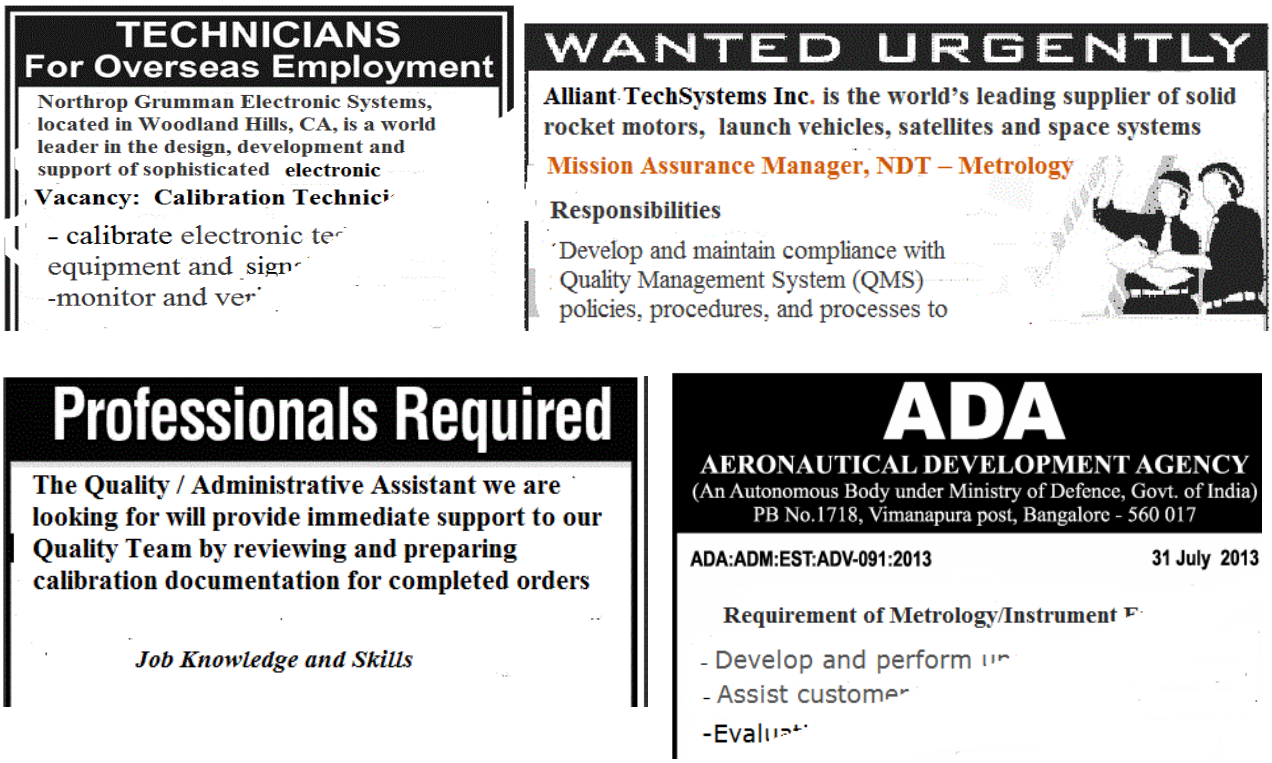
IX. Read the following sentences and give more detailed explanation to each point.

1. The first thing you should understand about metrology is that no measurement is exact or certain.
2. In metrology we must always consider this uncertainty when making a measurement.
3. But for every measurement - even the most careful - there is a margin of doubt.
4. One way of ensuring that your measurements are accurate is by tracing them back to national standards.
5. No measurement is ever guaranteed to be perfect.
6. Over time, the quality of measurements has improved because of the need for higher accuracy in many fields, as society has become increasingly technology-oriented.

X. There are many industries that employ metrologists. They may have different titles, depending on their industry and employer such as: calibration engineers, calibration technicians, quality engineers, process control technicians, and safety engineers.

a) Complete the job advertisement extracts with the appropriate phrases and words given: *customer with understanding instrument suitability based on*

engineering practices; be proficient with Microsoft Excel and Word; lead multiple teams in the execution of all Metrology; systems for airborne, ground, sea and space applications; uncertainty analysis for instruments and measured quantities; to ensure the performance and quality of products; test measuring; signal generating equipment to conform to set standards; provide technical guidance, assistance, and mentoring; evaluate the results of an analysis using techniques prescribed by supervisors; verify quality in accordance with statistical process; previous experience and knowledge of calibration;



TECHNICIANS
For Overseas Employment

Northrop Grumman Electronic Systems, located in Woodland Hills, CA, is a world leader in the design, development and support of sophisticated electronic

Vacancy: Calibration Technici

- calibrate electronic te
equipment and sign
-monitor and ver

WANTED URGENTLY

Alliant TechSystems Inc. is the world's leading supplier of solid rocket motors, launch vehicles, satellites and space systems

Mission Assurance Manager, NDT – Metrology

Responsibilities

Develop and maintain compliance with Quality Management System (QMS) policies, procedures, and processes to

Professionals Required

The Quality / Administrative Assistant we are looking for will provide immediate support to our Quality Team by reviewing and preparing calibration documentation for completed orders

Job Knowledge and Skills

ADA

AERONAUTICAL DEVELOPMENT AGENCY
(An Autonomous Body under Ministry of Defence, Govt. of India)
PB No.1718, Vimanapura post, Bangalore - 560 017

ADA:ADM:EST:ADV-091:2013 **31 July 2013**

Requirement of Metrology/Instrument E

- Develop and perform ur
- Assist custome
-Evalua

b) Imagine that you would like to apply for a job. Decide what advertisement you are interested in the most and explain why.

XI. The world faces a growing global energy challenge over the coming decades. "Measurements and the global energy challenge" is the topic for this year's Conference. To meet the challenge, it is necessary to improve the ability to measure a whole series of parameters. Work in small groups. Make up a list of your ideas and present them.

CASE STUDY

MAHR GROUP PRODUCTION

Task 1. Read the background information about the company and complete the table.

Company	
Foundation	
Purpose	
Experience in the industry	
Markets	
Top sectors	

The industrialization of the 19th century not only saw rapid growth in productivity, but also a call for precision in manufacturing machine parts. Carl Mahr recognized the demand this would create for precision length measurement instruments 150 years ago. Founded in Germany 1861, his business grew into a large-scale enterprise with over 1,500 employees. Mahr products have been used in many branches for a long time. The company's know-how creates customer benefits in the automotive industry and mechanical engineering, as well as in precision mechanics, plastics or medical technology. You can find Mahr metrology contacts in Europe, North America, Latin America. As one of the world's largest manufacturers of measuring equipment, its leadership in the field of innovation is unrivalled. The range of products extends from calipers to customized high-end measuring systems with direct connection to production process.

(Adopted from: http://www.millimess.com)

Task 2. The company is going to expand its market and sign the contracts with some new customers in Asia. In small groups brainstorm the new ideas and concepts for company's success. Think about the new sloganfor the company or its products. Share your ideas.

Task 3. Your team is responsible for making Power Point Presentation of the company. You need to headline each slide according to the information presented in it. Use one word for each headline.

Slide 1	Mahr has been producing measuring instruments for over 150 years	
Slide 2	The perfect solution for every need	
Slide 3	Top quality for absolute precision	
Slide 4	Results you can rely on	
Slide 5	Going its own way to new standards	
Slide 6	Innovation leader in industrial metrology	
Slide 7	Continuous growth, a global player	
Slide 8	Seeing things from a new perspective	

Task 4. Study the list of Mahr services. Discuss the following questions.

1. Can Mahr Group Production meet the requirements of any sector of industry?
2. What new products and services will be available in future?
3. Are these services profitable for the customers?

THE MAHR SERVICE PORTFOLIO

- Calibration and test equipment in one of the Mahr laboratories
- Inventory management and inventory organization
- Repair of testing equipment
- Direct exchange of testing equipment
- Exchange instead of repair
- System advice, Product training
- Measuring services
- Optical, Surface, Contour, Precision length, Form metrology
- Assistance with putting equipment into service
- Program creation
- The inspection of your measuring equipment
- The MahrExpert seminars to employees who would like to update and deepen knowledge

Task 5. Work in small groups.

a) You are the experts in different branches. Your company is interested in collaborating with Mahr Group Production. Read the abstract concerning the main challenges of your area and decide whether Mahr products and services can be profitable for your branch. Use the information from the previous exercises.

b) Summarize your ideas and present them to the rest of the group. Consider the following points:

- analysis of the main challenges of your area
- necessity of accurate measurements in your area

- useful products and services of Mahr Company
- arguments for and against collaborating with Mahr Group Production

Aerospace Industry Precision makes flying safe. Engines, wings, rudders, flaps, control systems, chassis, etc., must function absolutely properly during the flight in order to guarantee the safe transport of passengers. Only precision-crafted components function reliably for hours and in almost any environment. Global air traffic is rapidly increasing. This means that the requirements for lower exhaust emissions and thus lower fuel consumption are always increasing. In addition, the reduction of aircraft noise in urban areas is more vehemently demanded by the population, which in turn affects the noise emission of engines. In addition, suppliers are increasingly feeling the pressure on the costs of major aircraft manufacturers.

Medical Technology Precision promotes health. Highly-precise manufactured implants can be more easily implanted, cause fewer painful side effects such as metallic abrasion, and have a longer service life. Alloplastic implants are being used in operative fields more frequently. The essential objective is to give the patient freedom from pain and the most natural function possible. Directly associated with this is the demand for biocompatibility and long-term functionality (breaking resistance, low abrasion). New materials improve these implant qualities, allowing optimized design and increased production efficiency. For the patient, this continual improvement in quality means that further operations, so-called revisions, are only needed after many years and the implant can be kept for as long as possible.

Optics Industry The constant development of optical components in conjunction with modern light sources such as lasers and LEDs, high-performance image processing software and the huge increase in storage in computer technology now allow cost effective technical solutions that were unthinkable a few years ago. Lenses with high precision are made with glass abrasion processes such as grinding, polishing or finishing. The optimization of this manufacturing process, with measurements that accompany production, is an important starting point to reduce costs. Processes such as precision molding for producing high quality at relatively

low cost or injection molding for manufacturing low-cost plastic lenses are used in the mass production of lenses.

Electrical Engineering Industry The electrical engineering industry mainly follows the trend of energy efficiency. The reduction of energy consumption applies to all devices such as washing machines, dryers, refrigerators, dishwashers, consumer electronics and mobile phones. In order to reduce the consumption of energy, new materials are used, friction in mechanical components reduced and controls optimized. Another trend is the miniaturization of devices and components. This, in turn, implies a smaller size in electronic components and thinner multilayer printed circuit boards.

Automotive Industry In the foreseeable future, the internal combustion engine will remain the predominant type of drive. For this reason, many efforts are being made to significantly reduce the consumption of the engine and to meet stringent CO_2 emission regulations. An important element in the reduction of fuel consumption is downsizing. For example, the number of cylinders can be reduced from 4 to 3 or from 6 to 4 cylinders. In addition to the design of new engine concepts, work is primarily being done on the reduction of friction. Currently, the automotive industry is taking on the challenge of manufacturing components with high quality at a reasonable cost in medium to high volumes such as batteries, fuel cells and electric motors.

(Adopted from: http://www.millimess.com)

Task 6. As a representative of your branch of industry write a brief proposal of the recommendations concerning the collaborating with Mahr Company. Include the following information:

- ***Facts about Mahr Company***
- ***Activity of the company***
- ***Advantages of collaborating with the company***
- ***Future trends***

UNIT 3

METROLOGY, SENSORS AND CONTROL

PART I

I. Work in small groups. Study the cartoons. How are they relevant to the title of the unit? Write the captions to them. Share the ideas and choose the best ones.

a) 

b) 

c) 

Think about the systems and devices that can help people to control the following processes:

- electrical light in different parts of the building
- amount of solar radiation
- the flow of warm and cool air inside the system
- consumption of fuel flow

II. Sensors are everywhere and it would be impossible to imagine modern life without them. Sensors come in all shapes and sizes. Explain the functions and applications of the sensors listed below. Continue this list.

Geiger Counter

Proximity Sensor

Knock Sensor

Shock Sensor

Position sensor

Reading

III. Complete the table with the appropriate form of the words and give their Ukrainian equivalents.

Noun	Verb	Adjective
	to perceive	
validity		
		reliable
	to convert	
acquisition		
		definite
	to depend	

IV. Complete the sentences with the appropriate words from the table and translate them.

1. Modern networked smart sensors are deployed for the dual purposes of remote data ___ and intelligent sensor self-diagnostics information retrieval.
2. The standard ___ a measurement model that streamlines measurement processes.
3. The researches continue in order to extend new technology to dynamic measurements, measurements of different, time ___, chemical properties materials.
4. The direct sensors are those that employ certain physical effects to make a direct energy ___ into an electrical signal generation or modification.
5. We ___ inextricably on the operation and accuracy of sensors to ensure we are receiving the goods and services that we paid for to live more productive and comfortable lives.
6. Ultra-violet light waves cannot be ___ by the human eye.
7. But the statements are hardly all ___, and in the lack of trustworthy specimens little can be made of them.
8. Now, there is no doubt that, especially in mathematical equations, universal conclusions are obtainable from ___ premises expressed in these ways.
9. The system uses the silicon finger tip sensor to ___ the fingerprint.
10. Albert Einstein once said that wisdom is not the product of schooling, but of the life-long attempt to ___ it.

V. Read and translate the text. Put the phrases into the appropriate place in the text. Two of them are not necessary.

a) to signal the system about variations in the outside stimuli

b) since their components age and their parameters drift with time

c) many of them are used for metrology

d) it incorporates an immense number of measuring problems

e) no matter what you try to measure

f) the validity is particularly important

g) in case of connecting such a sensor device to a signal processing unit

Metrology Sensors and Control

Metrology embraces a wide range of electromagnetic, optical, mechanical, physical and chemical, nuclear and many other phenomena. (1) _____ that cover measurement transformations, estimation of measurement results and uncertainties, realization of the units of physical quantities and their dissemination. Experimenters in science and practical engineers are interested in higher measurement accuracy, in technical improvement of measuring instrumentation and in higher reliability of measurements.

The metrological reliability of measuring instruments built in equipment determines the validity of measurement information. The quality of production, operating costs, and the probability of accidents depend on the validity of measurement information coming to control systems. (2) _____ in such fields as nuclear power engineering, cosmonautics, aviation, etc. For some products in definite periods of their operation, even a short-term loss of confidence in measurement accuracy is unacceptable.

The key problems of the measurement information validity are related to the sensor metrological reliability, (3) _____. Sudden failures can also happen. All this can result in control errors. The sensor devices used to monitor the condition of technological equipment and the parameters of a technological process, are, as a rule, subject to a variety of influencing quantities. Possible consequences of these influences are depositions, magnetization, and so on. In some cases, the effect

of the influence quantity can be weakened by a careful design of the sensor.

Sensor is an element of a measuring system that is directly affected by a phenomenon, body, or substance carrying a quantity to be measured. Any sensor is an energy converter. (4) _____, you always deal with energy transfer from the object of measurement to the sensor. The process of sensing is a particular case of information transfer, and any transmission of information requires transmission of energy. The term sensor should be distinguished from transducer. The latter is a converter of one type of energy into another. A sensor does not function by itself; it is always a part of a larger system that may incorporate many other detectors, signal conditioners, signal processors, memory devices, data recorders, and actuators. The sensor's place in a device is either intrinsic or extrinsic. It may be positioned at the input of a device to perceive the outside effects and (5) _____. Also, it may be an internal part of a device that monitors the devices' own state to cause the appropriate performance. A sensor is always a part of some kind of a data acquisition system. Often, such a system may be a part of a larger control system that includes various feedback mechanisms.

(Adopted from: Dunn W. C. Introduction to instrumentation, sensors, and process control)

VI. Answer the questions to the text.

1. What is the difference between sensor and transducer?
2. Why are practical engineers interested in technical improvement of measuring instrumentation and in higher reliability of measurements?
3. How is the measurement information validity connected with the sensor metrological reliability?
4. What is the function of the sensor?
5. What are the measuring problems related to?
6. What are the consequences of the influence quantity which sensor devices are subject to?
7. Why must the sensor be a part of a larger system?
8. What can be the position of the sensor in the device?

VII. Complete the sentences using information from the text.

1. A sensor is a part of a larger system that can include …
2. Transmission of information in the process of sensing requires …
3. The sensor devices are applied to …
4. When … it monitors the devices' own state.
5. … rely on the validity of measurement information.
6. Sudden failures can result …
7. Thorough design of the sensor can …

VIII. Find in the text the terms which match the given definitions.

1. _____ a servomechanism that supplies and transmits the measured amount of energy for the operation of another mechanism
2. _____ a device that converts a signal from one physical form to a corresponding signal having a different physical form
3. _____ the quantity, property, or condition that is sensed and converted into an electrical signal
4. _____ a parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measured value
5. _____ the state of being legally or officially binding or acceptable
6. _____ a device that receives and responds to a signal or stimulus
7. _____ a reaction or response to a particular process or activity

IX. Put the following phrases into the appropriate column in the table. Using the given phrases make up the short description of each device.

A signal which can be measured or recorded; a specific type of a transducer; some form of energy to get the information; input or output devices; control or generate motion; to provide motion; one form of energy into another; analog or digital; a sensing element and a conversion or control element; change in a physical stimulus;

Sensor	Transducer	Actuator

X. Read the passage. Fill in the gaps with the words from the box. Two words are not necessary.

which, usually, as, that, rather, that is, same, where, also, than, however, thus, this, most, like

(1)____ world is divided into natural and human-made objects. The natural sensors, (2)____ those found in living organisms, (3)____ respond with signals, having an electrochemical character, (4)____, their physical nature is based on ion transport, like in the nerve fibers. In manmade devices, information is (5)____ transmitted and processed in electrical form, (6)____, through the transport of electrons. Sensors (7)____ are used in the artificial systems must speak the (8)____ language as the devices with (9)____ they are interfaced. This language is electrical in its nature and a man-made sensor should be capable of responding with signals (10)____ information is carried by displacement of electrons, (11)____ than ions. (12)____, it should be possible to connect a sensor to an electronic system through electrical wires rather (13)____ through an electrochemical solution or a nerve fiber.

XI. Complete the notes to the passage in Ex. X

1. Types of objects _____
2. Natural sensors respond _____
3. Information transfer _____
4. Sensor and device language _____
5. Connecting _____
6. Natural sensor features _____

XII. Match the words to make up collocations. Use them to write the short summary to the text "Metrology Sensor and Control"

1. technical	a) design
2. wide	b) engineer
3. careful	c) system
4. practical	d) reliability
5. control	e) range
6. high	f) accuracy
7. metrological	g) improvement

XIII. Work in small groups. You are process engineers at a manufacturing plant. Discuss the monitoring and control systems that will be needed for a new production line. Think about the answers to the following questions.

1. What problems have to be solved?
2. What parameters should be taken into account?
3. Which measurements need to be taken?
4. What systems and devices can be used?

XIV. Match two parts of the sentences.

a) Put the sentences in the order to make up logically structured passage.

1. Materials such as epoxies, solders, and insulators that	a) to changes in the packaging materials or in the leads.
2. Second, the materials used in construction of the temperature sensor must	b) measured must occur at a measurable level in both absolute signal and sensitivity to temperature change.
3. Two factors limit	c) are very useful at low temperatures can break down at higher temperatures.
4. The resulting strain can cause a shift in the low	d) be appropriate to the temperature range of use.

5. Exposure to extreme temperatures can induce strains in the sensor due	e) the useful range of a sensor.
6. First, the physical phenomena responsible for the temperature dependence of the property being	f) temperature calibration for that sensor.

b) Complete the following notes to the passage from (a).

- *cause and consequences of sensor strain*_____
- *temperature sensor materials*_____
- *limiting factors*_____
- *low temperature materials*_____

XV. Choose the correct option.

1. At present, a great number of _____ sensor devices provide monitoring of operating conditions and state of equipment.

a) distinguished b) embraced c) embedded

2. The conversion of science into a major productive force is _____ accompanied with growing interest in increasing measurement accuracy.

a) consequently b) inevitably c) particularly

3. In general, a variety of sensors are _____ in micromanufacturing.

a) affected b) employed c) incorporated

4. The sensors and metrology systems _____ for product and process analysis are, in general, slow and not readily implemented.

a) available b) unacceptable c) probable

5. In virtually every field of application we find sensors that _____ real-world data into electrical form.

a) transmit b) monitor c) transform

6. Once a sensor detects one or more of the signals (an input), it converts it into an analog or digital _____ of the input signal.

a) representation b) transmission c) deposition

7. Generally speaking, accuracy _____ the degree of “closeness” of the measurement to a “true value.”

a) depends on b) results in c) refers to

8. When sensors are used at input of a system, actuators are used to _____ output function in a system as they control an external device.

a) perceive b) convert c) perform

9. _____ of the sensor device characteristics can be made on the basis of the metrological self-check results if an error nature is known.

a) Validity b) Correction c) Variety

10. Today many groups around the world are investigating advanced sensors capable of _____ to a wide variety of measurands.

a) responding b) acquisition c) confidence

XVI. Translate the following passage into English.

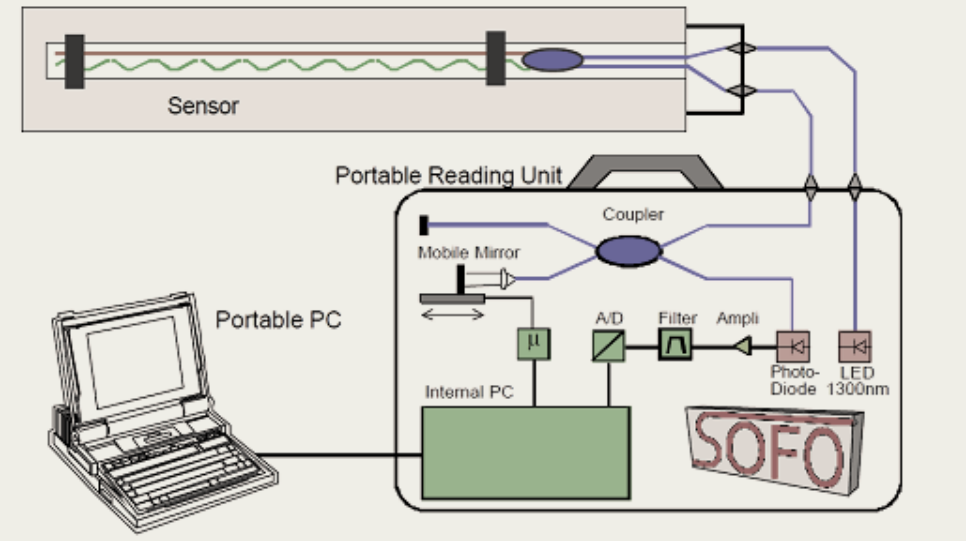
Засоби вимірювань постійно удосконалюються. Спектр задач вимірювання продовжує збагачуватися. Для більшості фізичних величин існує багато різноманітних технологій вимірювання. Вимірювальний пристрій складається з двох частин – вимірювальної головки і перетворювача. Розрізняють три класи датчиків: аналогові, цифрові та бінарні. Можливі області застосування датчиків дуже різноманітні. Застосування того чи іншого датчика визначається перш за все відношенням ціна / ефективність. В даний час різні датчики широко використовуються при побудові систем автоматизованого управління.

XVII. With the help of the figure below describe the structure of the deformation measurement system.

The ___ ___ system named SOFO (French acronym of "Monitoring of Structures by Optical Fibers") was ___ at the Stress and Deformation Measurement Institute of the Swiss Federal Institute of Technology. Its main ___ is the study of steel-concrete hybrid structures. The system is ___ on the low coherence interferometry in optical fibers.

It consists of a ___ unit, the fiber optic ___ and the appropriate software. The ___ is composed of a ___ emitter, a low-coherence Michelson interferometer with a mobile scanning ___, optical set up and an ___ PC.

Generally, the ___ consists of two single mode ___ fibers: the measurement and the reference fiber. The measurement fiber is in mechanical contact with the host structure and follows its deformation, while the ___ fiber, placed close to the measurement fiber, is loose and independent of the behavior of the structure. Any ___ of the structure will result in a ___ of the length difference of the two ___.



Read carefully the description of the system and give the answers to the following question.

- What does SOFO allow?
- What engineering structures can be tested by the system? (types, materials)
- In what cases is the application of the system limited?
- How can the application of the current system be extended?

Speaking

XVIII. Sensata Technologies is a world leader and early innovator in mission-critical sensors and controls. Its devices are used for numerous applications. Match the pictures with the appropriate descriptions.

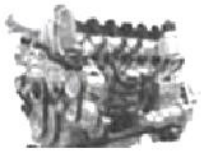
1. 

2. 

3. 

4. 

5. 

6. 

7. 

8. 

a) Heating, ventilation and air conditioning applications refer to the technology of environmental comfort in indoor or automotive environments.

b) Off-road vehicles are vehicles that do not travel on streets or highways and include tractors, forklifts, cranes, excavators, farm and construction equipment, gasoline-powered lawn and garden equipment, power boats, and more.

c) Many passenger cars and off-road vehicles utilize a variety of alternate fuels today, due to the consumer's growing demand for sustainable fuel choices driven by the movement for greener vehicles.

d) The acceptance of heat pumps as a renewable energy source recently highlighted its application in heating, cooling and industrial solutions. The application range is broad.

e) Many industries rely on the power of compressed air, gas or fluid for powering their manufacturing processes.

f) The power of wind energy provides an alternative to traditional electricity generation. Windmills harvest wind energy and convert this into green electricity.

g) Modern diesel engines are growing in popularity not only in Europe but globally. Experts predict that this growth will increase even more in the future.

h) Industrial refrigeration has become an essential part of modern life – from Food Retail to Temperature Controlled Supply Chain solutions and beyond.

XIX. Work in small groups. Think about the purpose of the sensors used for one particular area mentioned in the previous exercise and complete the table. Share your ideas.

Sensor Features	Sensor Benefits	Sensor Applications
1. **2.** **3.**		

Grammar

The Infinitive is a non-finite form of the verb which names an action.

	Active	Passive
Simple	to build, to type *You have to type your report.*	to be built, to be typed *Your report has to be typed.*
Perfect	to have built, to have typed *I know him to have built a new system.*	to have been built, to have been typed *This bridge must have been built by Paton.*
Continuous	to be building, to be typing *She must be typing the report.*	–

The infinitive can have various functions in the sentence. The Infinitive is used in the function of the subject, predicative, object, attribute and adverbial modifier. (See Appendix 1 p.138)

XX. Find the Infinitive in the sentences. Define its form and function and translate the sentences into Ukrainian.

1. Originally automotive engineered, these products can be applied to a whole new range of industries.
2. We are customer focused and globally deployed to satisfy the specific needs.
3. Passengers should check in at the airport thirty minutes before take-off.
4. He seemed to be studying for the test.

5. To increase the safety of the civil engineering structures many different systems for their auscultation have been developed.

6. It is important to measure a relative displacement of the structure with regard to a fixed point.

7. This fixed point could be chosen several meters deep in the soil, in a region not influenced by the presence of the structure.

8. My aim is to start up my own company.

9. He was the first person to design the rotor-wing aircraft.

10. You should have calculated the consumption of fuel.

11. The teacher made her finish the experiment.

12. I do not consider him to be so important.

13. The paper must have been written by the famous scientist.

14. To act appropriately, the operator must obtain timely information about the level of fluid in the tank.

XXI. Fill in the gaps with the Infinitives in the appropriate forms.

mimic; do; co-package; pick up; measure(x2); make; react; save; turn off; drive; use; house; have; be;

Nowadays consumer devices like cell phones appear (1)____ more and more sensors (2)____ power and enhance our interaction with them. Some of the latest devices is known (3)____ more than 10 sensors. A good reason is (4)____ a Proximity Sensor with an Ambient Light Sensor. An ambient light sensor acts like an eye for a system (5)____ the surrounding light. The measurement of this amount of light can (6)____ by a light emitting diode (LED). The designers made an ambient light sensor (7)____ the human eye. A proximity sensor is known (8)____ an infrared signal. Instead of the signal coming from the surrounding area, the proximity sensor must (9)____ an external infrared LED. There is another LED within the proximity sensor ready (10)____ this reflected light. This allows a system (11)____ to someone or something coming close. The user doesn't want their cheek (12)____ "pressing buttons" or

hanging up on a call while they have the phone up to their ear. It would be convenient if the phone could (13)____ the touch screen whenever the phone is brought up to a user's ear. This is exactly what the proximity sensor let the phone (14)____. A final and compelling reason (15)____ the proximity sensor and ambient light sensor in the same package is that it enables quick and undisturbed communication between the two.

XXII. Combine two sentences using the Infinitive.

e.g. The engineers use composite materials. Composites improve the aircraft performance.

In order to inprove the aircraft performance the engineers use composite materials.

1. The ambient light sensor is specifically designed. It removes as much energy in the infrared wavelengths as possible.
2. The operation of the ambient light sensor must be coordinated with the proximity sensor. This could be accomplished with a microcontroller.
3. The sensors have one main task. They provide the control system with information.
4. Greater sensitivity and faster response from arc sensors must be achieved. Different variations are developed.
5. We know the SI units. They based on the metric system.
6. Potentiometers are a convenient cost-effective method. It converts displacement in a sensor to an electrical variable.
7. The controlled process is the portion of the system in which the process variable must be regulated. It meets the setpoint.

XXIII. Using the given patterns make up your own sentences.

e.g. expect + to finish I expect to finish our project in several hours.

Are currently being developed + to enable; are needed + to ensure; is used + to control; attempt +to explain; intend + to indicate; use + to provide; fail + to explain; made + calculate

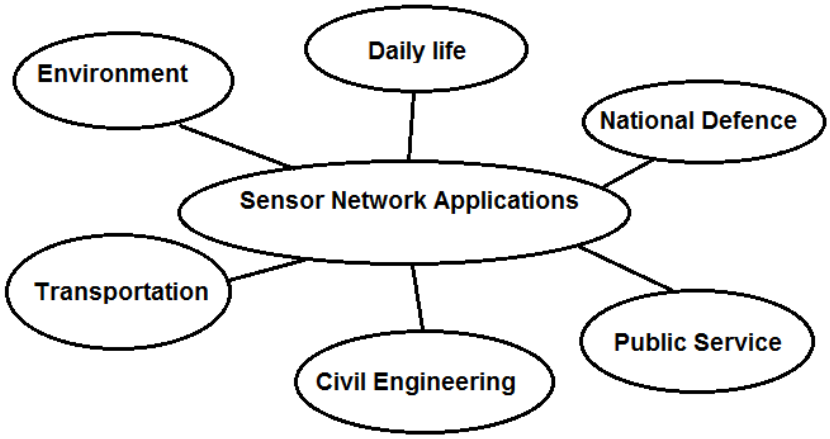
XXIV. Complete the sentences with the appropriate Infinitives in the Passive form.

to repair; to investigate (x2); to change; to separate; to achieve

1. These techniques allow the new data _____ thoroughly.
2. New techniques allowed the properties of this substance _____.
3. These techniques enable subtle control of the current _____.
4. This causes the components _____.
5. These techniques permit those phenomena _____ thoroughly.
6. He ordered these devices _____ as soon as possible.

PART II

I. Work in pairs. Look at the figure and brainstorm the list of promising applications in each case. Share your ideas.



II. Discuss the following questions.

1. What new possibilities will sensors offer?
2. Do you agree that the emergence of wearable sensors is the step in the evolution of computing?
3. What are the features of smart sensors?

Listening

III. Listen to the interview and give the answers to the following questions.

1. Who is Christoph Stiller?
2. What car was developed together with Mercedes Benz?
3. Why don’t they use roof sensors?
4. What is the disadvantage of roof sensors?
5. How many radar sensors is the car equipped with?
6. What is the cost of LIDAR sensor?
7. What information is stored in road maps?

IV. Listen to the interview again and complete the notes about the project.

Purpose of the research:

Kinds of sensors:

Sensors location:

Function of the sensors:

Precision:

Reading and Speaking

V. Skim the text and find the equivalents to the following Ukrainian words:

Сповіщати, двигун, надійність, ширина смуги, здійснювати, споживання, складна проблема, енергомережа, розумний, викид, науково-дослідницька робота, засіб, межа, розвиток.

Use most of the words to formulate the main idea of the text.

VI. Read and translate the text. Define the main signs of “Sensor Revolution”.

The Sensor Revolution

(1) Humans have always tried to increase their capabilities. Firstly, they extended their mechanical power by inventing the steam engine. The first industrial revolution was born. Secondly, people extended their brains. They invented means for artificial logic and communication: the computer and the internet. This

informatization phase is changing society. By inventing sensors, humans learn to expand their senses. Sensors development together with mechanization and informatization will bring about the era of full automation.

(2) Sensors, which are key enablers for the emerging robotics revolution, will play a role in all applications. Indeed a robotic device is a closed loop of actuation, computation, and perception (sensing). The digital and industrial revolutions ushered in the first two capabilities (actuation and computation). Mobile and automotive characteristics have been instrumental in the maturation of acoustic, optical, and positional sensors, while new sensor categories like touch, microwave, and environmental will serve drones and robots.

(3) The first decade of the 21st century has been labeled by some as the "Sensor Decade." With a dramatic increase in sensor R&D and applications over the past 15 years, sensors are certainly poised on the brink of a revolution similar to that experienced in microcomputers in the 1980s. Tremendous advances have been made in sensor technology and many more are on the horizon.

(4) The massive-scale deployment of sensors, already underway or envisioned in a variety of new sectors, represents a highly disruptive technological shift with the potential to significantly reshape the environment and transform many aspects of daily lives. Each year, billions of sensors are being deployed in all types of devices and applications, enabling the Internet of Things and the Internet of Everything. Sensor applications in multiple fields such as smart power grids, smart buildings and smart industrial process control contribute to more efficient use of resources and thus a reduction of greenhouse gas emissions and other sources of pollution.

(5) Smart sensors have the potential to significantly help societies resolve many of today's global challenges foreseen in areas such as environment, energy, food production, or healthcare. It is also recognized that, in order to contribute to such global challenges in a timely manner, major leaps and bounds need to be accomplished in the development of ultra-efficient sensors in characteristics such as size, cost, power consumption, data bandwidth, and reliability.

(Adopted from: http://www.te.com)

VII. Decide whether the following statements are true or false.

1. The use of sensors in modern society is increasingly pervasive.
2. The era of full automation resulted in the development of artificial logic.
3. Three great technological revolutions have transformed our cities and the lives of the people who inhabit them.
4. The drones and robots markets are the perfect target for emerging sensing technologies.
5. The first Industrial Revolution was marked by the invention of wheel.
6. Smart sensors significantly increase the use of resources.
7. Smart sensor systems potentially represent a new generation of sensing capability.

Writing

VIII. Work in pairs. You are responsible for making a Power Point Presentation. You have prepared the written text for the presentation (Text in Ex.VI). First, you need to headline each slide according to the passages in the text "Sensor Revolution". Then, think about short notes to each slide. Remember that the best slides may have no text at all.

	Headline	Main points
Slide 1		
Slide 2		
Slide 3		
Slide 4		
Slide 5		

IX. Read the passages and decide what terms and notions from the text "Sensor Revolution" they refer to.

1. _____ is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

2. _____ is an innovation that has the potential to revolutionize the transmission, distribution and conservation of energy. It employs digital technology to improve transparency and to increase reliability as well as efficiency.

3. _____ is based on the idea that in the future, Internet connections will not be restricted to laptop or desktop computers and a handful of tablets, as in previous decades. Instead, machines will generally become smarter by having more access to data and expanded networking opportunities.

4. _____ aims to create new technology or information that can improve the effectiveness of products or make the production of products more efficient. _____ refers to two intertwined processes of research (to identify new knowledge and ideas) and development (turning the ideas into tangible products or processes).

5. _____ rely on a set of technologies that enhance energy-efficiency and user comfort as well as the monitoring and safety of the buildings. Technologies include new, efficient building materials as well as information and communication technologies (ICTs).

6. _____ can be piloted using remote control or software that maps out a flight plan connected with GPS. _____ have the ability to go from one point to another simply by clicking a mouse or touching a screen, without humans directly intervening.

X. Complete the summary to the text "Sensor Revolution"

From the first mechanical loom we can distinguish (1) ____ in the ongoing process called the (2) ____. The First Industrial Revolution used (3) ____ to mechanize production. The (4) ____ Industrial Revolution is characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres. (5) ____ are an integrated part of most industries and the deployment of smaller, more reliable and sophisticated sensors across a (6) ____ of applications has seen demand spike. The relatively new concept of the (7) ____ is a key growth driver for the sensors sector. The advance in the field of sensor technology has lead to the (8) ____ of smart sensor systems. Smart sensor systems potentially represent new (9) ____ to solve the problems of humanity.

XI. Work in small groups.

a) Choose the topic and make up a plan containing 4-6 points.

Sensor revolution challenges

Promising applications of sensors

Evolution of sensors

Smart Technologies

Sensors capabilities, materials and technologies

b) To each point of your plan write 3-5 key words or phrases.

c) Give your notes to the students from another group to present your topic.

Useful phrases:

….. plays an important/vital role in …..

….. is an important issue for …..

….. is extensively/widely used in …..

….. is a very effective method for …..

In the last few years there has been a growing interest in …..

Quite recently, considerable attention has been paid to …..

….. have/has been gaining importance in recent years …..

….. have/has been utilized in many applications such as …

XII. Since 1948 the aerospace industry has relied on Hydra-Electric to design and manufacture sensors that are critical to aircraft systems. You're taking an interview. Robert Davis, Senior Director of Engineering, is your guest today. Study carefully the information about Hydra-Electric and write brief notes to prepare for the interview. (See Appendix 2 p.146)

- Each year Hydra-Electric dedicates resources for new R&D programs in conjunction with advancing customer needs.
- Hydra-Electric's products are designed and developed by experienced engineers who specialize in Computer Aided Design, hydraulics, materials, finite element analysis, fluid dynamics, and advanced mechanical plus electrical engineering design skills.

- Hydra-Electric incorporates a very broad-based machine shop including machinery from basic cutting tools to state-of-the-art, multi-axis CNC (computer numerical control) machining centers.
- Hydra-Electric employs Statistical Process Control (SPC) as an effective method for monitoring assembly processes, through the use of control charts.
- One of the largest departments at Hydra-Electric is Quality Inspection. Aerospace QC is arguably the most stringent of any manufacturing industry.
- Primary differntiators of Hydra-Electric: a proven innovator, solving the unsolvable, continually improving.

1950	Lockheed became Hydra-Electric's first switch customer.
1961	It developed switches for the Atlas launch vehicle, part of NASA's Mercury project for human spaceflight in which John Glenn was the first U.S. astronaut to orbit the earth.
1970	The first wide body jumbo jet, the Boeing 747 incorporated hydraulic and fuel flow switches from Hydra-Electric.
2006	Hydra-Electric provided high performance sensing instruments for Airbus A 380
2015	Hydra-Electric provided sensors for the environmental controls system of Pilatus's twin engine business jet, scheduled for the first flight

UNIT 4

SENSOR CLASSIFICATION

PART I

I. Our society depends inextricably on the operation and accuracy of sensors to ensure we are receiving the goods and services that we paid for to live more productive and comfortable lives and to run our industrial processes safely and efficiently. List the sensor types according to the given definitions. Discuss their importance.

1. It can detect the presence of anything that has a different dielectric property than air. It is often used on touch screens.
2. It is a device that produces an electrical signal that varies with an angular movement. These sensors are used to measure slope within a limited range of motion.
3. It can take light and color information and translate that into electronic signals, which can then be processed.
4. It uses the deforming of an insulating material to determine the amount of stress on an object. As the measuring material is deformed, the electrical properties change.
5. It can detect the speed at which an object is moving, the direction in which it is moving and the orientation of a device relative to the ground. It is used in many industries, and frequently included in smartphones.
6. It can measure whether or not an object is present or absent and can measure the distance to an object.
7. It is any device that can take optical information and convert it into electrical signals. It is utilized on digital cameras, for machine vision and, quite often, for quality control purposes in manufacturing industry work.

II. There are two basic types of sensors: analog and digital. The two are quite different in function and application.

a) Identify the features of each type of sensor by placing the options in the correct column.

Resolution is related to number of bits used; continuously varying output value over its range of measurement; sensitivity is closely related to resolution very large sensing range; resolution is limited by low-level electrical noise; only two states, often called "on" and "off"; sensitivity is the output slope vs. input line; the signal produced or reflected by the sensor is binary; sensor based on the usage of an amplitude modulation of electromagnetic processes;

ANALOG SENSORS	DIGITAL SENSORS

b) Make up sentences comparing analog and digital sensors. Use the following phrases:

On the one hand …, on the other hand …

An argument for / in favour of _____ is… / In contrast to…

There are a number of important differences between…

Reading

III. Skim the text and combine the words from columns A and B to make up collocations mentioned in the text. Give their Ukrainian equivalents.

A	B
1. precision	a) material
2. electrical	b) power
3. excitation	c) measurement
4. physical	d) drive
5. target	e) power
6. disk	f) resistance
7. external	g) variable
8. optimum	h) device
9. external	i) signal
10. noncontact	j) performance

IV. Read and translate the text. State the main criteria which are the basic for sensor classification.

Sensors are generally classified on the basis of entities which they detect and measure. All sensors may be of two kinds: passive and active. A passive sensor does not need any additional energy source and directly generates an electric signal in response to an external stimulus. That is, the input stimulus energy is converted by the sensor into the output signal. The examples are thermocouple, photodiode, and piezoelectric sensors. The active sensors require external power for their operation, which is called an excitation signal. That signal is modified by the sensor to produce the output signal.

Sensors can also be divided on the basis of physical variable they measure. Some of the common types of sensors are – mechanical, electrical, radiation, magnetic and chemical sensors.

The main sensor principles are: inductivity, capacitivity, and resistivity. Capacitive sensors are noncontact devices used for precision measurement of a conductive target's position or a nonconductive material's thickness or density. Capacitive sensors are widely applied in the semiconductor, disk drive and precision manufacturing industries where accuracies and high frequency response are important factors. Capacitive sensors are sensitive to the material in the gap between the sensor and the target. For this reason, capacitive sensors will not function in a dirty environment of spraying fluids, dust, or metal chips. Generally the gap material is air.

Inductive sensors, also known as eddy current sensors, are noncontact devices used for precision measurement of a conductive target's position. Unlike capacitive sensors, inductive sensors are not affected by material in the probe/target gap so they are well adapted to hostile environments where oil, coolants, or other liquids may appear in the gap. Copper, steel, aluminum and others react differently to the sensor, so for optimum performance the sensor must be calibrated to the correct target material. Inductive sensors are sensitive to different conductive target materials. Inductive sensors are frequently used to monitor rotating targets.

Resistive sensors are the most basic type of analog sensors. These sensors display a change in their electrical resistance and when placed in an electric circuit such as a voltage divider or a Wheatstone bridge produce a voltage signal equivalent to the measured physical quantity. Very commonly used resistive sensors include potentiometers, light sensors (photo resistors) or temperature sensors (thermistor).

Microelectromechanical systems (MEMS) are very small devices or groups of devices that can integrate both mechanical and electrical components. MEMS devices sense, think, act and communicate. They redirect light, pump and mix fluids, and detect molecules, heat, pressure, or motion. The interaction of electronics, mechanics, light or fluids working together makes up a microelectromechanical system or MEMS. Sensors are a major application for MEMS devices. MEMS sensors can be used in combinations with other sensors for multisensing applications.

(Adopted from: http://www.differencebetween.info)

V. Answer the questions to the text.

1. What is the difference between active and passive sensors?
2. What are the examples of passive sensors?
3. Where are the capacitive sensors applied?
4. Why are inductive sensors well adapted to hostile environments?
5. What is the purpose of induction sensors?
6. When do resistive sensors produce a voltage signal equivalent to the measured physical quantity?
7. What makes up a microelectromechanical system?

VI. Find in the text the terms which match the following definitions.

1. _____ a system in which the information is carried in the amplitude of the signal.
2._____ an instrument or a circuit consisting of four resistors or their equivalent in series, used to determine the value of an unknown resistance when the other three resistances are known.

3._____ an induced electric current formed within the body of a conductor when it is exposed to a time varying magnetic field; utilized in induction heating and in some braking and damping systems.

4._____ a thermoelectric device used to measure temperatures accurately, especially one consisting of two dissimilar metals joined so that a potential difference generated between the points is a measure of the temperature difference between the points.

5._____ a substance, such as silicon, that allows some electricity to flow through it, used in making electronic devices.

6._____ the degree to which a substance prevents the flow of electricity through it.

VII. Read the text again and complete the notes about capacitive, inductive and resistive sensors.

Application:

Features:

Advantages:

Disadvantages:

VIII. Complete the table of sensors classification according to the following criteria.

Power supply requirements	Nature of the output signal	Measurand	Physical measurement variable

IX. Fill in the gaps with the words from the box. Translate the passage into Ukrainian.

chip, smart, key, state, dimensions, fabrication, applications, frame

Solid (1) ____ MEMS are small sensors as they consist of movable proof mass plates that are attached to a reference (2) ____ through a mechanical suspension system. This is a technique of combining mechanical and electrical components together on a (3) ____ to generate a system of miniature (4) ____. Small means that

the dimensions are less than the thickness of human hair. MEMS sensors are (5) ____ components in many medical, industrial, aerospace, consumer and automotive (6) ____. These sensors are used in anything from (7) ____ phones, gaming, medical tests to satellites. Steps to (8) ____ of MEMS involve the basic IC fabrication method.

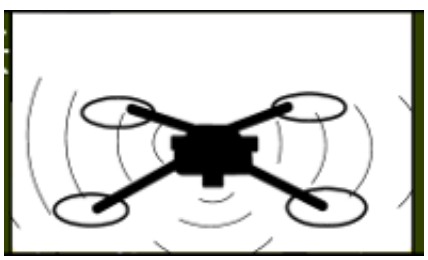
X. Sensor selection is the process of obtaining a suitable sensor for a desired measurement.

a) Work in pairs. Make a list of factors which influence sensor selection.

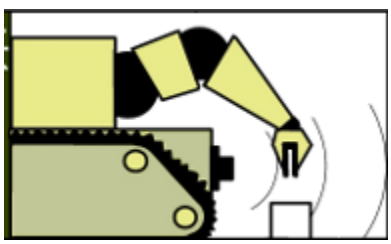
b) The selection criteria for sensors can be broken into three main sections: performance specifications, operating conditions, cost constraints. What does each section refer to?

c) Work in small groups and determine all the required sensors characteristics that match one of the fields of application presented below. Take into account the following factors:

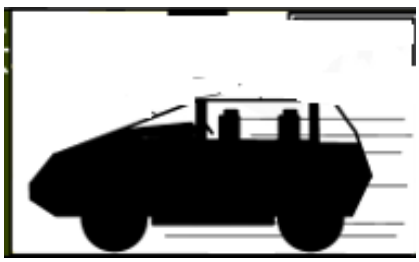
- Environmental conditions
- Size and available space
- Ease of use
- Ease of maintenance
- Required signal processing
- Power consumption
- Sensitivity
- Accuracy
- Cost



a) UAV applications



b) Robotic applications



c) Automotive applications

Listening

XI. Listen to the first part of the interview and complete the personal information about David Scaramuzza.

Universities/Places of work:
Position:
Scientific activity/Duration:
PhD getting:
European project:
Interests:

XII. Listen to the second part of the interview and underline the correct information.

1. David *started/ finished* his European project in 2009.
2. His team assembles quadrotors from *off the shelf/embedded* components.
3. David's research is focused on *autopilot/vision control* of the drones.
4. The group *is investing/is interested in* room inspection for nuclear facilities
5. The quadrotors are *used/not used* for package delivery
6. They *repair/replace* the rest of the electronics and put in a PX4 autopilot.

XIII. Choose the correct option.

1. Each sensor has certain capabilities and limitations, and thus the _____ of a given sensor depends largely on the application in which it is to be used.

a) compatibility b) availability c) suitability

2. With the specifications of the sensors, one can decide which sensor best _____ one's requirements.

a) meets b) corresponds c) answers

3. For portable applications, the instruments should have reasonable energy _____ and the option of powering the instruments with batteries should be easily available.

a) conservation b) generating c) consumption

4. To choose the correct sensor, one must first properly define the _____.

a) sensitivity b) application c) performance

5. The operation and _____ of the instruments should be easily performed by regular plant personnel with minimal special training requirements.

a) fabrication b) maintenance c) installation

6. Each sensor often provides an excessively large dataset from which we seek to extract relevant information by optimally _____ the data.

a) processing b) collecting c) transferring

7. A sensor _____ or quantifies the amount of energy or the amount of change in energy into a readable or useable output.

a) converts b) obtains c) stores

8. History has shown that _____ in materials science and engineering have been important drivers in the development of sensor technologies.

a) upgrading b) advancements c) enhancement

XIV. Complete the passage with the appropriate prepositions.

The military was an early adopter (1) ____of sensor technology. Whether deployed (2) ____ trained dolphins or underwater robots, the military has relied (3) ____ sensors to gather sensitive and critical data to inform missions. Remotely operated and autonomous underwater vehicles (ROVs/AUVs) are examples of sensor technologies developed largely (4) ____ military funding that have a number of civilian applications. (5) ____ example, ROVs, AUVs are used to map waterways, identify potential locations of oil and gas deposits and measure currents (6) ____ the polar ice cap. Data collected by ROVs and AUVs have proven vital to ensuring safe navigation; providing heat, light, and mobility (7) ____ the masses.

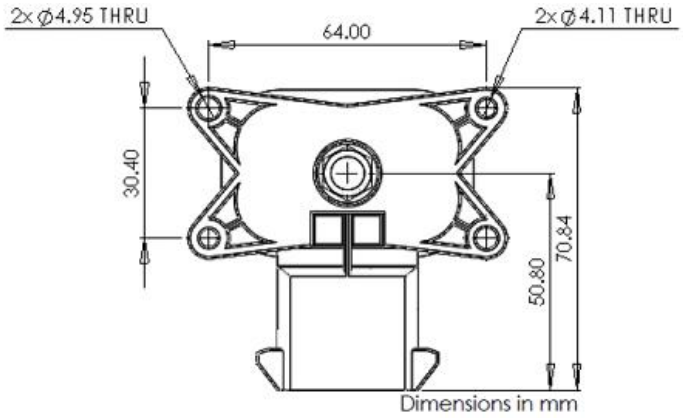
Sensors are used extensively in the marine industry. Hull sensor monitoring systems have a number of applications, which can be summarized (8) ____ the context of the lifecycle of the vessel, starting (9) ____ a full-scale verification of the structural design and ending with retirement when the hull shows fatigue. These embedded sensors have significantly improved the understanding of stresses and strains sustained by the hulls.

Writing

XV. Write the technical specification of the hydrogen sensor using information from the text and figure given below. (See Appendix 2 p.143)

Designed for hydrogen monitoring, this ceramic sensor exhibits a highly sensitive, selective, and rapid response to the presence of hydrogen in ambient air. It reliably measures H_2 concentrations over a wide range of temperature and humidity variation and provides a repeatable response, even in the presence of other combustible gases. Additionally, the hydrogen sensor is immune to signal saturation upon continuous exposure to low levels of hydrogen. The sensor provides a simple interface with a ratio-metric voltage output (1 to 4.5 VDC; 500mV increments), calibrated to detect up to 4% H_2 in air (100% of the LFL). Diagnostic states (< 1V, >4.5V) are provided to indicate error conditions. Microprocessor-based heater control ensures stable operation, in temperatures ranging from –20 to 80 C. The compact, rugged design and waterproof connector enable use of the hydrogen sensor in a range of application conditions.

(Adopted from: http://www.hydraelectric.com)



Sensor Dimensions

XVI. Complete the passage with the appropriate tense form of the verbs in brackets.

Sensor systems __1__(grow) in complexity so that they now contain many sensors that __2__ (integrate) to yield sophisticated data. These data need __3__(combine), to the user where there is an increasing need for automated

evaluation and inference to realize high quality information.

Research into sensors and sensor systems is very dynamic and __4__ (call) for many different skills and areas of expertise to be brought to bear on user defined problems. The University of Glasgow __5__ (be) one of the UK's leading Universities delivering research and knowledge exchange in sensors and sensor systems. The University __6__ (make) a commitment to grow its activities further. Researchers within the University __7__ (develop) a sensor system representation that identifies functional activities, thus more easily enabling interdisciplinary research. This sensors systems 'stack' approach __8__ (gain; rapidly) traction within the community and industry as an effective tool for considering complex sensor systems.

XVII. Translate into Ukrainian.

На сучасному ринку існує цілий ряд сенсорів, які відрізняються між собою технологією виготовлення та принципом дії. Тому перед аналізом конкретних існуючих сенсорних пристроїв необхідно розглянути їхній принцип дії, загальну класифікацію та їхнє призначення.

За характером формування електричного вихідного сигналу електричні датчики поділяються на параметричні (пасивні) і генераторні (активні). Також прийнята класифікація електричних датчиків залежно від принципу дії чи методу, який використовується при перетворенні вхідного сигналу в електричний вихідний сигнал.

Незалежно від значення і типу до всіх датчиків пред'являються визначені технічні вимоги. Основними з них є надійність, точність, чутливість, мінімальні габарити, маса.

Speaking

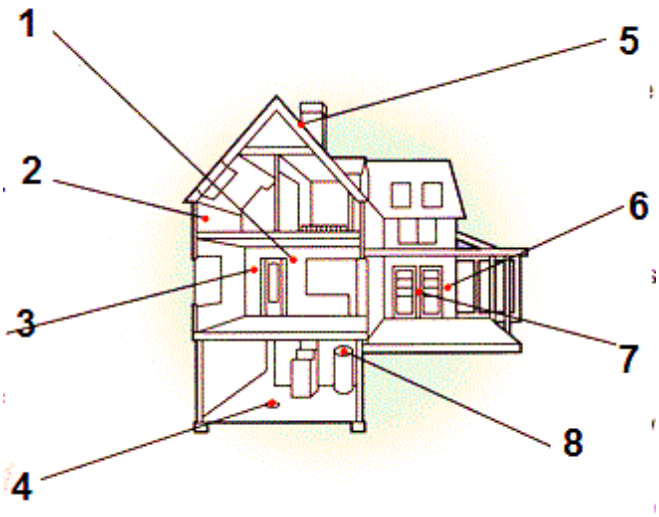
XVIII. Our dependence on sensors is increasing regularly to keep us safe, comfortable, and keep us in control. Without realizing it, we have become accustomed to living with – and relying on – sensors every day. Study the picture carefully and discuss in small groups the following questions:

What multiple functions can sensors serve in our homes?

What types of sensors can be used in our homes?

What are their purposes?

How is it possible to save by using different types of sensors?



Grammar

Gerund

A gerund is a common part of speech that most of us use every day, whether we know it or not. The gerund is a non-finite form of the verb with some noun features. It is formed by adding the suffix *-ing* to the stem of the verb. (See Appendix 1 p.137)

XIX. Match two parts of the sentences. Translate them into Ukrainian paying attention to Gerund.

1. Let's postpone	a) before choosing the sensor.
2. There is no point	b) having fulfilled her duty.
3. Study the characteristics thoroughly	c) having been given no information about the price of the shock sensor. .
4. He complained of	d) about transforming one kind of energy into another.

5. She was feeling guilty for not	e) making a decision until we have more data about new types of sensors.
6. He succeeded	f) has helped them to carry out the experiment.
7. Knowing the equation	g) in buying very expensive sensor for their new system.
8. She's thinking	h) in passing the examination.

XX. Complete the sentences with gerund by putting it in the appropriate form. (See Appendix 1 p.137)

1. The teacher appreciated my (try) the math problem.
2. Students are worried about (pass) the examination
3. He was blaimed for (make) the mess.
4. The success of any experiment depends on (measure) accurately all parameters.
5. By (realize) the threat to the environment we have made the steps to its protection.
6. Many unnecessary investigations were prevented from (make) an adequate theory.
7. By (define) the parameters the engineer has already made the step towards design process.
8. Let's proceed by (divide) research into several stages.
9. The results of the experiment depend on students (apply) the proper technique.

XXI. Complete the sentences with your own ideas using gerunds.

1. Sensors and sensor networks have an important impact …
2. A good example for …
3. … can be performed in the sensor processor itself, in the central processor of the data handling system or on ground after transmission of the raw data.
4. Since visual information is used …, the same system can also be used ….
6. …the introduction of visual monitoring can have a minimal impact on spacecraft design.

PART II

SMART SENSORS

I. Read the following quotes and discuss them in class.

Truly smart technologies will remind us that we are not mere automatons who assist big data in asking and answering questions.

Technology is nothing. What's important is that you have a faith in people, that they're basically good and smart, and if you give them tools, they'll do wonderful things with them. (Steve Jobs)

II. Any technological product or solution that can be hooked to the Internet, is interactive in nature and has a certain degree of intelligence would be classified as smart technology. But what does it mean a "smart sensor"? Is there any difference between the notions "smart sensor" and "intelligent sensor"? Share your ideas.

Reading and Speaking

III. Read and translate the text. Decide whether the statements are true or false.

1. A smart sensor offers more performance or functionality than an ordinary sensor.
2. Smart sensor systems can monitor themselves and respond to changing conditions optimizing safety and performance.
3. Smart sensor contains the microprocessor which accumulates data.
4. Smart sensors are devices that have some electrical property that changes with some physical phenomena.
5. This new generation of sensors possesses embedded intelligence to provide the end user with critical data in a more rapid, reliable, and efficient manner.
6. The main goal of smart sensor development is miniaturization.

(1) Sensors and sensor systems are vital to the awareness of our surroundings and provide safety, security, and surveillance, as well as enable monitoring of our health and environment. A transformative advance in the field of sensor technology has been the development of smart sensor systems. The term *smart sensor* was coined

in the mid-1980s. The smart sensor is the combination of a sensing element with processing capabilities provided by a microprocessor. That is, smart sensors are basic sensing elements with embedded intelligence. The sensor signal is fed to the microprocessor, which processes the data and provides an informative output to an external user. The fundamental idea of a smart sensor is that the integration of silicon microprocessors with sensor technology can not only provide interpretive power and customized outputs, but also significantly improve sensor system performance and capabilities.

(2) One major implication of smart sensor systems is that important data can be provided to the user with increased reliability and integrity. The capability of the smart sensor to perform internal processing allows the system not only to provide the user processed data, but also the ability of the sensor to be self-aware and to assess its own health or status and assess even the validity of the processed data. The smart sensor system can optimize the performance of the individual sensors and lead to a better understanding of the data, the measurement, and the environment in which the measurement is made.

(3) A second major implication of smart sensors is the development of a new generation of smart sensors that can be networked through the communication interface to have the capability of individual network self-identification and communication allowing reprogramming of the smart sensor system as necessary. Further, the output from a number of sensors within a given region can be correlated not only to verify the data from individual sensors, but also to provide a better situational awareness. These types of capabilities will provide for a more reliable and robust system because they are capable of networking among themselves to provide the end user with coordinated data that is based on redundant sensory inputs.

(4) The driving forces that develop smart sensor technology are mainly: aerospace, automotive and military industries, industrial control and automation, building automation, security and also environmental monitoring. For the control of a spacecraft a large amount of information has to be obtained by numerous on-board sensors, linked to the control centre on ground and processed. Introduction of smart

sensors on-board satellites offers two new avenues of opportunity. First, they allow for sensing the same signal as today but with better performance and/or with reduced accommodation requirements (mass, power and volume) and at lower costs. Second, they enable new types of measurements, enlarging the system capability.

(Adopted from: http://thesmarthut.com)

IV. Find in the text the words with similar meanings.

approach *(paragraph 4)*
originate *(paragraph 1)*
match *(paragraph 3)*
estimate *(paragraph 2)*
consciousness *(paragraph 1)*
characteristics *(paragraph 2)*
involvement *(paragraph 3)*
built in *(paragraph 1)*
excessive *(paragraph 3)*
supervision *(paragraph 1)*
housing *(paragraph 4)*
extend *(paragraph 4)*

V. Put the following words and phrases in the right column of the table. Explain your choice.

Networking; failure prevention; sensing element; reprogramming; self-identification; internal processing; microprocessor; output; silicon; power; situational self-awareness; intelligence; automation; self-testing; small physical size; reliability

Smart technology capabilities	Sensor structure	Smart sensor advantages

VI. Combine the words to make up collocations. Use them to write the short abstract to the text in Ex.III. (See Appendix 2 p.144)

Validity, intelligence, communication, to process, driving, robust, embedded, to assess, force, to improve, performance, data, system, interface.

VII. Work in pairs. Study the Figure below and make up the description of smart sensor characteristics which are of primary interest for space applications. Use the following phrases:

To summarize; characteristics are listed; to enlarge the system capability; to reduce data rate; the benefits of smart sensors; effective application.

Sensor Characteristics	System Level Potential	Related System Level Trades
• Real-time • Adaptive	• Enabling technology	• S/C Autonomy • Communication Link Scenario
• Reduced data rate • Reduced after-sensing computation	• Mass and power reduction • Increased information rate	• S/C Autonomy • Data Handling System Architecture • Communication Architecture • On-board memory
• Lower Mass and Power	• Mass and power reduction	• Data Handling System Architecture

VIII. Complete the passage with the words and phrases from the box. Think about the headline to the text.

a profound impact; embedded intelligence; monitor themselves; a new generation; a global scale; the end user; optimizing safety and performance; essential components

Smart sensor systems potentially represent (1) ____ of sensing capability, and self-awareness that are (2) ____ of future intelligent systems. Driving intelligence down to the component level through the design of smart sensor systems can and will have (3) ____ on applications such as food safety and biological hazard detection; environmental monitoring both locally and on (4) ____; health monitoring and medical diagnostics; and industrial and aerospace applications. Smart sensor systems can enable intelligent systems, which can (5) ____ and respond to changing conditions (6) ____. This new generation of sensors will possess (7) ____ to provide (8) ____ with critical data in a more rapid, reliable, robust, economical and efficient manner with a seamless interface to applications.

IX. Work in pairs.

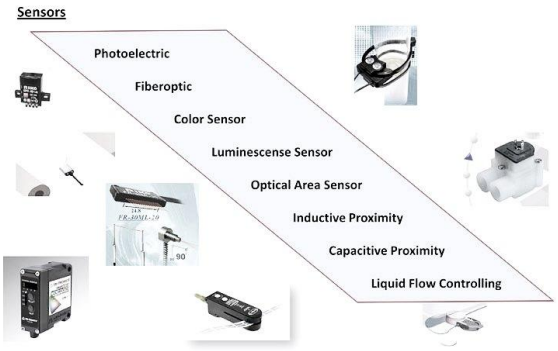
a) Make up a list of as many words and collocations in one of the category below as you can.

- Potential and limitations of sensors
- Smart sensor applications
- Sensor development stages
- Sensor technology

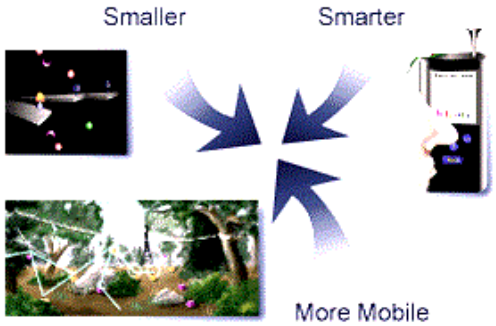
b) Pretend one of you is a scientist who deals with sensor technology and the other is an interviewer from a newspaper or engineering magazine. Roleplay an interview using the list of the words made for your category.

X. Use the following pictures as the slides for your presentation on the topic "Living in a Sensored World". Add the text to the slides if it is necessary and order the slides according to the plan of your presentation.

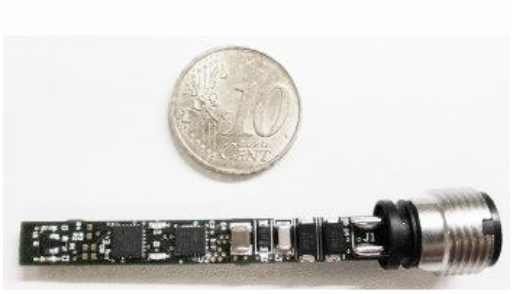
1.



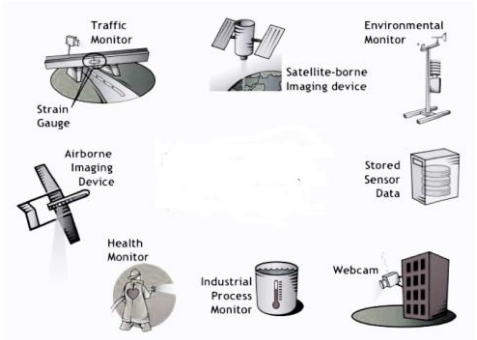
2.



3.



4.



5.

CASE STUDY
SPACE ROBOTICS

Task 1 Robotics celebrated its 50-year anniversary in terms of deployment of the first industrial robot at a manufacturing site. Since then, significant progress has been achieved. Robots are being used across the various domains of manufacturing, services, healthcare/medical, defense, and space. Name the factors that drive the adoption of robots.

Task 2 Listen to a conversation and complete the notes.

Robotic systems names:

The purpose of the rovers:

Accelerometer function:

Sensor data processing:

Task 3 Read the passage and give the definitions to the the key issues in Space Robotics mentioned in the text.

The last four decades of the 20th century witnessed a marvelous transformation in the technology of robot spacecraft. These exploring machines evolved from rather primitive, cumbersome, and often quite unreliable systems into long-lived, complex, science-oriented platforms - bristling with sophisticated instruments and governed by onboard computers that demonstrated the early levels of machine intelligence needed for autonomous operation at great distances from Earth.

The spacecraft's physical dimensions and mass are very important parameters. More recently, other factors, such as the robot system's level of machine intelligence, autonomy, fault tolerance, redundancy, and capacity for self-repair or fault isolation, have become significant for spacecraft engineering.

There are four key issues in Space Robotics. These are Mobility, Manipulation, Time Delay and Extreme Environments.

Task 4 Work in small groups. The engineers designed and built Lunar Spacecraft Orbiter. Its mission is to collect, store, and transmit data to scientists on Earth. The task of each group is to equip the vehicle with different types of sensors in order to meet all the goals. Consider the following aspects:

- instruments needed to get the desired scientific data
- power needed to run the spacecraft and its instruments
- communication between the Earth and the spacecraft
- the length of the mission

Task 5 Write the Project Proposal (See Appendix 2 p.). Remember that you are competing with other project proposals and not all can be selected for funding. You must be convincing in your argument that your project offers the best bang for the buck.

UNIT 5

NAVIGATION

PART I

I. More and more people in modern world especially drivers, pilots, shipmasters, cannot imagine their work and life without navigation. Speak about the role of navigation in their work. Share your ideas with the class.

II. The science of guidance, navigation, and control (GN&C) has been under development for over 100 years. Many exciting developments have taken place in this field. Discuss the following topics:

- Types of navigation systems
- Military and civil applications of navigation systems
- Performance and accuracy of modern navigation
- Navigation tools
- Future applications of navigation systems

III. Make up the list of the terms dealing with navigation. Explain your choice. Translate these terms and make up your own sentences about navigation.

celestial bodies, landmarks, mariners compass, angle, horizon, tracking, portable, agreement, sensor, radio signals, radar, velocity, bias, interference, mobile phones, shortcoming.

Reading

IV. Read and translate the text. Find the parts of the text which defining the role of sensors in navigation.

Navigation is typically associated with cars, aircraft, and ships. Within the industrial and medical segments, however, precision navigation is becoming more widely used in applications ranging from factory machinery and surgical robots to the first responder tracking. There are many existing approaches to derive location, direction, and movement as they relate to pointing, steering, and guiding equipment.

In fact, it has become common for many applications to rely on GPS (global positioning system). But when it comes to navigating indoors and addressing more complex and environmentally challenging scenarios, GPS alone is insufficient. For these kinds of applications, various sensor types can be employed to improve a system's ability to determine actual from anomalous motion. The ability of a given sensor to address a particular navigation problem is not only dependent on the performance level of the sensor but also on the unique dynamics of the application.

Today, to understand fully the entire range of navigation sensors, one needs to know a wide range of sciences, such as mechanical engineering, electronics, electro-optics, and atomic physics. Sensors are often compared on the basis of certain performance factors, such as bias and scale-factor stability and repeatability or noise (e.g., random walk). Sensor selection is made difficult by the fact that many different sensor technologies offer a range of advantages and disadvantages while offering similar performance.

Most solutions rely on multiple sensor types to deliver the required accuracy and performance under all conditions. Inertial sensors, such as micro-electro mechanical system (MEMS) based accelerometers and gyros, provide the potential to fully compensate for the shortcomings of other sensor types because they are free from many of the same interferences and do not require external infrastructure (no satellite, no magnetic field, no camera…just inertia).

MEMS inertial sensors are highly reliable and commercially attractive, offering lower power, size, and cost as demonstrated by their successful application in mobile phones and video games. However, there is a large variation in available performance levels, with devices suitable for gaming not able to address the high-performance navigation problems outlined previously. Precision industrial and medical navigation, for example, typically require performance levels that are an order of magnitude higher than is available from MEMS sensors used in consumer devices.

(Adopted from: http://www.aviation-safety-bureau.com)

V. Answer the questions to the text.

1. What are the advantages of MEMS sensors?
2. Why is it necessary to know a wide range of sciences to understand fully the entire range of navigation sensors?
3. In what cases is GPS insufficient?
4. Why can inertial sensors, such as micro-electro mechanical system based accelerometers and gyros compensate for the shortcomings of other sensor types?
5. What are the main criteria of sensors comparison?
6. Why is it difficult to select the right sensor for particular application?
7. What does the term "precision navigation" mean?

VI. Match the words from two columns to make up collocations mentioned in the text.

A	B
1. random	a) robot
2. guiding	b) stability
3. surgical	c) navigation
4. precision	d) system
5. scale-factor	e) walk
6. mechanical	f) infrastructure
7. external	g) equipment

VII. Complete the sentences with the collocations from the previous exercise.

1. With the introduction of faster continuous rolling mills, the demands on _____ gave rise to new trends in order to control the higher speed ranges and cater for easy and quick changeability of guide equipment.
2. Advanced combat tactics may be employed using _____. These include ambushes, deep space patrols, manual interceptions, and tow-kills.
3. The main product differentiators for the selection of inertial accelerometers are _____ and repeatability of the axis alignment.

4. _____ attacks include physical intrusions by unauthorized parties.

5. _____ is still a very new idea, and there is much more work to be done.

6. A _____ is a mathematical formalisation of a trajectory that consists of taking successive random steps.

7. A _____ manages power to accomplish a task that involves forces and movement.

VIII. Choose the correct option.

1. ___ the early navigators must have been, they were creative in compensating for their lack of technology.

a) As brave as b) The bravest c) The more brave

2. Viking explorer ___ with the discovery of Iceland, carried aboard a cage of ravens.

a) was credited b) credited c) had credited

3. The wide use of GPS aiding ___ the use of much lower performing inertial sensors to achieve the required navigation solution.

a) allow b) has allowed c) has been allowed

4. Early mariners found the compass inconsistent – most likely because they did not understand that it pointed to the magnetic north pole, not true north and this ___ variation.

a) is called b) pointed c) is understood

5. The fact that GPS may not always be available or cannot be acquired quickly enough means that other navigation sensors will always ___.

a) required b) be required c) require

6. Inertial sensors provide such a wide range of accuracy that it has become useful to characterize them ___ the application grade for which their accuracy is best suited.

a) due to b) in accordance with c) in terms of

7. Much more valuable, at the time, was the invention of the lead line (c.13th century), which was a tool ___ the depth of water and the nature of the bottom.

a) for measuring b) for observing c) for defining

8. Very small sensor size allows the ___ of GN&C into applications previously considered out of reach, and many of these newer applications will require production in much larger quantities.

a) installation b) introduction c) penetration

9. For many applications improved accuracy is not necessarily the driving issue, but meeting performance at reduced cost and size ___ .

a) to be b) was c) is

IX. Read the passage about the development of Inertial Navigation Systems.

a) Fill in the gaps with the words and phrases from the box.

apparent; gravity field; Air Force; electromechanical devices; perfectly; early leaders; high accuracy; solid-state; to further application; impetus for this significant progress;

Inertial Navigation Systems have progressed from the crude (1) ____ to the current (2) ____ devices used in modern vehicles. The (3) ____ came during the ballistic missile programs of the 1960s, in which the need for (4) ____ at ranges of thousands of kilometers using autonomous navigation systems was (5) ____.

One of the (6) ____ in inertial navigation was the Massachusetts Institute of Technology Instrumentation Laboratory (now Draper Laboratory), which was asked by the (7) ____ to develop inertial systems for missiles. The notable success of those programs led (8) ____ in aircraft, ships, and spacecraft such that inertial systems are now standard equipment in military and civilian navigation applications. INSs do not indicate position (9) ____ because of errors in components (the gyroscopes and accelerometers) and errors in the model of the (10) ____ that the INS implements.

b) Complete the notes to the above passage.

1. Type of devices used for many modern vehicles….
2. The first inertial system was developed by….
3. The reasons for the INS development….

4. INS applications….

5. Inertial navigation systems shortcomings…

6. The ranges for high accuracy necessity …

7. Type of the early navigation instrument …

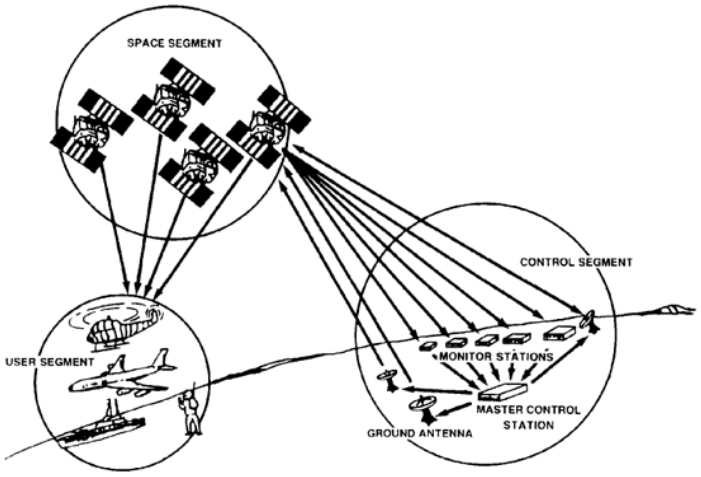
8. The components of Inertial Navigation System …

Speaking

X. There are many types of accurate navigation aids. Work in groups of three. Using the following notes and figures present the short information about the navigation system. Then compare these systems and discuss their applications.

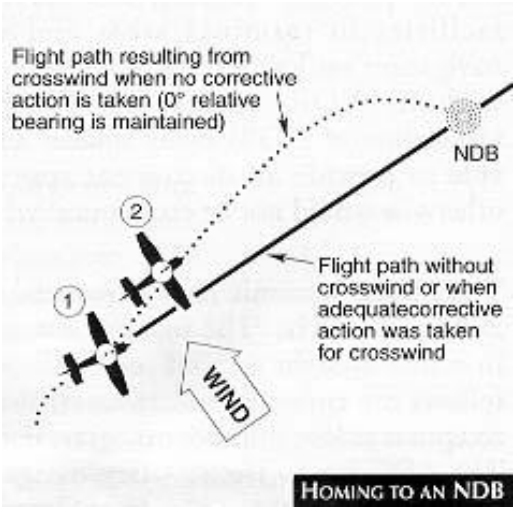
Student A

GPS/ constellation of 24 satellites/ the United States Department of Defense/ accurate/ calculating time, distance and positions/ no means to determine vertical position (altitude)/ reciever and a small antenna/ Small components, accurate, lightweight/



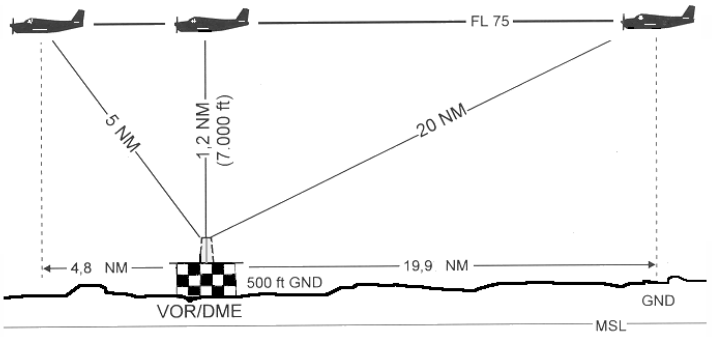
Student B

NDB's (nondirectional radio beacons)/ the oldest form/ electronic navigation/ low to medium frequency/ line of sight not limited/ ground based/ radio transmitter/ radio energy in all directions/ between 190 to 535 KHz/



Student C

VOR (Very high frequency Omni directional Range system)/ most commonly in USA/1,000 stations across/ high frequency/ atmospheric interference not subject/ VOR equipment/ reciever, antenna, and indicator/ frequency band of 108.0 – 117.95 MHz



XI. Translate into English.

Сьогодні проблема підвищення якості навігаційного забезпечення у військовій справі стає все більш актуальною. Інерційні навігаційні системи на гіростабілізованих платформах здатні забезпечувати точні вимірювання навігаційних параметрів у будь-яких умовах, не випромінюючи при цьому ніяких сигналів. До складу системи входять: інерційний блок на механічних гіроскопах і акселерометрах, блоки управління та індикації. Основні недоліки ІНС – висока вартість і складність настроювання. Точність ІНС залежить від плавності руху рухомого об’єкту. На теперішній час найбільш комерційно успішним видом ІНС є мікромеханічні системи.

Writing

XII. You are going to write the report on the topic "The role of sensors in Navigation systems" Write the detailed plan containing at least 6 points. Ask your friend to comment your plan (to replace or add some points etc.)

I. _____

a) _____

b) _____

II. _____

XIII. Match two parts of the sentences and arrange them in the order to make up meaningful passage.

1. The aim of such a system is	a) but only two are commonly used.
2. The first one is the Global Positioning System (GPS) which relies	b) to locate a vehicle on a road network as accurate as possible.
3. In the past decades, several studies were conducted in	c) able to provide a continuous navigation solution regardless of the environment.
4. The second technology is the Inertial Navigation System (INS), based on the Dead Reckoning (DR) algorithm	d) becoming more accurate and more accessible from the economic point of view.
5. For this, several technologies exist,	e) on the Radio-Frequency (RF) signals provided by the satellites.
6. The primary advantage of using GPS is the ability of	f) order to improve the accuracy and reliability of the land vehicle navigation systems.
7. In recent years, GPS receivers have evolved rapidly,	g) providing accurate navigation solution for long periods of time.

Listening

XIV. Listen to the text about the Global Positioning System. Decide whether the following statements are true or false.

1. GPS is a system that helps an individual to determine where they are located.
2. In 1978 GPS was being experimented with and a satellite was sent into space to test the technology.
3. That has been almost 40 years ago and today GPS is in many people's cars!
4. GPS tells the pilot where they are headed, how far away they are from the destination, as well as the attitude of the plane.
5. An aviation headset is still important even with the use of the GPS because you will need to communicate with the tower.
6. GPS has been around since the '60s, but it has not been fully operational in aircrafts that long.
7. Since the mid 1980s the GPS system has become incredibly important for pilots and all airplanes are now outfitted with this device.
8. GPS isn't just important for pilots, but also for every day drivers.

XV. Listen to the text again and complete the following notes.

1. One of the first industries used GPS:
2. The GPS system is designed specifically for the use in aircraft:
3. The public uses GPS:
4. The GPS in an airplane basically has:
5. The number of satellites:
6. GPS helps pilots:

Speaking

XVI. Currently, commercially successful MEMS components/products are primarily found in: medical and automotive industry, in consumer products. Make predictions about application areas and the future impact of MEMS. Will MEMS devices increasingly become a part of everyday life?

Grammar

Participle

The participle is a non-finite form of the verb. There are two forms of the participle - Participle I and Participle II. (See Appendix 1 p. 141)

	Participle I		Participle II
	Active	Passive	changed
Simple	changing	being changed	
Perfect	having changed	having been changed	

XVII. Fill gaps in the sentences using the appropriate participle

1.After ____ (design) in 1939 Sikorsky's helicopter was the first viable American helicopter of the rotor configuration. 2. Though ____ (be) a school teacher of mathematics all his life, Tsiolkovsky concentrated his attention on man's travel into space. 3. ____ (compare) to today's jet engines, the steam engines were rather huge. 4. While ____ (be) a teacher of deaf people Bell became interested in sound and its transmission. 5. Though _____ (discover), Newton's mistake had no influence on his theory. 6. While ___ (work) at a new transmitter for deaf people Bell invented a telephone. 7. ____ (heat) to 100 °C, water turns into steam.

XVIII. Choose the correct participle adjectives.

A. 1. We need highly ____ (developed/developing) electronics and new materials to make super aircraft. 2. New alloys have appeared during the last decades, among them a magnesium-lithium alloy ____ (being developed/ developed) by our scientists. 3. We are carried by airplanes, trains and cars with ____ (built-in/having built-in) electronic devices. 4. The components of aircraft ____ (produced/producing) should be very reliable. 5. Many aircraft have cable connection, system ____ (used/using) wires for ____ (transmitting/transmitted) signal to the other equipment. 6. The jet aircraft ____ (flying/flown) much faster than propeller-powered aircraft became very

popular. 7. A video phone has a device which allows us to see a room and the face of the person ____ (spoken/speaking). 8. New technologies reduce the number of workers ____ (being needed/needed).

B. 1. ____ (Driving/Driven) a car a man tries to keep steady speed and watch the car in front of him. 2. ____ (Stated/Having stated) the laws of gravity, Newton was able to explain the structure of the Universe. 3. ____ (Being/Been) more efficient than human beings, computers ____ (are using/are used) more and more extensively. 4. _____ (Having graduated/ Graduated) from Cambridge, Newton worked there as a tutor. 5. _____ (Being published/Having been published) in 1687, Newton's laws of motion are still the basis for research. 6. ____ (Being invented/Having been invented) the digital technology solved the old problems of noise in signal transmission. 7. ____ (Having been published/Having published his book about space exploration in 1895, Tsiolkovsky became known all over the world. 8. ___ (Built/Having been built) in 1986, the Aerospace Museum of California is located in North Highlands, California on the grounds of the former McClellan Air Force Base.

XIX. Join two sentences in one, using participial construction putting the subject of the first sentence into the second.

e.g. *The fuselage is the main body of the airplane. It must resist a main structural stress.*

The fuselage is the main body of the airplane which resisted a main structural stress.

1. The fuselage also contains a baggage compartment. It is of semi-monocoque construction of many modern training airplanes.

2. A light framework is covered with a skin. This framework is the semi-monocoque construction.

3. The semi-monocoque construction absorbs much of the stress. It usually covered with aluminum skin.

4. The internal framework of a strut-type structure absorbs almost all of the stress. The best features of the internal framework of the strut-type structure are used in the semi-monocoque construction.

5. The wings are important components of aircraft. They are designed to cope with the flight loads of lift and drag.

6. The wings are designed to cope with the flight loads of lift and drag. They may support other external devices such as engines (on multi-engine airplanes) and flaps.

7. Spars are attached to the fuselage and extend to the wingtips. The spars carry the major loads of the wings.

XX. Join two sentences using participial construction leaving the subject of the second sentence.

e.g. *The navigation system in most airplanes relies on sensors. Most sensors are of high accuracy.*

Most sensors being of high accuracy, the navigation system in most airplanes relies on them.

1. Visual monitoring of spacecraft is an emerging field of smart sensor technology. It reduces mass.

2. Struts connect some wings to the fuselage to provide extra strength. They transmit some of the wing loads to the fuselage.

3. The weight of the fuel in the tanks provides a downward force on the wing structure. It reduces the upward bending effect of the lift forces.

4. The next generation IRIS-3 smart sensor supports local image storage. It handles between ten and hundred images.

5. The empennage is the tail section of the airplane. It is generally constructed like the wings.

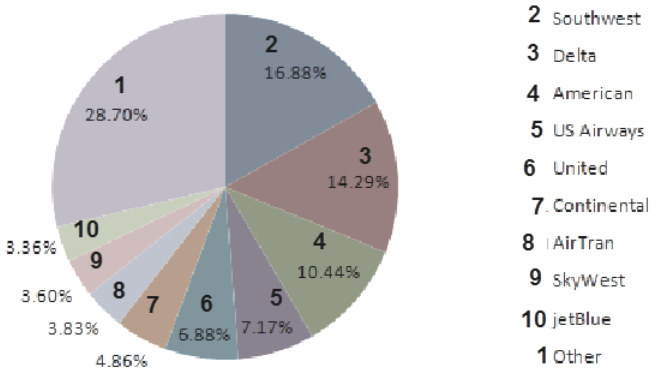
6. The main flight control surfaces are the elevator, ailerons and rudder. They are operated from the cockpit by moving the control wheel and rudder pedals

7. Many different sensor technologies offer a range of advantages and disadvantages while offering similar performance. Sensor selection is made difficult by this bact.

Writing

Pie chart Description

XXI. Work in pairs. Study the pie chart. What information does it contain?



a) Complete the table with information from the pie chart.

Airline	Passengers	Market Share
Southwest	106,225,000	
	89,952,000	14.29 %
American	65,711,000	10.44 %
US Airways	45,141,000	
	43,307,000	6.88 %
Continental	30,606,000	
	24,078,000	3.83 %
Sky West	22,646,000	
	21,129,000	3.36 %
Other	180,662,532	28.70 %

b) Read the description of the pie chart given above and fill in the gaps with the missing words or phrases.

(1)____ US domestic market is 629,457,532 scheduled passengers (2)____ year. It is true that Delta carried the most total passengers in 2010, but that includes (3)____ international and (4)____ passengers. For domestic only, (5)____ was the largest carrier in the US. Also note that with United and Continental's merger, the combined United Airlines will become (6)____ in the world (with domestic and international traffic combined, but not US domestic only). Even with the United merger, Southwest will remain the largest domestic carrier by over 30 million (7)____ per year. Here is the top (8)____ by domestic passengers carried in (9)____.

XXII. Write a short description of two pie charts. Compare the pie charts. The text and the notes given below will help you.

The pie charts compare …

The pie charts are divided into sectors which represent a percentage of …

It can be seen that …

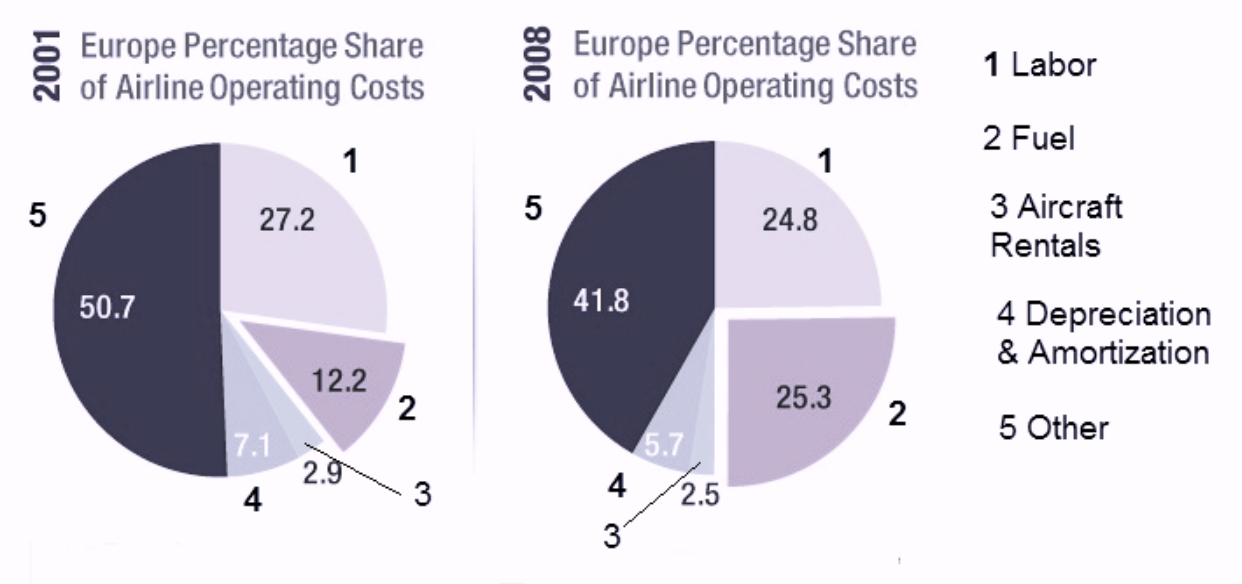
It is clear that the largest proportion of …

The percentage rose (fall) to nearly at ___% in ___.

Some sectors remained relatively unchanged.

It is evident from the information provided that …

In conclusion …



According to the IATA, fuel represented 13% of the expenses incurred by global commercial airlines in 2001. That figure reached 33% in 2008 amid a period of unprecedented oil prices, and it has since hovered in the mid-20s. The IATA has estimated a 24% fuel cost figure for 2009. The organization has forecast that it will creep up to 26% this year. In the case of Europe, airline fuel costs have followed the global trend. In fact, as the pie charts below illustrate, fuel cost is the only expense that increased for European airlines from 2001 through 2008.

PART II

THE HISTORY OF NAVIGATION

I. Discuss the following topics:

1. The notable facts from the history of navigation
2. The main navigation tools
3. How to find the position

II. Translate the following words and memorize them.

landmarks	chip log	dead-reckoning	radio receiver
record	lead line	needle	updated
sounding reed	forerunner	crude	deviation
shallow water	descendant	to circumvent	onboard

III. How do you think what this proverb tells about? Explain your point of view.

Een schip op het strand is een baken in zee.

{A ship on the beach is a lighthouse to the sea.} DUTCH PROVERB

Listening

IV. Listen to the text "Aircraft Navigation Technology" and complete the table.

Date (Period of time)	Event
In the early 1920s	
	Simple equipment to help pilots maintain attitude was introduced.
In 1929	
In the 1930s	

	The Inertial Navigation System (INS) and the Inertial Guidance System (IGS) were appeared.
In 1928	
	The earliest radio navigation aid was the four-course radio range.
By 1935	

V. Listen to the text "Aircraft Navigation Technology" again and complete the notes.

1. Operational principle of Artificial Horizon:
2. How early pilots found their way in daytime flight:
3. Magnetic Compass location:
4. The basic or primary insruments included:
5. The purpose of Inertial Guidance System:
6. Vertical speed indicator shows:
7. The features of the four-course radio range navigation:
8. The task of the early air traffic controllers:

Reading and Speaking

VI. Read and translate the text. Define all periods of navigation development.

Navigation is the art of getting from one place to another, safely and efficiently and there are a variety of means by which this may be achieved. The Polynesians cross the Pacific Ocean about two millennia ago using their understanding of celestial bodies and landmarks.

The first record of boats large enough to carry goods for trade is around 3500 B.C. and this would mark the birth of the art of navigation. Coastal navigators relied upon the sounding reed (c. Egypt 1500 BC) to measure shallow water depths and the wind rose which described the eight major winds attributed to their originating countries. These first navigators stayed close to shore and navigated by sight of landmarks or land characteristics that they could see.

One of the earliest man-made navigation tools was the mariner's compass, an early form of the magnetic compass and lead line (c.13th Century). The first compasses were very crude. The needle would point in a northerly direction.

Mariners at this time also used the cross-staff and the astrolabe (c.1484 Martin Behaim) to measure the angle above the horizon of the sun and stars to determine latitude. The forerunner of the much more portable (and accurate) sextant, the astrolabe was used to measure the altitude of a sun or star. A major advance that made dead-reckoning much more accurate was the invention of the chip log (c.1500-1600).

In 1701, charts of magnetic variation in different parts of the world were available, making the magnetic compass a valuable and consistent navigational tool. In 1764 John Harrison invented his seagoing chronometer accurate to one-tenth of a second per day. James Cook used Harrison's chronometer to circumvent the globe. Cook made detailed charts and he changed the nature of navigation forever and charts were rapidly developed around the world.

In 1884, by international agreement, the meridian of Greenwich, England was adopted as the Prime Meridian (0°).

The ship's chronometer remained an expensive but necessary navigation tool until radio signals became universal. The radio receiver provided a continuously updated time signal from the Prime Meridian in Greenwich, England.

The 20th century has seen advances in navigation tools beyond anything Columbus might have imagined. In 1907 Elmer Sperry introduced the gyroscopic compass which is unaffected by variation or deviation as it points to true north, not magnetic north.

British physicist Robert Watson-Watt produced the first practical radar (radio detection and ranging) system in 1935. Radar can determine the presence and range of an object, its position in space, its size and shape, and its velocity and direction of motion.

The hyperbolic navigation system knows as Loran (Long RangeNavigation) was developed in the U.S. between 1940 and 1943. It uses pulsed radio transmissions

from master and slave stations that are received onboard and recorded as small waves on the screen of a cathode-ray tube.

GPS (Global Positioning System), initiated in 1973, is operated and maintained by the U.S. Department of Defense. This space-based radio-navigation system consists of 24 satellites and provides accurate positioning to within about 30 feet as well as velocity and time worldwide in any weather conditions. GPS works the same way as Loran but the signals come from satellites. Because you can receive GPS signals using small, inexpensive equipment it is being used in many new applications.

(Adopted from: http://www.boatsafe.com)

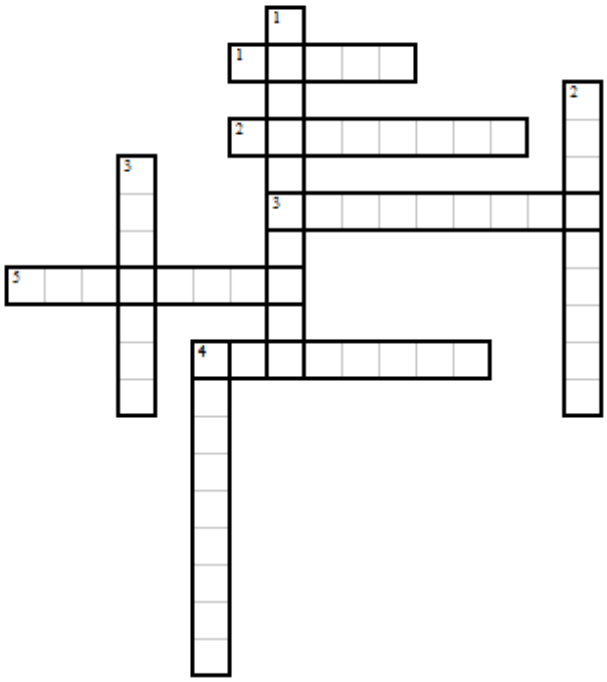
VII. Answer the questions to the text.

1. What is navigation?
2. Where were the first records about some art of navigation done?
3. What does celestial navigation mean?
4. Were the first compasses very imprecise or sensitive?
5. What was the forerunner of the much more accurate sextant?
6. What major advance made the invention of the chip log in the 16th century?
7. What advance was made in navigation tools in the 20th century?

VIII. Complete the crossword with the words from the text using the following descriptions.

Across	Down
1. confirms the actual position during a journey	1. to go around or bypass
2. the condition or quality of being true, correct, or exact	2. the planet Earth
3. the extent, dimensions, quantity, etc., of something, ascertained especially by comparison with a standard	3. the line where the earth or sea seems to meet the sky
4 the height of a thing above a reference level, especially above sea level or above	4. something used as a symbol of a particular person, office, or status

the earth's surface.	
5. the angular distance north or south from the equator of a point on the earth's surface, measured on the meridian of the point.	



IX. Complete the sentences using information from the text "The History of navigation."

1. The difference of the signals from the two stations is represented by …
2. In the time around 3500 B.C. there was …
3. The north was pointed ….
4. Coastal navigators were depended on…
5. … until radio signals became universal.
6. The invention of the chip log was…
7. Navigation by sight was used…
8. … was the mariner's compass.
9. …to measure the angle above the horizon of the sun.

X. The prime meridian and the International Date Line was a very important decision for navigation in the world.

a) Fill in the gaps with the words given in the box.

Longitude, halfway, celestial bodies, runs, shoots out, craters, to mark, prime meridian, to establish,

In 1884the Greenwich Meridian became the international standard for the (1) ___. The prime meridian also sets Coordinated Universal Time (UTC). The prime meridian also helps (2) ___ the International Date Line. The Earth's (3) ___ measures 360, so the (4) ___ point from the prime meridian is the 180 longitude line. The meridian at 180 longitudes is commonly (5) ___ as the International Date Line. The Earth is not the only (6) ___ with a prime meridian. Scientists use (7) ___ or other geographic features (8) ___ prime meridians on other planets and (9) ___. The prime meridian of Mars runs through a crater named Airy-0. The prime meridian of the Earth's moon (10) ___ near a crater named Bruce. Today, the prime meridian is marked by a laser beam that (11) ___ northward from the Royal Observatory in Greenwich, England.

(Adopted from: http://www.thegreenwichmeridian.org)

b) Complete the table with the information from the text about the prime meridian and the International Date Line.

Types of prime meridians	The functions of the prime meridian	The methods of establishing the prime meridian

XI. Choose the best completion of the sentence and translate them into Ukrainian.

1. Whenever you want to find a store in a mall or walk home from school...

a) you are using the tools of the early navigators

b) you are using the radio information

2. These first navigators usually traveled by day ...

a) close to shore and navigated by sight of landmarks

b) and sought a calm harbor or anchorage at night

3. When the navigator did venture out of sight of land, he was able to determine his latitude (north/south direction) ...

a) by observing the height of the sun during the day and the North Star at night

b) by observing the height of the sun during the day and the Big Dippe at night

4. Experienced mariners …, though this was not an exact science.

a) were said to track their course by major constellations

b) were said to plot their course by major constellations

5. Using a simple form of dead-reckoning, the navigator can determine the distance traveled from one point to another...

a) by multiplying the time underway by the speed of the vessel

b) by following the east/west movement of the sun or the track of the stars

6. Using a combination of depth soundings, the sun or stars and the wind rose, these early navigators...

a) had to get to their destinations successfully

b) had to guess where they were when land could not be seen

XII. Study these pictures carefully.

a) Work in pairs. Check yourself how you know the history of navigation. Fill in the names of the navigation tools from the box in the picture captions below.

marine sandglass, lead line, marine sandglass, prime Meridian, seagoing chronometer, GPS, astrolabe, chart, sextant, dead reckoning, magnetic compass, LORAN, radar, mariner's compass, gyrocompass, celestial navigation , cross-staff, chip log

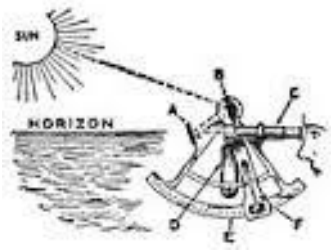


Fig.1

Fig.2

Fig.3

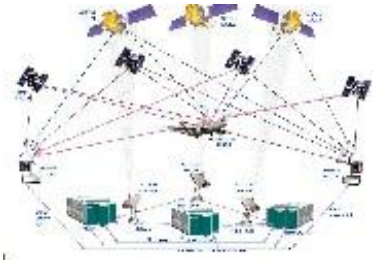


Fig. 4

Fig.5

Fig.6

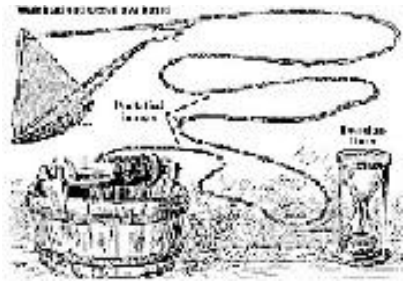


Fig.7

Fig.8

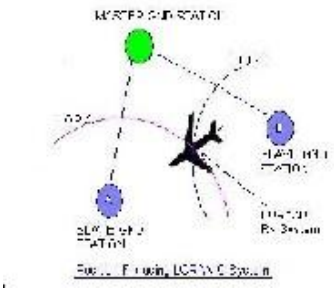


Fig.9

Fig. 10

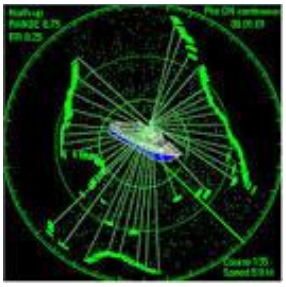


Fig.11

Fig.12

Fig.13

Fig.14

Fig.15

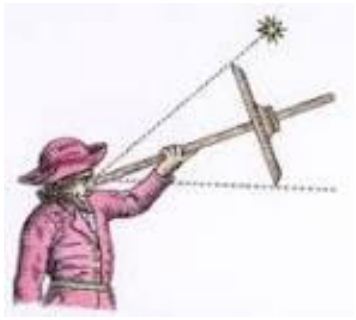


Fig. 16

Fig.17

Fig.18

b) In the given texts below fill in the gaps with the appropriate names of navigation tools from the previous exercise. Check each other.

1. In 13th century much more valuable was the invention of the ___, which was a tool for measuring the depth of water and the nature of the bottom. This line was weighted with lead and had graduated markings to determine sea depth.

2. Prior to the ___, all of the seafaring nations had their own ___, causing longitude to be different on charts created in different countries.

3. The calculation of the present position by the difference in two times was considered so important that countries offered prizes for the invention of an accurate ___. The British prize was won by John Harrison in 1764 for his ___ accurate to one-tenth of a second per day.

4. ___ works the same way as Loran (time difference between separate signals) but the signals come from satellites. Because you can receive ___ signals using small, inexpensive equipment it is being used in many new applications.

5. An ___ is a two-dimensional model of the celestial sphere. An ancient instrument used widely in medieval times by navigators and astronomers to determine latitude, longitude, and time of day.

6. A major advance that made dead-reckoning much more accurate was the invention of the ___ (c.1500-1600). It was tossed overboard over the stern as the pilot counted the knots that were let out during a specific period of time. From this he could determine the speed the vessel was moving.

7. Toward the end of the 1600's and into the 1700's, was invented an astronomical instrument ___ used to determine latitude and longitude at sea by measuring angular distances, especially the altitudes of sun, moon, and stars.

8. ___ is the calculation of one's position on the basis of distance run on various headings since the last precisely observed position, with as accurate allowance as possible being made for wind, currents, compass errors, etc.

9. The ___ was first invented as a device for divination as early as the Chinese Han Dynasty (since about 206 BC), and later adopted for navigation by the Song Dynasty Chinese during the 11th century and was recorded in Western Europe and in Persia around the early 13th century.

10. The ___ system is a radio aid to navigation. It provides means, independent of all other aids for locating a moving vehicle at a given moment and for directing it to a predetermined point or along a predetermined path.

11. ___ is used to locate objects beyond the range of vision by projecting radio waves against them.

12. ___ is a compass used in navigation that consists of parallel magnetic needles or bundles of needles permanently attached to a card marked to indicate direction and degrees of a circle.

13. In 1907 Elmer Sperry introduced the ___ which is unaffected by variation or deviation as it points to true north, not magnetic north.

14. ___ was one of the earliest ways in which humans could orient themselves to travel long distances. In the past, however, the sky was more akin to an ancient atlas which humans used to navigate long before sophisticated maps were developed.

15. In radio communications, a ___ is an electronic device that receives radio waves and converts the information carried by them to a usable form. It is used with an antenna.

16. ___ is an instrument formerly used at sea for taking the altitude of a celestial body.

17. Navigation ___ combine aspects of topographic, general reference and thematic maps and are produced as navigation aids for ships, boats and aircraft. Specialist knowledge is usually required to read ___.

18. ___ is a timepiece of simple design that is a relative of the common hourglass, a marine (nautical) instrument known since the 14th century (although reasonably presumed to be of very ancient use and origin).

XIII. Make a presentation about the navigation tools using the information from the previous exercise. The list of the phrases given below helps you to make it.

I'd like to start by introducing myself.
My name's … and the topic for my presentation today is…
Hello. My name's..... and today I'm going to be talking about…
I intend to discuss ... I hope to consider the main issues around ...
... and this is the theme for my presentation today.
My talk will last for about..... minutes and there'll be time at the end for questions.
If you look at these pictures you can see that ...
I would like to draw your attention to this point …
Now let's turn to the issue of …
In conclusion, ...
In view of the evidence I have presented I think it is fair to say that…

UNIT 6

FLIGHT SAFETY

PART I

I. Read the extracts below and gives the answers to the questions. Discuss in groups of four.

- Where were these extracts taken from?
- Who is the author?
- How do you understand these extracts?
- What does the author want to express?
- Would you like to read it? Why/Why not?

a) Most gulls don't bother to learn more than the simplest facts of flight - how to get from shore to food and back again. For most gulls, it is not flying that matters, but eating. For this gull, though, it was not eating that mattered, but flight. More than anything else, Jonathan Livingston Seagull loved to fly.

b) You will begin to touch heaven, Jonathan, in the moment you touch the perfect speed. And that isn't flying a thousand miles an hour, or a million, of flying at the speed of light. Because any number is a limit, and perfect speed, my son, is being there.

(Adopted from: http://izquotes.com; https://en.wikiquote.org)

II. Work in small groups. Make up a list of famous people in the field of aviation. Think about their achievements and their role in the development of aeronautics. Share your knowledge.

III. Match the words with their Ukrainian equivalents.

1. posthumous publication	a) повітряні гімнасти
2. aloft	b) орнітоптери
3. whet one’s appetite	c) авіаційні роздуми
4. aerialists	d) посмертне видання

5. dispel fears	e) вгорі
6. aeronautical musings	f) стимулювати аппетит
7. ornithopters	g) розвіяти побоювання

Reading

IV. Read and translate the text and choose the best title from the list below.

a. Wright Brothers in Aviation
b. Famous People in Aviation
c. The Role of Leonardo do Vinci in Aviation
d. The History of Flight

_____

(1) The history of flight is the history of a human dream to soar through the sky like a bird. Clear understanding of bird flight was not attained until the twentieth century, the issue was considered settled with the posthumous publication in 1680 of Giovanni Alfonso Borelli De Motu Animalum. Borelli described bird flight as the combined effect of the action of the individual feathers as they twist and turn during flight and the complex flapping of the wings, and claimed to prove that human musculature was far too weak to support a system of this kind.


George Cayley
Glider with Tail

(2) Amazingly, the theory of the airplane may be said to have been born by 1799—more than a century before the Wright brothers' achievements at Kitty Hawk—in the work of Sir George Cayley. Cayley understood the basic principles of flight and constructed working models, perhaps even one that carried a human being aloft, and for this reason he is known as "the father of aeronautics". But Cayley had a long tradition on which to build, and in many ways his genius lay in being able to bring together well-established science with the legends and dreams of flight.


Montgolfier
Balloon

(3) While the foundations of heavier-than-air flight were being laid, lighter-than-air flight was progressing through the

late 1700s. The Montgolfier brothers made their historic flight in 1783, and the balloon soon found a successful military application when it was used by the French at the Battle of Fleurus to defeat the Austrians. As thrilling as balloon flight was, its main contribution was to whet the aerialists' appetite for real controlled flight, a dream that would not be realized for a century.

(4) It is not possible to write a history of aviation without mentioning Leonardo da Vinci, the 

Italian artist and scientist who lived and worked in Florence in the late fifteenth century, even though fate dictated that he would have virtually no impact whatever on the development of flight. In spite of his brilliance, the world knew nothing of his theoretical work in aviation for the simple reason that nearly none of his notes were published until the late 1800s. Unlike Bacon, whose influence lay mainly in his efforts to dispel the human fear of flying as an impossible or demonic activity, Leonardo was very secretive about his aviation research, committing his drawings and notes to paper in a mirror writing that would conceal his findings from most observers. Leonardo discussed some things with his contemporaries, but it does not seem that anyone had any idea of his aeronautical musings. In all, Leonardo left behind a large body of work about flight: more than five hundred sketches and thirty-five thousand words. Much of his work involved the careful study of birds and of bat like wing sections. He realized that human physiology was not capable of birdlike flight, but he designed many ornithopters that required coordinated pedaling of arms and feet. Most of his conclusions about how birds fly were wrong, and these errors rendered most of his aircraft useless. Two aspects of Leonardo's work are interesting, though.

(5) First, he did realize that an aircraft would require a tail section to stabilize the flight. And, second, he conceived of a proto-helicopter that used a wide screw to lift itself into the air. The principle behind this device, the Archimedean screw, was known since antiquity and was used to transport water uphill or up from a well. Leonardo seems to have been the first to apply the mechanism to aviation.

(Adopted from: http://www.century-of-flight.net)

V. Read the text again and complete the table.

Date	Inventor	Details
15th century		He lived and worked in Florence
	Montgolfier brothers	
----------		the father of aeronautics
18th century		There was no published paper of his theoretical work in aviation
posthumous publication in 1680		He gave a clear understanding of bird flight
1790-1857	Sir George Cayley	
1900		first manned gliding experiments.
English Renaissance. The Scientific Revolution		The human fear of flying was dispelled

VI. Read the following sentences and find out what information is not mentioned in the text.

1. Birds seem to fly with so little effort that it was only natural that early attempts to fly would be attempts to emulate birds.
2. Bird flight was described as the combined effect of the action of the individual feathers as they twist and turn during flight and the complex flapping of the wings.
3. Several scientific findings laid the foundations for the science of flight.
4. The theory of the airplane may be said to have been born in eighteens century.
5. Cayley is known as “the father of aeronautics.
6. Lighter-than-air flight was progressing through the late 1700s.
7. The Montgolfier brothers made their historic flight in 1783.
8. Leonardo da Vinci made the first real studies of flight in the 1480's.
9. Leonardo da Vinci had over 100 drawings that illustrated his theories on flight.
10. Leonardo da Vinci did realize that an aircraft would require a tail section to stabilize the flight.

VII. Find the synonyms of the following words in the text.

fly up *(paragraph 1)*

justify *(paragraph 1)*

argument *(paragraph 3)*

investment *(paragraph 3)*

achieve *(paragraph 1)*

conquer *(paragraph 3)*

obtainment *(paragraph 2)*

influence *(paragraph 4)*

VIII. In the text find the phrases with the similar meanings.

at the top *(paragraph 2)*

up to the heavens, an eagle rose *(paragraph 1)*

the rope twined and whirled *(paragraph 1)*

tied common knowledge with fable *(paragraph 2)*

the flyer felt enthusiastic *(paragraph 3)*

to establish a precedent *(paragraph 3)*

understand an essential foundation or starting point *(paragraph 2)*

IX. Read the following sentences and give more detailed explanation to each point.

The main issue was considered after the posthumous publication in 1680 of Giovanni Alfonso Borelli De Motu Animalum**.**

Cayley understood the basic principles of flight and constructed working models.

Wright brothers' achievements.

The Montgolfier brothers made their historic flight in 1783.

Leonardo da Vinci works' made impact on the development of flight.

X. Read the passage. Find and correct seven mistakes.

Aerodynamics affects the motion for a large airliner, a model rocket, a beach ball thrown near the shore, or a kite flying high overhead. In 1726, Sir Isaac Newton became first person to develop a theory of air resistance, making him one of first aerodynamicists. Dutch-Swiss mathematician Daniel Bernoulli in 1738 described a fundamental relationship among pressure, density, and velocity for incompressible flow known today Bernoulli's principle. In 1757, Leonhard Euler published general

Euler equations, which could applied to both compressible and incompressible flows. The Euler equations were extended to incorporate the effects of viscosity in the first half of the 1800s, resulting the Navier-Stokes equations. The Navier-Stokes equations are the most general governing equations of fluid flow and are difficult solve.

XI. Match two parts of the sentences and translate them into Ukrainian.

1. Lilienthal made his flights from an artificial hill he built near Berlin	a) which was first demonstrated by Wilbur and Orville Wright in 1903.
2. In 1889, Charles Renard, a French aeronautical engineer,	b) particularly when it interacts with a solid object, such as an airplane wing.
3. Most of the early efforts in aerodynamics worked towards achieving heavier-than-air flight,	c) are the fundamental forces of flight: lift, drag, thrust, and weight.
4. Dr. Ludwig Prandtl formulated a large number of major theories	d) and from natural hills, especially in the Rhinow region.
5. At the beginning, in 1891, Lilienthal succeeded	e) attacking ships and setting ships on fire using an array of mirrors
6. In mechanics Archimedes defined the principle of the lever and is credited	f) which states that properties such as beauty are abstract universal entities that exist independent of the objects
7. Aerodynamics is a branch concerned with studying the motion of air,	g) became the first person to predict the power needed for sustained flight.
8. Aristotle famously rejected Plato's theory of forms,	h) which were and are still being used today to design practical aircraft.
9. Archimedes designed machines capable of lifting	i) with inventing the compound pulley and the hydraulic screw for raising water from a lower to higher level.
10. In many aerodynamics problems, the forces of interest	j) with jumps and flights covering a distance of about 25 metres (82 ft).

Listening

XII. Listen to the text and fill in the gaps to complete the sentences.

1. _____ don't provide enough information to allow a pilot to land.
2. On December 29, 1970, _____ came into effect.
3. Each satellite is equipped with _____.
4. GPS is becoming the _____ of navigation worldwide
5. _____ navigation information is increasingly displayed on a monitor.
6. The form of navigation aid, which _____, saves lives of injured pilots and crew who are unable to call for help themselves.

XIII. Listen to the text and answer the questions.

1. What frequencies did radio navigation rely on before World War II?
2. What code did direction finder and the non-directional beacon use?
3. How are modern aircraft tracked?
4. What means of communication are used by pilots and controllers?
5. Which technology is unique to determine aircraft position anywhere on the Earth?
6. What is GPS based on?
7. What is called ZULU time?
8. What did the Occupational Safety and Health Act require?

Speaking

XIV. The history of flight developed into modern aviation. It is the result of more than 2000 years of development. Aviation has become a very important type of transport. Discuss the following topics about the history of flight and modern aviation in class.

- Early years of flight
- Kites
- Modern theory of flight
- Balloons

- Sir George Cayley and the first modern aircraft
- The Wright brothers
- Modern aviation

XV. Faculty of Aerospace Systems of National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" invites foreign students to get the Bachelor or Master Degree. You are asked to write the faculty background for the site. You should include the following points:

- History of the faculty
- Programme objectives
- Career opportunities
- Students facilities

Grammar

Infinitive+Gerund

In English language some verbs are followed by the gerund (doing) and others are followed by the infinitive (to do).

Often we use the gerund for an action that happens before or at the same time as the action of the main verb.

Often we use the infinitive for actions that follow the action of the main verb.

(See Appendix 1 p.139)

XVI. Choose the correct answer.

1. (To judge/Judging) from the story of Daedalus and Icarus, humans have been interested in aerodynamics and flying for thousands of years.
2. Dr. Ludwig Prandtl seem (to be/being) a father of modern aerodynamic theory.
3. In 1949 Dr. Hans Multhopp started (working/to work) for the Martin Aircraft Co.
4. Dr. Adolph Busemann considered (beginning/to begin) his work in developing the swept wing theory.

5. Until the war's end Dr. Woldemar Voig had postponed (redesigning/to redesign) the Me 262.

6. Theodore von Karman in 1930 wished (to move/moving) to Pasadena, to become director of the Guggenheim Aeronautical Laboratory at Cal Tech (GALCIT).

7. In 1920 he moved to the US to work for NAS and he suggested (to design and supervise/ designing and supervising) the NACA variable density wind tunnel.

8. After the war Dr. Richard Vogt came to the US under "Operation Paperclip". Working at the Boeing Aircraft Co., he continued (to design/designing) unusual aircraft such as nuclear-powered bombers in the mid 1950's.

9. Aristotle was the first, who decided (classifying/to classify) areas of human knowledge into distinct disciplines such as mathematics, biology, and ethics.

10. As the father of the field of logic, Aristotle was the first (to develop /developing) a formalized system for reasoning.

XVII. From the words given below make up sentences with Gerund and Infinitive and explain their meanings.

Forget, remember, go on, quit, regret, stop, try, and continue.

XVIII. Complete this article. Fill in the gaps with to-infinitive or –ing form of the given verbs:

discover, express, use, lift, be, calculate, include, bear, design, be

Archimedes of Syracuse was a Greek mathematician, physicist, engineer, inventor, and astronomer. Although few details of his life are known, he is regarded (1) ___ one of the leading scientists in classical antiquity. He is credited with (2) ___ innovative machines, (3) ___ siege engines and the screw pump that bears his name. Modern experiments have tested claims that Archimedes designed machines capable of (4) ___ attacking ships out of the water and setting ships on fire (5) ___ an array of mirrors. Archimedes is generally considered (6) ___ the greatest mathematician of antiquity and one of the greatest of all time. He used the method of exhaustion (7) ___ the area under the arc of a parabola with the sum summation of an infinite series,

and gave a remarkably accurate approximation of pi. He also defined the spiral that was considered (8) ___ his name, formulae for the volumes of solids of revolution, and an ingenious system for (9) ___ very large numbers. He managed (10) ___ the law of hydrostatics, sometimes known as 'Archimedes' principle', stating that a body immersed in fluid loses weight equal to the weight of the amount of fluid it displaces.

XIX. Change Infinitive into Gerund.

1. As aircraft speed increased, designers began to encounter challenges associated with air compressibility at speeds near or greater than the speed of sound.
2. The ratio of the flow speed to the speed of sound was named the Mach number after Ernst Mach, who was one of the first scientists investigated the properties of supersonic flow.
3. The rapid increase in drag led aerodynamicists and aviators begin to disagree on whether supersonic flight was achievable.
4. In his study of color effects, Euler proposed to use the observation of the conjunction of Venus but no effects were observed during this conjunction.
5. The Russian Academy continued to publish Euler's works for another half century after the death of the great scientist.
6. Daniel Bernoulli is one of the earliest writers who made an attempt to devise the kinetic theory of gases and he proposed to explain Boyle's law.

PART II

AIRPLANE COMPONENTS AND SYSTEMS

I. Read the following quotes. Why did these famous people think so? Speculate about events in the past using the construction:

Modal verb (must, might, could, can't) + have + past participle

Degrees of certainty	*more certain*	*must*
	less certain	*might, could*
	certain that the statement is false	*can't*

“I am well convinced that Aerial Navigation will form a most prominent feature in the progress of civilization.” (Sir George Cayley)

“Heavier-than-air flying machines are impossible.” (Lord Kelvin)

“When once you have tasted flight, you will forever walk the earth with your eyes turned skyward, for there you have been, and there you will always long to return.” (Leonardo Da Vinchi)

“The Wright Brothers created the single greatest cultural force since the invention of writing. The airplane became the first World Wide Web, bringing people, languages, ideas, and values together.” (Bill Gates)

II. Many factors influence the safety of modern aircraft. Some are related to design, others to the maintenance and operation of the aircraft. The factors and approaches employed vary with the type of aircraft. Work in small groups and brinstorm the safety factors for:

- civil aircraft
- military aircraft
- helicopters
- gliders
- UAVs

III. Choose the words that deal with the structure of the aircraft. Give their Ukrainian equivalents.

elevator	maintenance	hinge	strut
rigorous	friction	rudder	swing
flap	yaw	redesign	equipment
redundancy	artificial	retractable	reliability
pitch	lift	amount	takeoff
roll	cargo	brakes	maneuver
failure	crew	downward	drag

Reading and Speaking

IV. Read and translate the text. Make a list of airplane components mentioned in the text and explain their functions.

Airplane designs, equipment reliability, and flight crew training have all improved since the Wright brothers' first powered flight. Airplane certification processes and oversight are rigorous. Airlines and manufacturers closely monitor equipment failure rates for possible redesign of airplane parts or modification of maintenance procedures. Improvement in airplane designs and equipment components has always been a major focus in the aviation industry.

Airplanes are heavy and massive, which may make them seem impossible to be able to fly. Even though these metal machines, which are often also filled with many pounds of cargo, are extremely heavy, they have specialized parts and a design that allows them to lift off the ground and move through the air safely for many hours.

The basic parts of arplane are the fuselage, wing, tail, and engine. The fuselage is the body of the plane, which may carry passengers, cargo or both. The wings of an airplane generate most of its lift, the force that keeps the airplane up in the air. In the case of an airplane engine, the thrust generated by the engine can help to produce or increase the airflow over the airplane, helping the airplane fly. Drag is a kind of aerodynamic friction. Smaller, low-speed airplanes use propellers instead of jet engines. Lift, weight, drag, and thrust are called the forces of flight.

Wings are used to control and maneuver the airplane. Smaller wings located on the tail of the airplane are called stabilizers. The stabilizers keep the airplane flying straight. The vertical stabilizer keeps the nose of the airplane from swinging from side to side, a motion called yaw. The horizontal stabilizer controls pitch, or the up-and-down motion of the nose of the airplane. The hinged part on the vertical stabilizer is called the rudder. The rudder directs the nose of the airplane to the left or to the right. The hinged part of the horizontal stabilizer is called the elevator, which is used to direct the nose of the airplane up or down. The wings of an airplane have hinged parts: ailerons, which are used to roll the wings from side to side and the wing flaps, which are located closest to the fuselage. During takeoff and landing, the wing

flaps are directed downward in order to increase the amount of lift produced by the wings.

The undercarriage or landing gear consists of struts, wheels and brakes. The landing gear can be fixed in place or retractable. Many small airplanes have fixed landing gear which increases drag, but keeps the airplane lightweight. Larger, faster and more complex aircraft have retractable landing gear that can accommodate the increased weight.

The importance of reliable flight instruments has been known from the time that pilots first began to rely on artificial horizons. This resulted in continual improvements in reliability, design, redundancy, and information provided to the pilots. Airplanes are designed to make sure pilots have at least the minimum information needed to safely control the airplane and airplanes are equipped with flight instruments to provide the necessary information for controlling the airplane.

(Adopted from: http://everything.explained.today)

V. Answer the following questions.

1. What is a requirement for any airplane to fly?
2. How many components does modern aircraft consist of?
3. What forces does the airplane need to fly?
4. What are the functions of wing?
5. When are the wing flaps directed downwards?
6. Where does an aircraft carry fuel in?
7. What do stabilizers prevent?
8. What are the main components of the undercarriage?
9. What is the primary task of the aviation industry?

VI. The exercise contains information about components of an airplane. Match the halves of the sentences then put them in the right order.

1. The pilots sit in the cockpit	a) is streamlined to decrease the drag.
2. Some aircraft carry fuel in the fuselage	b) which are designed to move people

	and cargo from one place to another.
3. A bulky fuselage can also	c) in the rear of the fuselage.
4. The wings are the most important	d) the fuselage also produces a little lift.
5. Airplanes are transportation devices	e) depending on the mission of the aircraft.
6. For this reason, a fuselage	f) others carry the fuel in the wings.
7. The modern aircraft has five basic structural components	g) at the front of the fuselage.
8. Passengers and cargo are carried	h) produce a lot of drag.
9. While wings produce most of the lift,	i) fuselage, wings, tail structures, power plant and the landing gear
10. Airplanes come in many different shapes and sizes	j) lift-producing part of the aircraft.

VII. Fill in the gaps with the words in the brackets putting them into the appropriate form. The first one is done for you.

Autoflight Systems

Autoflight systems include the autopilot, autothrottles, and all related systems that perform flight management and (guide) *guidance*. The systems integrate information from a (vary) ____ of other airplane systems. They keep track of altitude, heading, airspeed, and flight path with unflagging (accurate) ____. The pilot community has tended to develop a great deal of (confident) ____ in the systems, and that has led to complacency in some cases. As (rely) ____ as the autoflight systems may be, they can, and have, malfunctioned. Because of the (integrate) ____ of systems, it may be (extreme) ____ difficult for the pilot to analyze the cause of the anomaly, and airplane upsets have occurred. Since advanced automation may tend to mask the cause of the anomaly, an important (act) ____ in (take) ____ control of the airplane is to reduce the level of automation. Disengaging the autopilot, the autothrottles, or

both, may help in analyzing the cause of the anomaly by (put) ____ the pilot in closer touch with the airplane and perhaps the anomaly.

VIII. Work in pairs. Read the short passage about Flight Safety Foundation and complete the section that states the objectives of the organization. Share your ideas.

Flight Safety Foundation (1947) is an independent, nonprofit, international organization concerning research, education, advocacy and publishing in the field of air safety. FSF brings together aviation professionals from all the sectors to help solve safety problems facing the industry. With a membership that spreads throughout the world, FSF brings an international perspective to aviation issues for its members, the media and the traveling public. Membership ranges from individuals to airlines to manufacturers, from labor and management and in every corner of the industry.

The Foundation's stated objectives are:

1. _____
2. _____
3. _____
4. _____

IX. Ensuring safe travel for all passengers and crew is the primary focus of men and women who design, build, test, deliver and support airplanes.

a) Match the stages with the appropriate sets of words and phrases.

1. Design	a) to enhance safety; sophisticated; visible in flight deck systems; terrain avoidance warning systems; to reduce accidents
2. Testing	b) the primary consideration; to meet the standards; stringent; to be vital to the safe operation; backup; airplane structure; load; to withstand

3. New technology	c) to develop aids; to respond to challenging situations; updated; to reduce airplane accidents; to recognize and avoid
4. Training	d) certification requirements; to fix problems; structural strength; airplane's ability to carry loads; to validate durability; wind tunnels

b) ln pairs, analyze the notes given in the table above. Imagine that you are giving a presentation. Prepare the texts which help you to describe the purposes and improvements of each stage.

X. Aviation safety is the number one priority for everyone working in the aviation industry. Pretend one of you is an apprentice who has invented one of the things in the list and the other is a chief engineer who won't accept that it is a good idea. Roleplay trying to persuade him or her that it will improve the aircraft performance and save money.

- communication system
- ligter material for aircraft fuselage
- testing methodologies
- manufacturing processes
- advanced welding technologies such as electron beam
- alternative fuels
- ecoefficient design
- higher efficiency engine components
- turbine materials with increased temperature
- aircraft configuration
- software product for simulation
- maintenance process

CASE STUDY

TECHNICAL MUSEUM IN "IGOR SIKORSKY KYIV POLYTECHNIC INSTITUTE"

Task 1. Work in groups. The first group of young enthusiasts is going to create two additional expositions in the technical museum in "Igor Sikorsky Kyiv Polytechnic Institute" particularly expositions about "The history of navigation". Complete the table with the background information from the box about the history of navigation.

Cross-staff; chip log; world map; astrolabe; charts of magnetic variation; Portolan Charts; sextant; lead line; seagoing chronometer; magnetic compass; Prime Meridian; sounding reed and wind rose; gyroscopic compass; dead-reckoning; radar; celestial navigation; Loran; close to shore; GPS.

Around 3500 B.C.; ancient times; 1973; ancient times; 1940 – 1943; 1500 B.C.; 1935; 13th Century; 1907; 13thCentury; 1884; 13th Century; 1764; 1480; 1730; 1500-1600; 1701; 1514; 1569.

County of Flanders (in modern-day Belgium); United Kingdom; Egypt; England; United States; Portugal; United States; Polynesia; Britain; China.

John Hadley and Thomas Godfrey; Johann Werner; Bartolomeu Crescêncio; Martin Behaim; Department of Defense; Robert Watson-Watt; Elmer Sperry; John Harrison; Gerardus Mercator.

Tools or methods	**Period of time**	**Country**	**Author**
1.		_____	_____
2			_____
3		_____	_____
4			_____
5			_____
6		_____	_____

7		_____	_____
8		_____	
9			
10		_____	
11			
12		_____	_____
13		_____	
14			
15			_____
16			
17			
18			_____
19			

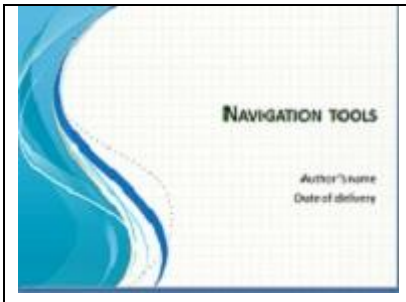
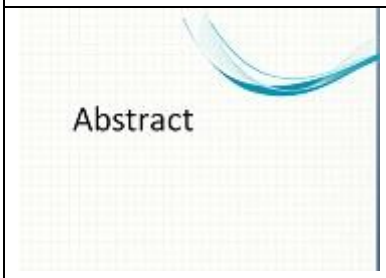
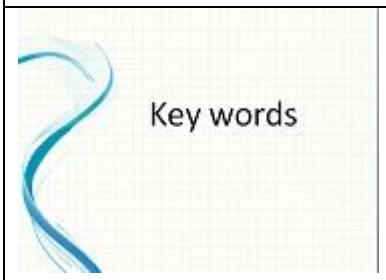
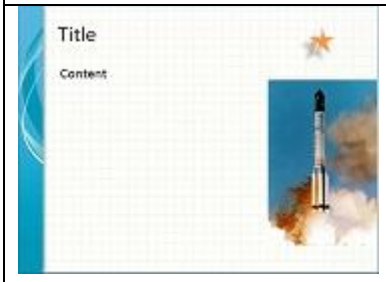
Task 2. Complete the table with information about navigation tools that are used in marine navigation till now and what navigation tools are used in aviation.

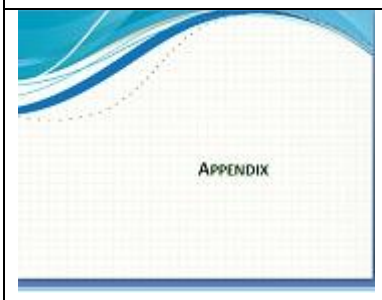
Marine navigation tools	**Aviation navigation tools**

Task 3. Explain how these tools work. Tell about advantages and disadvantages of these navigation tools. Think about your slogan. Share your ideas.

Task 4. Write a museum guide for this exposition.

Task 5. Prepare a Power Point Presentation about the exposition "The history of navigation tools". This pattern can be used as the example for representation. Before preparing the presentation look through the following tips.

	**Sections.** Sections allow ordering slides and organizing collaboration of several authors.
	**Notes.** Use the notes section for placement of the speaker notes or additional data for audience. Pay attention to font size.
	**Compatible colors.** Pay special attention to schedules, charts and inscriptions. Consider what will be printed in the black-and-white mode or in shades of gray.
	**Charts, tables and schedules.** Don't complicate perception: whenever possible use simple styles and colors. Supply all charts and tables with signatures.
	**Summarize** the result of the presentation, having repeated important points.
	Add slides to the section on each subject, including slides with tables, charts and images.

	Notes to slides.
	Make the presentation laconic. Move excessive contents to the appendix.

Task 6. The second group of young enthusiasts is going to create two additional expositions in the technical museum in "Igor Sikorsky Kyiv Polytechnic Institute" particularly expositions about "The history of flight". Read a short additional text about the early history of flight. Use the information from this text and from the text in part two on p. 123 and write a museum guide for this exposition.

The early history of flight

Greek Legend – Pegasus Bellerophon the Valiant, son of the King of Corinth, captured Pegasus, a winged horse. Pegasus took him to a battle with the triple headed monster, Chimera. Icarus and Daedalus - An Ancient Greek Legend Daedalus was an engineer who was imprisoned by King Minos. With his son, Icarus, he made wings of wax and feathers. Daedalus flew successfully from Crete to Naples, but Icarus, tired to fly too high and flew too near to the sun. The wings of wax melted and Icarus fell to his death in the ocean.

King Kaj Kaoos of Persia King Kaj Kaoos attached eagles to his throne and flew around his kingdom. Alexander the Great Alexander the Great harnessed four mythical wings animals, called Griffins, to a basket and flew around his realm.

Around 400 BC – China The discovery of the kite that could fly in the air by the Chinese started humans thinking about flying. Kites were used by the Chinese in

religious ceremonies. They built many colorful kites for fun, also. More sophisticated kites were used to test weather conditions. Kites have been important to the invention of flight as they were the forerunner to balloons and gliders.

For many centuries, humans have tried to fly just like the birds. Wings made of feathers or light weight wood has been attached to arms to test their ability to fly. The results were often disastrous as the muscles of the human arms are not like birds and cannot move with the strength of a bird.

The ancient Greek engineer, Hero of Alexandria, worked with air pressure and steam to create sources of power. One experiment that he developed was the aeolipile which used jets of steam to create rotary motion.

Hero mounted a sphere on top of a water kettle. A fire below the kettle turned the water into steam, and the gas traveled through pipes to the sphere. Two L-shaped tubes on opposite sides of the sphere allowed the gas to escape, which gave a thrust to the sphere that caused it to rotate.

(Adopted from: https://www.grc.nasa.gov)

Task 7. Prepare a Power Point Presentation about the exposition "The history of flight" Use the information from task 5 on p.130.

Task 8. The museum is going to open several new expositions. You want to prepare these expositions. Persuade the museum management to choose your candidacy. In small groups discuss the new arguments and concepts for your success. Share your ideas.

Some proposals how to make a good discussion

Think before you speak.

Listen carefully to what others have to say.

Do not interrupt when someone else is speaking.

Only say what you truly believe.

Do not remain silent. Make sure to contribute to the discussion.

Let other people speak.

You can use these expressions

Sequencing/Ordering

- Firstly….secondly…..thirdly….
- Then……. Next…..finally/ lastly….
- Let's move / go on to……

Giving reasons/ causes:	*therefore, so, as a result, that's why….*
Contrasting:	*but, however*
Comparing:	*similarly, in the same way*
Contradicting:	*in fact, actually*
Conclusion:	*in conclusion, to conclude*
Highlighting:	*in particular, especially*

APPENDIX 1

GRAMMAR REFERENCE

MODALS

Modal verb	Meaning	Modal verb	Meaning
Ought to	obligation *Drivers ought to drive slower in wet weather.*	**Have to**	necessity *I have to make a call before we leave.*
Can	ability *I can speak English.*	**May**	to give permission *You may take only one brochure.*
	possibility *I know you can win the competition.*		speculate about past actions *It may have already been broken before you bought it.*
	to ask for or give permission *Can I ask you a question?*		to ask for permission *May I sit next to you?*
Could	past ability *Could we move on to the next topic now please?*	**Must**	to express obligation or duty *I must memorize all of these rules about modal verbs.*
	to ask for permission or to request something *Excuse me, could I just say something?*		to emphasize the necessity of something *You must study the last two chapters before the test.*
	Suggestion *He could try and fix it himself.*		expresses positive logical assumptions (Must + have + past participle) She must have been at home - her car was there.
Might	possibility *She might be late because of the public transport strike.*	**Should**	to give advice, a recommendation or a suggestion *I think you should study for the test so that you don't fail.*
	polite permission *Might I suggest an idea?*		

GERUND

A gerund is one of three types of verbals. A verbal is formed using a verb, but it functions as a different part of speech in the sentence.

The Forms of the Gerund

	Active	Passive
Indefinite *(expresses an action simultaneous with that expressed by the finite verb)*	**writing, asking** *e.g. I remember asking her about it.*	**being written,** **being asked** *e.g. She doesn't like being asked such questions.*
Perfect *(expresses an action prior to that expressed be the finite verb)*	**having written,** **having asked** *e.g: I completely forgot having asked him to help me.*	**having been written,** **having been asked** *e.g. He could not remember ever having been asked to do such a thing.*

Functions of Gerunds in Sentences

In sentences the gerund is used in the functions of the subject, predicate, part of a compound verbal predicate, attribute, adverbial modifier (of time, manner, cause).

Losing a game is always unpleasant. *(subject)*

My greatest wish was taking up basketball. *(predicative)*

I enjoy watching the relay. *(object)*

The coach avoided discussing the expected outcome of the competition. *(object)*

She had no hope of breaking the World Record in Javelin throw. *(attribute)*

The barometer is an instrument for measuring pressure. *(attribute)*

The hall is often used for *holding* inter-college competitions. *(adverbial modifier of purpose)*

INFINITIVE

The Infinitive in English has six forms. (see page 58)

The Indefinite Infinitive is used:

a) if the action it expresses is simultaneous with that of the finite verb.

b) with verbs denoting hope, intention, etc.

The Continuous Infinitive expresses an action in its progress simultaneous with that of the finite verb.

The Perfect Infinitive expresses an action prior to that of the finite verb. After the verbs should, ought, could, might in the affirmative form as well as after was/were used in modal meaning the Perfect Infinitive shows that the action was not carried out.

Functions of the Infinitive

Subject	To understand statistics, that is our aim. To visit the Grand Canyon is my dream.
Object	He agreed to come at 10.
Adverbial Modifier	The opportunity was too good to be missed. She seemed more anxious to listen to the troubles of others than discuss her own.
Attribute	He was the last to realizethe danger.
Part of the Compound Predicate.	The plan was to go the dean.

The Bare Infinitive

The word to is frequently used with an infinitive, but it is not an essential part or sign of it. When an infinitive is used without the marker **to** it is called a bare infinitive.

The bare infinitive is used as the main verb after most modal auxiliary verbs (such as can or should) *e.g. I can do it* .

Several common verbs of perception (see, watch, hear, feel, and sense) take a direct object and a bare infinitive. *e.g. I saw it happen*

The bare infinitive is also used with several common verbs of permission or causation, *(*make, bid, let, have). *e.g. I made/bade/let/had him do it.*

The bare infinitive is also used after had better. *e.g. You had better leave now*

INFINITIVE OR GERUND

Verbs followed by a Gerund or Infinitive with little to no change in meaning:

begin	prefer
start	propose
continue	hate
like	can't bear
love	can't stand
cease	neglect
bother	

We do not usually have two – ing forms together.

Examples:

a. It began to rain/It began raining *b. I started to work/I started working*	In (a) There is no difference between "began to rain" and "began raining"
c. It was beginning to rain.	If the main verb is progressive, an infinitive (not a gerund) is usually used

Verbs followed by a Gerund or Infinitive with a change in meaning:

Forget, remember, go on, quit, regret, stop, try, continue	
Sam often ***forgets to lock*** the door.	***Forget*** + infinitive = forget to perform responsibility, duty or task
I***'ll never forget seeing*** the Alps for the first time	***Forget*** + gerund = forget something that happened in the past.
Judy always ***remembers to lock*** the door.	***Remember*** + infinitive = remember to perform responsibility, duty, or task
I ***remember seeing*** the Alps for the first time.	***Remember*** + gerund = remember something that happened in the past.
I ***regret to tell*** that you failed the test.	***Regret*** + infinitive = regret to say, to tell someone, to inform someone of some bad news.
I ***regret lending*** him some money. He never paid me back	***Regret*** + gerund = regret something that happened in the past.
He ***went on to learn*** English and French	**Go on** + infinitive = He ended one period of time before this
He ***went on learning*** English and French	**Go on** + gerund = He continued learning the languages
I ***stopped to call*** you.	***Stop*** + infinitive = I interrupted another action in order to call you.
I ***stopped calling*** you.	***Stop*** + gerund = I stopped this activity. Maybe we had a fight.
I ***tried to open*** the window.	***Try*** + infinitive =I attempted this action but didn't succeed.

I ***tried opening*** the window.	***Try*** + gerund = This was one option I sampled. Maybe the room was hot.

Notice the patterns with ***prefer:***
prefer + gerund: ***I prefer staying*** home ***to going*** to the concert;
prefer + infinitive: ***I prefer to stay*** home ***than*** (***to) go*** to the concert.
Forget followed by a gerund usually occurs in a negative sentences or a question: e.g. *I'll never forget, I can't forget, Have you ever forgotten*, and *Can you ever forget* can be followed by a gerund phrase.

Verbs followed by Gerunds

admit	discuss	mention	recommend
anticipate	dislike	mind	regret
appreciate	don't mind	miss	report
avoid	encourage	permit	require
complete	enjoy	postpone	resent
consider	finish	practice	resist
defend	forgive	prevent	risk
delay	imagine	quit	suggest
deny	involve	recall	tolerate
despise	keep	recollect	urge

Verbs followed by Infinitives

afford	continue	offer	request
agree	decide	pay	say
ask	determine	plan	seem
attempt	expect	prefer	tend
begin	hope	prepare	undertake
can't afford	intend	pretend	want
choose	manage	proceed	wish
claim	need	promise	would like

PARTICIPLE

The participle is a non-finite form of the verb which has a verbal and an adjectival or an adverbial character. The participle is intermediate between verbs and adjective.

There are two participles in English ─ Participle I and Participle II, traditionally called the Present Participle and the Past Participle.

Participle I we add -**ing** to the infinitive of the verb.

Participle II we add -ed to the infinitive of regular verbs and 3rd column of the table of the irregular verbs.

Present Participle Active and Passive usually denotes an action simultaneous with the action expressed by the finite verb; depending on the tense-form of the finite verb it may refer to the present, past, or future.

Examples of **present participle** in active voice.

When reading The Pickwick Papers, one can't help laughing.
When reading The Pickwick Papers, I couldn't help laughing.
When reading The Pickwick Papers, you will roar with laughter.

Examples of **present participle** in passive voice.

Being left alone, Pauline and I kept silence for some time.
Being dissatisfied with the job, he decided to resign.

Present Participle Perfect Active and Passive denotes an action prior to the action expressed by the finite verb.

Examples of **present participle perfect** in active voice.

Having read ten pages of the book, he decided to have a break.
They were, indeed, old friends, having been at school together.

Examples of **present participle perfect** in passive voice.

Having been translated into several languages, this article is well known in many countries.
Having been written long ago the manuscript was illegible.

Participle II has no tense distinctions; it has only one form which can express both an action simultaneous with, and prior to, the action expressed by the finite verb.

The Past Participle is often used when we want to express a passive action.

Examples of **past participle**.

The magazines read by him last week included several scientific articles.
Published in 1967, the research was adapted by the scientists all over the world.

The Subjective Participial Construction

The Subjective Participial Construction is a construction in which the participle (mostly Participle 1) is in predicate relation to a noun in the common case or pronoun in the nominative case, which is the subject of the sentence.

The aircraft was seen approaching the airport.
Then aircraft noise was heard penetrating into the building.

Absolute Participial Construction

This construction is made up of a noun followed by a participle.

The student knowing English well, the examination did not last long.

The Nominative Absolute Participial Construction.

The Nominative Absolute Participial Construction is a construction in which the participle stands in predicate relation to a noun in the common case or a pronoun in the nominative case; the noun or pronoun is not subject of the sentence.

The door and window of the vacant room being open, we looked in.

The Nominative Absolute Participial Construction is used in the function of an adverbial modifier.

It can be an adverbial modifier:	
of time	*The lamp having been lit, Mrs. Macallan produced her son's letter.*
of cause	*It being now pretty late, we took our candles and went upstairs.*
of attendant circumstances	*He turned and went, we, as before, following him.*
of condition	*Weather permitting, we shall start tomorrow.*

The Prepositional Absolute Participial Construction.

The Prepositional Absolute Participial Construction may be introduced by the preposition *with.* It is in most cases used in the function of an adverbial modifier of attendant circumstances.

There are two types of absolute constructions in which we find no participle. The second element of the construction is an adjective, a prepositional phrase, or an adverb.

The student sat silent and still, with his eyes fixed on the text-book.

I found students waiting for the teacher, with the books on the table.

We can join two sentences with participle.

APPENDIX 2

WRITING AND SPEAKING GUIDE

TECHNICAL SPECIFICATION

A specification or spec can be understood as a requirement or qualification which needs to be met as a particular document by a product, service, individual, company or organization**.**

Types of Technical Specifications

Depending on which subject matter they are being used for, the Specifications, are generally of three kinds:

1. Functional Specifications

It tell the user how well a particular system or a technical object works or goes about executing the particular function that it is supposed to perform.

2. Design Specifications

It informs you about the requirements of that particular item on the basis of which it will work well for you. It also informs you in clear terms how the structure of the project has been formulated.

3. Technical Specifications

These specifications deal with all the internal working of the particular project, software or program. It will contain technical language and terminology that only the person who is in that field shall be able to comprehend.

Structure of Technical Specifications

Section 1:

Administration – definitions, descriptions, quality assurance, warranties

Procedures – delivery, storage, handling

Maintenance – extra materials required, service

Section 2:

Product – information including manufacturer's details, materials, equipment requirements, system requirements

Section 3:

Execution of the specification – preparation, installation, quality control, training

Rules for Compiling the Technical Specification

Some basic rules to follow when compiling specifications include:

- the technical aspects of the document are written in simple business language;
- language should be specific and the use of inaccurate or generic phrases should be avoided;
- every function should be as detailed as possible with purposes and goals mentioned;
- all specifications must be written in a bullet point format, starting with the most important characteristics of the item (each bullet point should address only one characteristic and sequentially numbered starting from 1);

ABSTRACT

An abstract is basically a short summary that is used for research surveys or large papers.

If you are a student you may have to write an abstract as part of a larger paper to summarize it in a single paragraph.

The abstract is used by many people as a way to determine whether or not they want to read the entire work.

When researching material for a dissertation or thesis, the abstracts of research and academic papers are read to determine whether or not the information is worth reading in detail.

In order to write an abstract that will capture the attention of readers while summarizing the entire paper there are a few tips that you should follow:

- Present the topic and the need for the work
- State the specific objectives
- Summarize the major conclusions and recommendations
- Make sure that you have no more than 150-200 words

Useful phrases:

The paper/article/…

…discusses/deals with/considers/explains/ introduces …..

covers/suggests/proposes/ …..

serves as an introduction to …..

The main objective/goal/purpose of the paper/article is …..

….. plays an important/vital role in …..

In conclusion, it is evident that this study/article has shown …..

This paper has clearly shown that …..

….. can be successfully used for a number of ….. applications.

PROJECT PROPOSAL

A Project Proposal is a document which you present to potential sponsors or clients to receive funding or get your project approved. It contains key information about your project. It is essential for sponsors since they'll use them to evaluate the project and determine whether or not they'll allocate funds for it. Project proposals do not follow the 'one size fits all' principle. This can be attributed to the fact that there are many different types of proposals, all serving a unique purpose in their own right. Also, the amount of detail used when outlining proposals can vary significantly. Despite the fact that many different formats are available, roughly 80-90% of all Project Proposals follow a similar template. They mostly all have the same structure which contains a few key points.

- **Project title**

The project title should be short, concise, and preferably refer to a certain key project result or the leading project activity.

- **Abstract**

Many readers lack the time needed to read the whole project proposal. It is therefore useful to insert a short project summary - an abstract. The abstract should include: the problem statement, the project's objectives, key project activities, the total project budget.

- **Project justification**

Problem statement The problem statement provides a description of the specific problem(s) the project is trying to solve. There should also be an explanation of the needs of the target group that appear as a direct consequence of the described problem.

Priority needs The needs of the target group that have arisen as a direct negative impact of the problem should be prioritized.

The proposed approach The project proposal should describe the strategy chosen for solving the problem and precisely how it will lead to improvement.

Project results Results describe the services or products to be delivered to the intended beneficiaries.

Project implementation The implementation plan should describe activities and resource allocation in as much detail as possible. It is exceptionally important to provide a good overview of who is going to implement the project's activities, as well as when and where.

HOW TO CONDUCT AN INTERVIEW

Interviews have four stages that precede the writing of a story: arrangements, preparation, the actual interview and the reconstruction. Interviews are time consuming and they are resource intensive.

Arrangements Once you have decided to interview someone, call in advance to make an appointment. Identify yourself by your name and the name of your publication.

Preparation Do as much research as possible in advance on the person and/or topic you are working on. Sources might include the library, public records, the internet and people you know who can provide background information.

	Prepare your questions in advance in writing and bring them to the interview.
The interview	Questions should be as short as possible. Give the respondent time to answer. Be a good listener. Try to draw out specifics: How long, how many, when, etc.?
Reconstruction	As soon as it's practical after the interview, find a quiet place to review your handwritten notes. Underline quotes that seemed most compelling.

In the personal interview, the interviewer works directly with the respondent.

Qualification Criteria for the Interviewer:

Knowledgeable - being familiar with the topic.
Structuring - outline the procedure of the interview.
Clear - simple, easy and short questions which are spoken distinctly and understandably.
Gentle - being tolerant, sensitive and patient to provocative and unconventional opinions.
Critical - to test the reliability and validity of what the interviewee tells.
Remembering - retaining the subject information from the interviewee.

Types of Topics in Questions:

Behaviors - what a person has done or is doing.
Opinions/values - what a person thinks about the topic.
Background - standard background questions, such as age, education, etc.

Stages of Interview Investigation:

Thematizing - the why and what of the investigation.
Designing - plan the design of the study.
Interviewing - conduct the interview based on a guide.
Transcribing - prepare the interview material for analysis.
Analyzing - decide on the purpose, the topic, the nature and methods of analysis that are appropriate.
Verifying - ascertain the validity of the interview findings.
Reporting - communicate findings of the study based on scientific criteria.

APPENDIX 3

ABBREVIATIONS

A/D	Analog to Digital
CAD	Computer Aided Design
CNC	Computer Numerical Control
DME	Distance Measuring Equipment
DR	Dead Reckoning
FSF	Flight Safety Foundation
GN&C	Guidance, Navigation, and Control
GPS	Global Positioning System
IC	Integrated Circuit
IGS	Inertial Guidance System
INS	Inertial Navigation System
LED	Light Emitting Diode
MEMS	Microelectromechanical System
NASA	National Aeronautics and Space Administration
NDB	Nondirectional Radio Beacon
NMI	National Metrology Institutes
PC	Personal Computer
PhD	Doctor of Philosophy
QMS	Quality Management System
R&D	Research and Development
RF	Radio-Frequency
ROV	Remotely operated vehicle
SPC	Statistical Process Control
UAV	Autonomous Underwater Vehicles
UAV	Unmanned Aerial Vehicle
VOR	Very High Frequency Omnidirectional Range System

AUDIO CRIPTS

UNIT 1

Frank: So why are you so against genetically modified food, then? I think you've been taken in by all the bad press.
Ann: No, that's not true. I've read up on the subject and I think there are just too many risks.
Frank: The GM foods that you get are probably safer than non-GM foods.
Ann: Don't be daft. Where've you got that from?
Frank: Well, there are tighter controls for GM food. There are controls in each country and then at a European level as well. If they pass through all of those controls before they reach the shops they must be OK.
Ann: I just don't like the idea of having my food altered. What's wrong with the food we've always had?
Frank: We have to move with the times. The possibilities for GM food are endless.
Ann: What – redder tomatoes or bigger strawberries?
Frank: Yes, for one thing – but what about vegetables with a higher vitamin content or bananas with vaccines built into them?
Ann: What? (laughing)
Frank: It's true. They've developed a way to produce bananas with the Hepatitis B vaccine.
Ann: Mm, not sure what I think of that. We haven't done enough research and playing around with crops is playing havoc with the wildlife. There are whole species of birds that are in danger of becoming extinct. Larks, for example, they are rapidly decreasing in numbers and it's because of the chemicals they are using on GM foods.
Frank: They haven't proved that.
Ann: Not yet, no. But it's only a matter of time.
Frank: Mm.
Ann: And another thing that worries me is the power that a few food companies will have if we start to rely on GM food. They'll dominate the poor countries even more than they do today.
Frank: They'll feed them.
Ann: At a price, yes. Maybe. I'm worried about the food chain too.
Frank: What do you mean?
Ann: Well, playing around with nature causes no end of damage to some plants and animals. When a species dies out or mutates, it has a knock-on effect on the whole ecosystem.
Frank: I think you're being cynical. You're not giving GM food a chance.
Ann: Not cynical, just cautious.
Frank: OK, consider this. Global warming is threatening to destroy the habitat of polar bears.
Ann: What's this got to do with genetically modified food?
Frank: Everything. We could use GM food to change the polar bears' habitat now. That way we can prevent them from becoming extinct.
Ann: OK, I quite like that idea.
Frank: Good. You're starting to come round to my way of thinking.
Ann: No, I'm just trying to understand. I don't like being a guinea pig and we are all being guinea pigs for the experiments they're doing on GM foods. I guess I don't like the way things seem to just be happening without much of a debate.
Frank: What do you mean? We're talking about it all the time.
Ann: Talking maybe, but nobody's listening.

UNIT 2

Fraser Cain: So how heavy is a kilogram? How long is a second? How warm is a degree? We measure our universe in so many different ways using different units of measurement, but how do scientists come up with the measurement tools which are purely objective? All right Pamela, so now I'm a Canadian, and so I think in metric. I, fortunately, or maybe unfortunately, am also able to think in imperial most of the time, but there's one thing that I just can't think in imperial, which is

temperature.
Dr. Pamela Gay: Really?
Fraser Cain: Yeah. I am incapable. And I try, and so somebody goes, "Oh, it's like 70 degrees out," and I'm just like, "What is this gibberish?" I don't know what that means. I don't know what it means. I'm not even going to listen to you know, because I don't want to find it. So if you say that it's -40, then I've got some common ground, but most of the case, I actually have no idea. I don't know if it's warm or if it's cold, and of course if it's 100 degrees, I don't know. Is that boiling water? I don't know. I don't know.
Dr. Pamela Gay: So I have to admit that temperature is one of those things that my brain gets broken with, because I deal so much with people like you, who think in Celsius, and so much with – Well, my weather comes in imperial, sadly. And for whatever reason, my brain automatically switches to Celsius when it hits 32 degrees Fahrenheit and zero Celsius. So suddenly it's like, if it's below freezing, it needs to be a negative number as far as my brain is concerned.

UNIT3

Audrow Nash: Hi, welcome to Robots Podcast. Can you introduce yourself?
Christoph Stiller: My name's Christoph Stiller. I'm a professor in Mechanical Engineering at Karlsruhe Institute of Technology in Germany.
Audrow Nash: Can you tell me the goal and motivation behind your research?
Christoph Stiller: We're working on autonomous cars, and in particular we focus on computer vision for vehicles (cars that see their environment), and on trajectory planning for vehicles (the decision on where to drive, given the world that the car sees).
Audrow Nash: What kind of sensors do you use on your vehicles?
Christoph Stiller: Our main sensors are video cameras, but we also do experiments with LIDAR and radar sensors.
Audrow Nash: You have a car named Bertha, and it does not have roof-mounted sensors. Can you tell me a bit about that?
Christoph Stiller: Bertha was developed together with Mercedes Benz and the goal was to use only close-to-market sensors. In particular, we only used cameras that were looking around the vehicle, and radar sensors that came from serious production levels. No expensive GPS, no expensive LIDAR sensors, and in particular, nothing on the roof.
Audrow Nash: What is the motivation behind not using roof sensors?
Christoph Stiller: Our other vehicle was driving with roof sensors and those sensors were quite expensive; we had LIDAR sensors that cost us about $70,000 each, and we had a high precision GPS and with an inertial measurement unit and that cost us about the same amount of money on top. That's far from serious production.
Audrow Nash: Are there other disadvantages to using roof sensors? For example they get dirty, was that a concern?
Christoph Stiller: Yes, of course. If a roof sensor is not cleaned it will get dirty, just like how the windshield on your car gets so dirty that you can't look out anymore after a few hundred kilometers of driving. The same happens to a camera lens: if you drive with your camera lens for a long time, or with LIDAR sensors (which are also optical systems), the lens of that system gets contaminated with dirt or insects, and so the sensor gets blind. In the best case you notice that you can't drive autonomously anymore.
Audrow Nash: If your sensors are not on the roof, where are they in the car?
Christoph Stiller: [Human drivers look out the window. In our system] they're very close to the roof behind the windshield. When the driver gets irritated by a dirty window, and he engages the wipers, and then our cameras are also cleaned because it's in the wiper area.
Audrow Nash: What other sensors do you have in addition to the vision system that watches what's happening ahead of the car?
Christoph Stiller: We also have radar sensors. Many cars already have one radar sensor, but we equipped our vehicle with three radar sensors. These came from serious production because we

needed the larger viewing angle for those sensors so that we could look into the traffic area and see whether [there was] an oncoming vehicle that we would need to consider.
We also use a standard GPS unit, but it has a precision of about 20 meters, similar to what you have in your smartphone. It's not an expensive unit, it's only a low precision unit that gives us a very coarse positioning. We prerecord that tell us where to drive, which lanes we're supposed to take, what possibilities we have, who has precedence at what intersection, where traffic lights are … all this information is stored in maps.

UNIT 4

1
Audrow Nash: Hi, can you introduce yourself.
Davide Scaramuzza: Yeah. My name is Davide Scaramuzza and I am an Assistant Professor at the University of Zurich where I lead the robotics and perception group. My group is about three years old now. Before that I worked at ETH and the University of Pennsylvania. In fact, I got my PhD at ETH Zurich with Professor Roland Siegwart, and then I stayed there for another three years as a post-doc and led a European project called sFLY which was the first project to demonstrate autonomous navigation of vision controlled drones without GPS.
Then I moved to the University of Pennsylvania where I worked with Professors Kostas Daniilidis and Vijay Kumar. Then, in 2012, I got my position as Assistant Professor at the University of Zurich.
Audrow Nash: Now, your research, what is the goal, what are you working towards and what's your motivation?
Davide Scaramuzza: I'm interested in developing autonomous machines, for both air and ground, that use mainly sensors for navigation and perception. I'm particularly interested in vision because I think vision is the most powerful sense for us humans, and for insects, in general. In fact, most of the brain cortex is dedicated to processing visual images. I'm very interested in exploiting image information for navigation, interpretation, reasoning, path planning and so on.

2
Audrow Nash: I see. Can you talk a bit about the drone research platform that you're using with these vision systems?
Davide Scaramuzza: Yes. Since 2009 when I started doing this European project, most of my research has been formed around drones and vision control.
Audrow Nash: Are your drones quadcopters?
Davide Scaramuzza: Yes, we use quadrotors. We assemble them from off the shelf components. Actually, we're very happy with the air drone but we only use the frame, the motors and the motor controllers from it. We replace the rest of the electronics and put in a PX4 autopilot. We run all our control perception planning algorithms on board on an android and send it to the PX4 autopilot, which we rewrote from scratch.
Audrow Nash: This is done entirely on board the quadrotor?
Davide Scaramuzza: This is all done entirely on board.
Audrow Nash: What are some applications of quadrotor drones, eventually?
Davide Scaramuzza: Well, now you can use quadrotors for search and rescue, law enforcement, room inspection, agriculture, even package delivery. Currently, my group is investing in room inspection for nuclear facilities, like CERN or Fukushima, and reactor buildings. We also have an interest in room inspection for bridges and search and rescue operations, after an earthquake for example. All the applications, where GPS is not available, basically, because this allows us to focus on computer vision and visual control tools.

3
Narrator: If the Mars rovers could talk, what a tale they'd tell of their dusty, bumpy journey. Finally we hear from them.
I'm Jane Platt with NASA's Jet Propulsion Laboratory in Pasadena, California.
For the past six years, we've marveled at all the diverse pictures from Mars, beamed back by Spirit and Opportunity. You've heard scientists and engineers waxing poetic about the rovers. But you've never heard the rovers themselves speak -- until now.
Audio clip of rover Spirit
Narrator: OK, so that's not exactly Spirit talking. The rovers have no onboard microphone. But that is audio the engineers made from an instrument on the rovers -- in this case, from Spirit. A motion sensor, called an accelerometer, measures bumps and vibrations in the rocky Martian road as the rovers roam around. The sensor's data were converted to audio files. The original purpose to help determine whether Spirit had bumped into a rock. A familiar concept to us.
Belluta: Actually, you're driving your car, and all of a sudden you hear a funny noise, a funny sound, and from the type of sound, you can have a hint of the type of trouble that your car might have.
Narrator: Rover driver Paolo Bellutta of JPL. They do have software to analyze the data from the rover's accelerometer, but Bellutta says they figured, why not try using our good ol' human ears.
Bellutta: On compact discs, the sound is encoded in numbers, so I followed the same principle. I took the numbers from the accelerometer and generated a file that has the same format as a compact disc and then converted to an mp3, the file format that we all use in our iPods and other devices.
Narrator: The audio frequency was super-low, much too low for us Earthlings to hear. So engineers sped things up about a thousand times, so we could hear it. OK, so this audio clip was made from sensor data in 2005, when Spirit was exploring "Husband Hill."

UNIT 5

Navigation Services - Global Positioning System

GPS, or Global Positioning System, is a system that helps an individual to determine where he is located as well as where other things are located. GPS has become incredibly popular over the years with even more mobile devices available. However, GPS in aviation has been around longer. As long ago as 1978 GPS was being experimented with and a satellite was sent into space to test the technology. That has been almost 30 years ago and today GPS is in many people's cars! Nevertheless, aviation was one of the first industries to become involved with GPS because location and speed are very important in the field of aviation.
The United States Department of Defense handles GPS, but allows the public to use it for free. The GPS in an airplane basically has a map of the route from the original location to the destination. Information is programmed into the GPS and it helps for autopilot and things of that nature. It also tells the pilot where they are headed, how far away they are from the destination, as well as the height of the plane. GPS is invaluable to pilots and it is very helpful.
One popular option is the Garmin aviation GPS. This GPS system is designed specifically for the use in aircraft. Not all GPS systems will work in an aircraft like they would in a car, so buying a specialized aircraft GPS is important. An aviation headset is still important even with the use of the GPS because you will need to communicate with the tower not to mention you will need to protect your hearing.
Of course, GPS has been around since the '70s, but it has not been fully operational in aircrafts that long. It was not until the mid 1990s that GPS became fully functional with 24 satellites and aviation accepted the new technology and put it to work. Since the mid 1990s the GPS system has become incredibly important for pilots and all airplanes are now outfitted with this device. It helps pilots stay on course and if something happens the system lets them know how to get back on the right path. GPS isn't just important for pilots, but also for every day drivers. And, although GPS has been around for quite some time it is just gaining popularity and understanding with the general public.

Aircraft Navigation Technology

Early pilots looked out of their open cockpits for roads, rail lines, and airports to find their way in daytime flight. Pilots watched the horizon to make sure they were flying with the aircraft's nose and wings in the proper position relative to the ground, called attitude. As airmail pilots began flying at night and in all kinds of weather in the early 1920s, new equipment helped pilots navigate and maintain aircraft attitude when they could not see the ground. Navigation aids were developed for use inside the aircraft and also to guide the pilots from the ground.

Simple equipment to help pilots maintain attitude was introduced during the 1920s. These devices included such ideas as a bubble of liquid to help keep wings level and a device that measured pressure at different heights, called an altimeter that told a pilot his altitude above ground level. A simple magnetic compass for direction was installed either in the cockpit panel or held in the pilot's hand.

In 1929, Lawrence Sperry and his Gyroscope Company introduced important new technology—the Artificial Horizon—that operated on gyroscopic principles.

In the 1930s, new mechanical aids emerged, some based on Sperry's gyroscope and others based on the rush of air through intakes under the wing or the aircraft belly to measure speed and altitude.

Navigation information was displayed on a group of instruments called the basic or primary six, which included the attitude indicator, a vertical speed indicator showing the rate of climb and descent, airspeed indicator, turn-and-bank coordinator, a heading indicator showing the magnetic compass course, and the altimeter. These instruments are still used.

Refined versions of Sperry's invention appear in 2001 as the Inertial Navigation System (INS) and the Inertial Guidance System (IGS). These systems measure changes in the aircraft's location and attitude that have taken place since the aircraft left the ground. These new devices include an accelerometer to detect changes in airspeed as well as attitude.

Radio navigation aids were developed around the same time as mechanical aids. In 1926, successful two-way radio air-to-ground communication began, and the first transmitter/receiver went into mass production in 1928.

The earliest radio navigation aid was the four-course radio range, which began in 1929. Four towers set in a square transmitted the letters A and N in Morse code. A pilot flying along one of the four beams toward the square would hear only an A or N in the dashes and dots of the code.

The first radio-equipped airport control tower was built in Cleveland, Ohio, in 1930, with a range of 15 miles (24 kilometers). By 1935, about 20 more towers had been erected. Based on pilot radio reports, a controller would follow each plane with written notes on a position map. The controller would clear an aircraft for takeoff or landing, but the pilot still could decide on the best path for himself.

UNIT 6

Aircraft Navigation Technology

Until World War II, radio navigation relied on low frequencies similar to those of an AM radio. Devices such as the automatic direction finder and the non-directional beacon, like the 1920s system before them, used Morse code, and the detection of weaker to stronger volume let a pilot know if he was on course. After the war, higher frequency transmitters, called the very high frequency omni-directional radio range or VOR, further refined the early concept of allowing pilots to fly inbound or outbound along a certain quadrant on a line called a radial. These transmitter locations, their frequencies and identifying Morse codes are all printed on navigation charts. The various radio-based systems are sufficient for navigating between airports but are called non-precision aids because they are not accurate enough and do not provide enough information to allow a pilot to land.

Today's aircraft are tracked as computer-generated icons wandering across radar display screens, with their positions, altitude, and airspeed updated every few seconds. Pilots and controllers communicate using both voice and data transmitting radios, with controllers relying on radar tracking to keep aircraft on course. Today, cockpit navigation information is increasingly

displayed on a monitor, but the position of information and its format are nearly identical to the basic six instruments of early and simpler aircraft.

New technologies, though, have led to a debate as to whether the federal government, using fixed electronic stations, or the pilots should control navigation like in the earliest days. The global positioning system (GPS) is one technology that allows pilots to accurately determine their position anywhere on the Earth within seconds, raising the question whether they need any help from the ground.

GPS is becoming the primary means of navigation worldwide. The system is based on satellites in a continuous grid surrounding the Earth, each equipped with an atomic clock set to Greenwich, England, called ZULU time. The GPS units in the aircraft, or even in a pilot's hand, find the nearest two satellite signals in a process called acquisition. The time it takes for the signals to travel creates a precise triangle between the two satellites and the aircraft, telling the pilot his latitude and longitude to within one meter or a little more than one yard. In coming years, this system will be made even more precise using a GPS ground unit at runway ends.

Despite these advances, pilots can still crash because they get lost or lose track of hazards at night or in bad weather. On December 29, 1970, the Occupational Safety and Health Act came into effect. It requires most civilian aircraft to carry an emergency locater transmitter (ELT). The ELT becomes active when a pilot tunes to an emergency radio frequency or activates automatically when the aircraft exceeds a certain force in landing, called the g-force, during a crash. This form of navigation aid, which transmits signals to satellites overhead, saves lives of injured pilots and crew who are unable to call for help themselves.

REFERENCES

1. Angelo J. A. Robot spacecraft/ Joseph A. Angelo. – New York, 2007 – 321p.
2. Azar B.Sh. Understanding and Using English Grammar, Third Edition / Betty Betty Schrampfer Azar. – New Jersey, 1992. – 357 p.
3. Bennett G.I., Austin M. S. Innovative Economics Limited/ Graceann I. Bennett, Manila S. Austin. Communispace "Tech", 2009. – 63 p.
4. Eisenbach I. English for Materials Science and Engineering: Exercises, Grammar, Case Studies/Iris Eisenbach. - Springer Fachmedien Wiesbaden GmbH, 2011. – 118 p.
5. Dunn W. C. Introduction to instrumentation, sensors, and process control/ William C. Dunn. – Artech house Inc., 2006 – 348 p.
6. Fraden J. Handbook of Modern Sensors Physics, Designs, and Applications/ Jacob Fraden. – Springer, 2010 – 489 p.
7. Gerson S. Writing That Works: A Teacher's Guide to Technical Writing/ Steven M. Gerson. – Kansas Curriculum Center Washburn University, 2008. – 101 p.
8. Hofmann D., Tarbeyev Y.V. Theoretical, physical and metrological problems of further development of measurement techniques and instrumentation in science and technology/ D.Hofmann, Y.V. Tarbeyev. – Acta Imeko, Volume 3, Number 1, 2014. – p. 23-31
9. Hydzik T. Microelectromechanical Systems Advanced Materials and Fabrication Materials/ Travis Hydzik. – Washington, D.C.: National Academy Press, 1997 – 48 p.
10. Lide D. R., Wood G. H. The Story of the ICSU Committee on Data for Science and Technology/ David R. Lide, Gordon H. Wood. – CODATA, 2010. – 82 p.
11. Lide D. R., Wood G. H. Technology / David R. Lide, Gordon H. Wood. – CODATA: France, 2012 – 68 p.

12. Marks J. Check your English Vocabulary for Computers and Information Technology. Third Edition / Jon Marks. – London: A&C Black, 2007. – 88 p.
13. Powell M. In Company/ Mark Powell. – Macmillan: Macmillan Publeshers Limited, 2002. – 142 p.
14. Shrampfer Azar. – NY: Pearson Education, 2002. – 567 p.
15. Thompson A., Taylor B. Guide for the Use of the International System of Units (SI)/ Ambler Thompson, Barry N. Taylor. – U.S. Government Printing Office, 2008. – 76 p.
16. Wilson J. S. Sensor Technology Handbook/ Jon S. Wilson. – Gardners Books, 2005 – 689 p.
17. Abstract writing. [Електронний ресурс] – Режим доступу:– http://4writers.net/blog.
18. Actuators, sensors, transducers. [Електронний ресурс] – Режим доступу:– http://www.wisegeek.org.
19. Airplane safety. [Електронний ресурс] – Режим доступу:– http://www.boeing.com.
20. Aviation's Crazy, Mixed Up Units of Measure. [Електронний ресурс] – Режим доступу:– http://www.aerosavvy.com.
21. Aviation safety. [Електронний ресурс] – Режим доступу:– http://www.aviation-safety-bureau.com.
22. Gerund and infinitive. http://englishstandarts.blogspot.ru.
23. Grace Murray Hopper. [Електронний ресурс] – Режим доступу:– http://biography.yourdictionary.com
24. History Flight Safety Foundation. [Електронний ресурс] – Режим доступу:– http://everything.explained.today.
25. How to conduct an interview. [Електронний ресурс] – Режим доступу:– http://stringers.media.mit.edu.
26. Hydra-Electric Company. [Електронний ресурс] – Режим доступу:– http://www.hydraelectric.com.

27. Interview. [Електронний ресурс] – Режим доступу: – http://www.public.asu.edu.
28. Living in a Sensored World. [Електронний ресурс] – Режим доступу:– http://www.te.com.
29. Mahr metrology. [Електронний ресурс] – Режим доступу:– http://www.millimess.com.
30. Occupational Outlook Quarterly. [Електронний ресурс] – Режим доступу:– www.bls.gov.
31. Podcast. [Електронний ресурс] – Режим доступу:– http://www.astronomycast.com.
32. Podcasts audio script. [Електронний ресурс] – Режим доступу:– http://www.cmpod.net.
33. Proposal writing. [Електронний ресурс] – Режим доступу:– http://project-proposal.casual.pm.
34. Rear Admiral Grace Murray Hopper. [Електронний ресурс] – Режим доступу:– http://biography.yourdictionary.com.
35. Sensors. [Електронний ресурс] – Режим доступу:– https://www.elprocus.com.
36. Sensors application. [Електронний ресурс] – Режим доступу:– http://www.nsf.gov.
37. Sensors classification. [Електронний ресурс] – Режим доступу:– http://www.differencebetween.info.
38. Sensor selection criteria. [Електронний ресурс] – Режим доступу:– http://www.maxbotix.com.
39. Smart technology. [Електронний ресурс] – Режим доступу:– http://thesmarthut.com.
40. Trancducers. [Електронний ресурс] – Режим доступу:– http://www.electronicshub.org.
41. Technical specification writing. [Електронний ресурс] – Режим доступу:– http://www.writeawriting.com.

42. Types of sensors. [Електронний ресурс] – Режим доступу:– http://www.ehow.com.