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«Томский государственный университет систем управления и радиоэлектроники»

КАФЕДРА ИНОСТРАННЫХ ЯЗЫКОВ

ENGLISH FOR GRADUATE STUDENTS

Themes Book 1

АНГЛИЙСКИЙ ЯЗЫК ДЛЯ СТУДЕНТОВ МАГИСТРАТУРЫ

Учебное пособие
(часть 1)

ТОМСК 2015

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Contents

Theme 1. EARNING A DEGREE

Reading, Vocabulary and Listening objectives: basic scientific language, learning and research activities, graduate degree program ***Speaking and Writing objectives:*** tell and write about own learning scientific experience ***Recommended Grammar:*** Present Simple and present Continuous

Lead-in

You are going to read the text about Master's degree programme in University of Birmingham. Do you know anything about Masters' training abroad?

Reading and Vocabulary

Task 1. a. Read the words and phrases from the first text and tick the ones which you know. Clear up the meaning of unknown ones.

interactive digital media	embedded digital signal	innovation
media compression	processing	seamless
embedded system	communications network	sophisticated
spoken language processing	industrial studies	enhanced
image interpretation	individual project	advance
3D environment	be designed to	linkage
communications	equip	requirement
engineering	research	qualify
advanced digital design	development	secure

b. Which of the subjects or activities in the first column do you do in your study?

Task 2.Read the first paragraph and tell about 2 types of Master's degree programs which are provided by this university.

Task 3.Read the whole text and complete the table after the text with the information about the University of Birmingham.

University of Birmingham

Electronic and Computer Engineering Masters/MSc with Industrial Studies

Electronics is at the heart of a wide range of business and entertainment systems and is vital to the growth of the global economy. This programme is designed to equip you with the knowledge and skills you will need to play a leading part in the future research, development and application of these technologies. This variant of our standard MSc in Electronic and Computer Engineering includes an industrial placement module, providing an opportunity for you to develop ideas for your individual project.

Key facts

Type of Course: Taught, continuing professional development

Duration: 18 months full-time

Start date: September/October 2012

Entry requirements

At least *an upper second-class Honours degree (диплом специалиста или бакалавра со средним баллом не ниже 4*. from a university of high international standing

International students

We accept a range of qualifications from different countries

English language requirements: TOEFL (paper-based) 580, (computer-based) 230, (Internet-based) 92, IELTS 6.5

Programme Overview

Electronics is at the heart of a wide range of business and entertainment systems. The integration of computing and communications with interactive digital media is evident in many modern innovations that are creating a revolution in business and the life of individuals.

These systems are vital to the growth of the global economy; reducing costs, improving quality and providing ever more sophisticated services. All aspects of business, from research and development to production, marketing and sales, benefit from rapid advances in such technology. Our social lives, entertainment and education are also enhanced by continuing advances in personal electronic systems, media compression and seamless connectivity using communications systems.

This degree programme is designed to equip you with the knowledge and skills you will need to play a leading part in the future research, development and application of these technologies.

You have a wide possible range of module choices in this degree programme. The linkage between modules is minimized so that students are free to create a personalized study package. Thus topics from embedded systems, spoken language processing, image interpretation and 3D environments for virtual reality and serious games, and some aspects of communications engineering can be combined in one degree programme.

In addition to the modules taken as part of a standard MSc programme, the with Industrial Studies programme includes an industrial placement module. This provides an opportunity for you to develop ideas for your individual project on a topic related to the interests of the host company. The placement takes place during the summer, following the sessional examinations. After the industrial placement you return to the University to begin an individual project.

To qualify for this degree you must meet the standard requirements for an MSc, obtain and pass an industrial placement. To obtain a placement students must pass the January examinations at the first attempt and be selected by a company. Selection for a placement involves interviews with companies, which are arranged by the School from our extensive network of industrial contacts. The University will provide training in the preparation of a CV, and in interview technique but cannot guarantee a placement. Students, who do not meet the requirements for a degree with industrial studies, including those who are unable to secure a placement, will revert to a standard degree programme.

Compulsory Modules	**Semester**
Introductory Module for Computing	1
Advanced Digital Design	1
Embedded Digital Signal Processing	2
Individual Project	3

Cross Programme Options (Take one of the following)	**Semester**
Advanced Interactive 3D Environments for Virtual Reality & Serious Games	2
Small Embedded Systems	2
Computer and Communications Networks	2

№	Questions	University of Birmingham	Your university
1.	What is the name of a degree programme?		
2.	How long is the course?		
3.	What are the entry requirements?		
4.	If you are a foreigner, what else do you need?		
5.	What subjects will you study?		
6.	How is the professional development carried out?		
7.	What do you need to do to get a placement?		

Task 4.Complete the column for your university and compare with your partner.

Task 5.Find the words or phrases in the text that correspond to the following Russian ones:

1. сессия
2. цифровые носители информации
3. широкий спектр
4. программа магистратуры
5. производственная практика
6. требования для поступления
7. пройти зачисление
8. выигрывать
9. постоянный прогресс
10. высокий международный статус

Specialized Reading

Task 6.Read the text and say which degree you are doing: Master of Engineering or Master of Science in Engineering.

Master of engineering versus master of science

1. When deciding between the Master of Engineering versus Master of Science in Engineering degrees, the choice boils down to what an individual really wants from the future. Both of these graduate programs provide a distinct path to multiple career opportunities, but a few differences separate them. As a basic rule of thumb, the Master of Science degree includes more research based work, and the Master of Engineering degree includes more coursework.

2. After graduating with that well earned bachelor's degree in engineering, many students look to graduate school as a prerequisite to the optimum job out there. Some graduates pursue a master's after a few years in the field while others continue right after receiving their undergraduate degree. For the students who have either of these degree in mind, they may have questions over the difference between them. The differences are not plenteous, but they are important for students who have a firm grasp on their career goals. As graduates focus on certain goals they aim to accomplish in life and learn more about the degree programs, they will have a clearer understanding of which is proper for them.

Master of science in engineering

3. A plethora of colleges offer The Master of Science in Engineering program in many different areas of technical study. A Master of Science in Engineering degree can have an area of focus in a wide range of fields, including electrical engineering, mechanical engineering, and engineering management. This type of degree usually emphasizes research and requires a thesis for completion, making it the optimum degree for graduates who wish to pursue a Doctorate of Philosophy (Ph.D.) after completing the master's program.

4. Requirements for this degree usually encompass 30 semester hours past the Bachelor of Science level. The thesis is worth anywhere from 4 to 8 credit hours depending on the college, and it must be original research. Some colleges will require that a master's student undergo a comprehensive examination. This degree is widely accepted by employers and easily recognized in all fields.

Master of engineering

5. Many universities offer a Master of Engineering for students who hold a bachelor's degree in engineering. The Master of Engineering program is aimed at equipping students with technical preparation for fieldwork practice. Students in this program spend more time in actual coursework than research, so this degree does not prepare students well for a Ph.D. program. However, most employers accept a Master of Engineering as easily as a Master of Science in Engineering.

6. This degree usually requires 30 semester hours of coursework, and certain colleges require a capstone paper based on an engineering project to be presented before graduation. Some Master of Engineering programs offer credit for internships, and many require a comprehensive examination. This degree does not include a

thesis, so it can normally be completed in less time than a Master of Science in Engineering.

7. Students who wish to continue education past the master's level should earn the Master of Science in Engineering, and students who want to be a step above the rest in the workplace will find a satisfying path with the Master of Engineering degree. In consider the Master of Engineering versus Master of Science, the choice basically comes down to whether a student wishes to pursue a Ph.D. or research career in engineering or an engineering career devoted to fieldwork.

Task 7.Are the following sentences true (T) or false (F) or you can't say for sure?

1. There are lots of differences between Master of Science program and Master of Engineering program.
2. All students do Master's Degree just after Bachelor's Degree.
3. Master of Science does not include any coursework.
4. To do Master of Science degree you need to accomplish Bachelor of Science degree.
5. After Master of Engineering you can't do a PhD program.
6. After both programs you have to take a comprehensive examination.
7. Master of Science program can take longer than Master of Engineering program.
8. You have to present a kind of diploma work at the end of both programs.

Task 8.What are Russian equivalents for the following words and phrases?

Master of Engineering, Master of Science in engineering, a graduate, a graduate school, a prerequisite, to pursue, an undergraduate, plentiful, electrical engineering, mechanical engineering, engineering management, to encompass, to undergo, original research, to recognize, a field, to equip with, actual, PhD, an employer, to complete, to earn, workplace, to devote, to earn a degree

Task 9.Match the following terms with their Russian equivalents.

1. coursework	a. кандидатский минимум
2. comprehensive examinations	b. единица учебной нагрузки, определенное количество которых необходимо набрать для получения зачета
3. fieldwork	c. производственная практика; преддипломная практика; стажировка
4. internship	d. совокупность работа, требуемых от студента в течение курса обучения; процесс обучения
5. capstone paper	e. диссертация; дипломная работа
6. credit hour	f. работа на местах
7. thesis	g. итоговая работа, включающая результаты использования знаний в процессе производственной практики

Task 10. Match the verbs in box A with the nouns in box B to make phrases and translate them.

A
do, include, receive, earn, pursue, hold, accomplish, accept, offer, complete

B
coursework, research work, a degree, a program, a thesis, the aim

Task 11. Find synonyms to the following words and phrases in the text.

1.many (para 1)	5. real (para 5)
2. to achieve (para 2)	6. usually (para 6)
3. to give importance to (para 3)	7. sensible (para 7)
4. authentic (para 4)	8. dedicated to (para 7)

Task 12. Match the following colloquial phrases with their Russian equivalents and use them in your own sentences.

1.to boil down to smth	a. быть на голову выше кого-либо
2.as a basic rule of thumb	b. сводиться к чему-либо
3.to have a firm grasp	c. рассматривая что-либо против чего-либо
4.to be a step above smb	d. в качестве общего правила
5.in consider smth versus smth	e. хорошо представлять себе

Task 13. Complete the table with the words from the text according to their pronunciation.

1. /ˈemfəsʌɪz/		7. /kəˈrɪə/	
2. /ɔpəˈtjuːnɪti/		8. /ˈθiːsɪs/	
3. /ˈbætʃələ/		9. /pəˈsjuː/	
4. /ɪmˈplɔɪə/		10. /əkˈsept/	
5. /ˈkɔːswəːk/		11. /ɪˈkwɪp/	
6. /əːn/		12. /ˈɪntəːnʃɪp/	

Recommended function

Study

<u>**Function 1 "HOW TO translate an English sentence".**</u>

Listening

Junaid Merchant shares his experience as a graduate student in the Master of Science in Experimental Psychology programme in *Setan Hall Universityin Carolina, the USA.*

Task 14. a. Check you know these words.

design, original research, develop, scientist, advance, rat lab, teaching experience, opportunity, benefit, stuff, accomplish, innovation, professor, faculty, fears, experiment, conferences, thesis project, carry out, sophisticated, government services, expectations, support, motivating, conduct, animal, post-traumatic stress, resources, questions, publications, energizing, PhD programme, gain, empowering

b. Listen and watch the video and underline the words in the box that you will hear.

Task 15. Answer the questions on the video.

1. Why did he decide to do a Master's program in Setan Hall?
2. What is he expected to produce in the end of his study?
3. What does the program require from him to do?
4. What does he research?
5. What makes him feel he is a scientist?
6. What does he learn in a rat lab?
7. What does he think about his teaching experience?
8. What sort of future does he imagine?

Task 16. Decode one of the 4 parts of the listening text:

Part 1 – 00.07 "I decided to …" – 00.42 "… to accomplish what I want to do."
Part 2 – 00.42 "The programme requires …" – 01.11 "... I feel I am a scientist."
Part 3 – 01.12 "I also work …" – 02.00 "… to pursue teaching more."
Part 4 – 02.01 "Ten years from now …" – 02.18 "… the rest of my life."

Speaking

Task 17. Prepare a talk about your studies. Use these questions to help you:

1. Why did you decide to do a Master's program in TUSUR?
2. What did you have to do to get a placement?
3. What do you have to do in your study?
4. What do you expect to produce in the end of your study?
5. What does the program require from you to do?
6. What do you research?
7. What subjects do you have to learn?
8. What do you learn in your labs?
9. Do you have to teach?
10. What sort of future do you imagine?

Writing

Study

Function 9 "HOW TO make a simple translation into English"

and write a short paragraph about your studies. Use the following phrases in your text:

to be designed to/for	to be free to do smth
to equip smb with the knowledge and skills	to provide an opportunity for you to do smth
to develop ideas	a topic related to smth
rapid advances in technology	to meet the requirements
continuing advances in smth	to pass examinations at the first attempt
to play a leading part in	to provide training
a wide range of choices	to guarantee a placement
to be vital to smth	to secure a placement

Theme 2. MOST FAMOUS

Reading, Vocabulary and Listening objectives: different sciences, professional and personal life of a famous scientist, a discovery or invention
Speaking and Writing objectives: telling about a famous scientist and his discovery or invention
Recommended Grammar: Past Simple and Present Perfect

Lead-in

Who are the most famous scientists in your sphere of study? What do you know about them?

Reading and Vocabulary

Task 1.a. This is essential vocabulary from the first text. Make sure you know the words and phrases.

number theory	sum	a constant
arithmetic series	integer	a magnitude
regular polygon	straightedge	an angle
natural number	compass	a plane
triangular number	heptagon	a mid-plane
parallel postulate	heptadecagon	an equation
non-Euclidean geometry	polynomial	an argument
differential geometry	prime	curvature
conformal map	congruence	circle
method of least squares	treatise	theorem
fitting	surveying	an area

b. Check the pronunciation:

mathematician
geometry
geodesy
geophysics
astronomy
analysis
integer
heptadecagon
straightedge
compass
theorem
observation
plagiarism
treatise
successful
curvature

c) Explain the following terms:

integer	heptagon	heptadecagon
straightedge	compass	regular polygon
polynomial	natural number	prime
triangular number	magnetometer	curvature

Task 2.Read the text quickly and list the most important achievements of Carl Gauss.

Carl Gauss

He was a talented child, at the age of three informing his father of an arithmetical error in a complicated payroll calculation and stating the correct answer. In school, when his teacher gave the problem of summing the integers from 1 to 100 (an arithmetic series) to his students to keep them busy, a. … . At the age of 19, Gauss demonstrated a method for constructing a heptadecagon using only a straightedge and compass. (The explicit construction of the heptadecagon was accomplished around 1825 by Erchinger.) Gauss also showed that only regular polygons of a certain number of sides could be made in that manner (b. … .)

Gauss proved the fundamental theorem of algebra, c. … . In fact, he gave four different proofs, the first of which appeared in his dissertation. In 1801, he proved the fundamental theorem of arithmetic, d. … .

At the age of 24, Gauss published one of the most brilliant achievements in Mathematics, *Disquisitiones Arithmeticae* (1801). In it, Gauss systematized the study of number theory (properties of the integers). e. … .

In 1801, Gauss developed the method of least squares fitting, 10 years before Legendre, but did not publish it. The method enabled him to calculate the orbit of the asteroid Ceres, which had been discovered by Plazzi from only three observations. However, after his independent discovery, Legendre accused Gauss of plagiarism. Gauss published his monumental treatise on celestial mechanics *Theoria Motus* in 1806. He became interested in the compass through surveying and developed the magnetometer and f. … . With Weber, he also built the first successful telegraph.

Gauss arrived at important results on the parallel postulate, but failed to publish them. Credit for the discovery of non-Euclidean geometry therefore went to Janos Bolyai and Lobachevsky. However, he did publish his seminal work on differential geometry in *Disquisitiones circa superticies curvas.* g. … . He also discovered the Cauchy integral theorem

$$\oint_\gamma f(z)\,dz = 0.$$

for analytic functions, but did not publish it. Gauss solved the general problem of making a conformal map of one surface onto another.

Unfortunately for mathematics, Gauss reworked and improved papers all the time, therefore publishing only a fraction of his work, in keeping his motto “**pauca sed matura**” (few but ripe). Many of his results were later repeated by others, since his brief diary remained unpublished for years after his death. This diary was only 19 pages long, but later confirmed his priority on many results he had not published. Gauss wanted a heptadecagon placed on his gravestone, but the carver refused saying

h. … . The heptadecagon appears, however, as the shape of a pedestal with a statue built in his honor in his home town of Braunschweig.

Task 3.Insert these sentences into the text.

1. … which states that every polynomial has a root of the form a+bi.
2. … which states that every natural number can be represented as the product of primes in only one way.
3. … it would look like a circle.
4. … Gauss immediately wrote down the correct answer 5050.
5. Gauss Proved that every number is the sum of at most three triangular numbers and developed the algebra of congruencies.
6. … with William Weber measured the intensity of magnetic forces.
7. … a heptagon, for example, could not be constructed.
8. The Gaussian curvature (or “second” curvature) is named for him.

Task 4.Are the following sentences true (T) or false (F)?

1. Gauss became interested in mathematics when he started school.
2. In his dissertation he proved the fundamental theorem of algebra.
3. Gauss developed the method of least squares fitting and accused Legendre in plagiarism when he published his findings.
4. His interest in compass and magnetic field helped him develop the telegraph.
5. Gauss didn’t publish his results on the parallel postulate, so he didn’t get any credits in geometry.
6. Gauss made a lot of discoveries before other scientists but didn’t want to publish them because he thought they were not completed.

Task 5.There were some sciences in the text mentioned. What are the people working in these fields called? Complete the table.

Fields	People
mathematics	
physics	
astronomy	
optics	
chemistry	
biology	
geography	
ecology	

Task 6.Read and translate the text.

GAUSS'S LAW

1. Introduction

The electric field of a given charge distribution can in principle be calculated using Coulomb's law. But the actual calculations can become quite complicated.

2. Gauss's Law

An alternative method to calculate the electric field of a given charge distribution relies on a theorem called Gauss's law. Gauss' law states that

"If the volume within an arbitrary closed mathematical surface holds a net electric charge Q, then the electric flux Φ[Phi] through its surface is Q/ε[epsilon]$_0$"

Gauss's law can be written in the following form:

$$\Phi = \frac{Q}{\varepsilon_0}$$

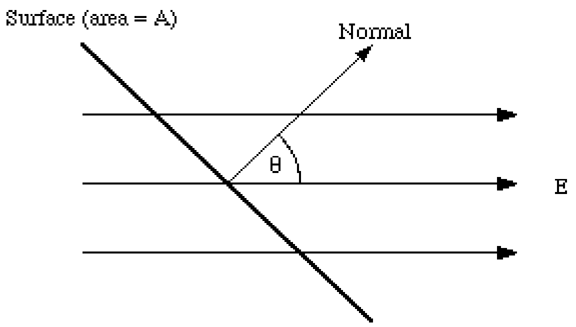


Figure 1. Electric flux through surface area A.

The electric flux Φ [Phi] through a surface is defined as the product of the area A and the magnitude of the normal component of the electric field E:

$$\Phi = E\,A\cos(\theta)$$

Where θ [theta] is the angle between the electric field and the normal of the surface (see Fig. 1). To apply Gauss' law one has to obtain the flux through a closed surface. This flux can be obtained by integrating the second equation over all the area of the surface. The convention used to define the flux as positive or negative is that the angle θ [theta] is measured with respect to the perpendicular erected on the outside of the closed surface: field lines leaving the volume make a positive contribution, and field lines entering the volume make a negative contribution.

Example 1: Field of point charge.

The field generated by a point charge q is spherical symmetric, and its magnitude will depend only on the distance r from the point charge. The direction of the field is along the surface (see Fig. 2). Consider a spherical surface centered around the point charge q (see Fig. 2). The direction of the electric field at any point on its surface is perpendicular to the surface and its magnitude is constant. This implies that the electric flux Φ [Phi] through this surface is given by

$$\Phi = \int_S \bar{E} \cdot d\bar{s} = 4\pi r^2 E$$

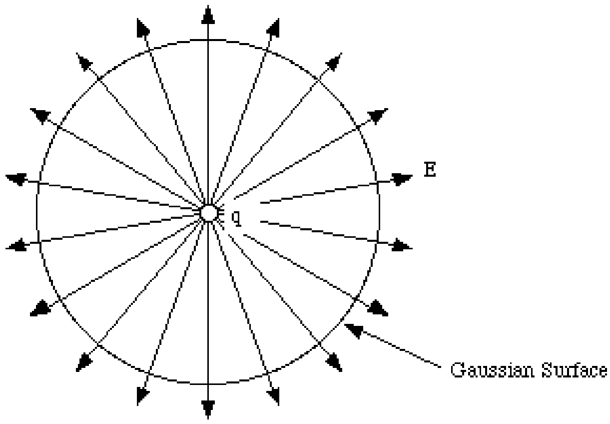


Figure 2. Electric field generated by point charge q.

Using Gauss's law we obtain the following expression

$$\Phi = 4\pi r^2 E = \frac{q}{\varepsilon_0}$$

or

$$E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$$

which is Coulomb's law.

Example 2: Problem 16

Charge is uniformly distributed over the volume of a large slab of plastic of thickness d. The charge density is ρ [rho] C/m^3. The mid-plane of the slab is the y-z plane (see Fig. 3). What is the electric filed at a distance x from the mid-plane?

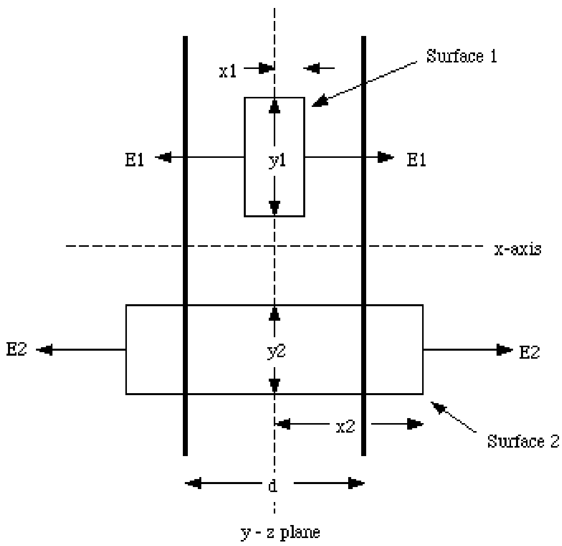


Figure 3. Problem 16.

As a result of the symmetry of the slab, the direction of the electric field will be along the x-axis (at every point). To calculate the electric field at any given point, we need to consider two separate cases: $- d/2 < x < d/2$ and $x > d/2$ or $x < -d/2$. Consider surface 1 shown in Fig. 3. The flux through this surface is equal to the flux through the planes at $x = x_1$ and $x = - x_1$. Symmetry arguments show that

$$\bar{E}(x = x_1) = - \bar{E}(x = - x_1)$$

The flux Φ [Phi]$_1$ through surface 1 is therefore given by

$$\Phi_1 = 2 A_1 E(x = x_1) = 2 y_1 z_1 E(x = x_1)$$

The amount of charge enclosed by surface 1 is given by

$$Q_1 = 2 x_1 y_1 z_1 \rho$$

Applying Gauss' law to these equations we obtain

$$2 y_1 z_1 E(x = x_1) = \frac{2 x_1 y_1 z_1 \rho}{\varepsilon_0}$$

or

$$E(x = x_1) = \frac{\rho x_1}{\varepsilon_0}$$

Note: this formula is only correct for $- d/2 < x_1 < d/2$.

The flux Φ [Phi]$_2$ through surface 2 is given by

$$\Phi_2 = 2 A_2 E(x = x_2) = 2 y_2 z_2 E(x = x_2)$$

The charge enclosed by surface 2 is given by

$$Q_2 = d y_2 z_2 \rho$$

This equation shows that the enclosed charge does not depend on x_2. Applying Gauss's law one obtains

$$2 y_2 z_2 E(x = x_2) = \frac{d y_2 z_2 \rho}{\varepsilon_0}$$

or

$$E(x = x_2) = \frac{\rho}{\varepsilon_0} \frac{d}{2}$$

3. Conductors in Electric Fields

A large number of electrons in a conductor are free to move. The so called free electrons are the cause of the different behavior of conductors and insulators in an external electric filed. The free electrons in a conductor will move under the influence of the external electric field (in a direction opposite to the direction of the electric field). The movement of the free electrons will produce an excess of electrons (negative charge) on one side of the conductor, leaving a deficit of electrons (positive charge) on the other side. This charge distribution will also produce an electric field and the actual electric field inside the conductor can be found by superposition of the external electric field and the induced electric field, produced by the induced charge distribution. When static equilibrium is reached, the net electric field inside the conductor is exactly zero. This implies that the charge density inside the conductor is zero. If the electric field inside the conductor would not be exactly zero the free electrons would continue to move and the charge distribution would not be in static equilibrium. The electric field on the surface of the conductor is perpendicular to its surface. If this would not be the case, the free electrons would move along the surface, and the charge distribution would not be in equilibrium. The redistribution of the free electrons in the conductor under the influence of an external electric field, and the cancellation of the external electric field inside the conductor is being used to shield sensitive instruments from external electric fields.

The strength of the electric field on the surface of a conductor can be found by applying Gauss' law (see Fig. 4). The electric flux through the surface shown in Fig. 4 is given by

$$\Phi = A E$$

where A is the area of the top of the surface shown in Fig. 4. The flux through the bottom of the surface shown in Fig. 4 is zero since the electric field inside a conductor is equal to zero. Note that this equation is only valid close to the conductor where the electric field is perpendicular to the surface. The charge enclosed by the surface shown in Fig. 4 is equal to

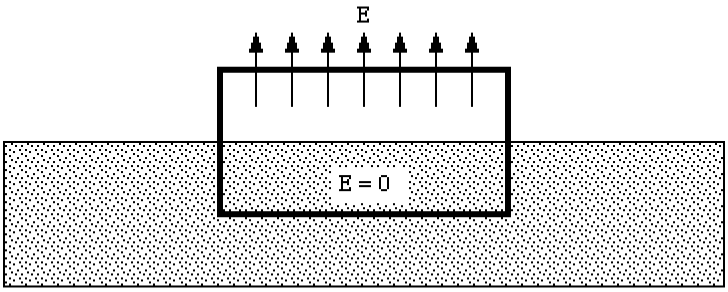


Figure 4. Electric field of conductor.

$$Q = A \sigma$$

where σ [sigma] is the surface charge density of the conductor. This equation is correct if the charge density σ [sigma] does not vary significantly over the area A (this condition can always be met by reducing the size of the surface being considered). Applying Gauss' law we obtain

$$\Phi = A E = \frac{Q}{\varepsilon_0} = \frac{A \sigma}{\varepsilon_0}$$

Thus, the electric field at the surface of the conductor is given by

$$E = \frac{\sigma}{\varepsilon_0}$$

Task 7.Answer the questions on the text.

1. What does Gauss's Law state?
2. What does the first example show?
3. What does the second example show?
4. What happens in the conductor in the electric field?

Task 8.Put these words into the groups: nouns, adjective and adverbs, and translate them.

complicated, a charge, normal, arbitrary, surface, magnitude, angle, flux, area, perpendicular, spherical, constant, uniformly, plane, density, thickness, mid-plane, argument, enclosed, equation, behavior, external, excess, distribution, induced, bottom, valid, significantly

Task 9.How do you pronounce these symbols and what do they mean?

Symbol	Pronunciation	Meaning
Φ		
ε		
θ		
π		
ρ		
σ		

Task 10. Underline the stressed syllables in the following words. Check that you know their meaning.

distribution, calculations, complicated, mathematical, magnitude, a component, convention, measured, perpendicular, contribution, spherical, a direction, following, uniformly, symmetry, to consider, to separate, an argument, behavior, a conductor, an insulator, influence, an electron, deficit, equilibrium, redistribution, cancellation, an instrument, significantly

Task 11. Write the words from the text to the following transcriptions.

1 ./'æksɪs/		9./ɪ'kweɪʒ(ə)n/	
2. /'æktʃʊəl/		10./'veəri/	
3./'æŋg(ə)l/		11./'ækses/	
4./'θɪərəm/		12./kən'sɪdə/	
5./'ɔpəzɪt/		13./ʃi:ld/	
6./'vɔlju:m/		14./streŋθ/	
7./'ku:ləm/		15./kləʊzd/	
8./'sə:fɪs/		16./ɪk'stə:n(ə)l/	

Task 12. Translate these phrases:

1. … relies on a theorem …
2. Gauss's law states …
3. … one has to obtain …
4. Consider a spherical surface…
5. This implies that …
6. Applying Gauss's law one obtains…
7. Note that …

Recommended function

Study

<u>Function 10 "HOW TO say numbers and formulas</u>"

and say all the formulas in the text.

Listening

You will watch a video about **Coulomb's Law.** Do you know what it says?

Task 13. What are English equivalents to the following words and phrases?

электрический заряд	постоянная
электрическая сила	величина, значение
положительный заряд	вещество
отрицательный заряд	стрелочка
нейтральный заряд	расстояние
одноименный заряд	знак (+, -)
разноименный заряд	ноль
притягиваться	числитель
отталкиваться	знаменатель
сильный	произведение
слабый	удваивать

Task 14. Underline the stressed syllables in these words.

object, distance, Coulombic, constant, electrically, neutral, representation, repel, attract, interact, quantity, multiplied, attractive, denominator, fraction, quadruple, inverse, permittivity, approximately.

Task 15. Pronounce all the formulas from the video.

Task 16. Decode one of the parts:

Part 1 – 00.28 "Matter can be …" – 01.12 "… with electrically charged objects."
Part 2 – 01.13 "The closer two charges …" – 02.41 "… also get multiplied."
Part 3 – 01.58 "Let's say …" – 02.41 "… the force between them is zero."
Part 4 – 02.41 "So, multiplying the charges…" – 03.23 "… distances are very important."

Recommended function and Speaking

Study

<u>Function 5 "HOW TO talk about cause and effect"</u>

and prepare a talk about a scientist and a **l**aw or a discovery he made. Include some formulas. Use most of these phrases in your talk.

… contributed significantly to …	rely on …
one of the most brilliant achievements in …	depend on …
… enabled him/her to …	seminal work on …
arrived at important results on …	can be obtained by …
can be written in the following form	with respect to …
solved the general problem of …	this implies that …
which sates …	can be found by applying …
fundamental treatise on …	If this is not the case …

Writing

Write down **10 formulas** which you deal with in your study or work in symbols and comment on them in words.

Theme 3. INSIDE A COMPONENT

> ***Reading, Vocabulary and Listening objectives:*** different electric components and improvements into them
> ***Speaking and Wring objectives:*** telling about a component and latest improvements into it, describing a process inside a component
> ***Recommended Grammar:*** Present Simple and Past Simple Passive

Lead-in

Work with your partner and tell what components you associate these things with. What do you know about them?

a)electron gun
b)dopant
c)saturation
d)actuator
e)forward biased
f)p-type region
g)refractive index
h)bandgap
i)dot pitch
j)tunnel barrier
k)magnetic deflection
l)gain
m)electro luminescence
n)pole
o)phosphor coating
p)wavelength
q)conduction band
r)organic semiconductor
s)electric arc

Reading and Vocabulary

Task 1.a. Check you know these words and phrases from the first text.

tunnel barrier	mismatch (n)	rely on (v)
oxide barrier	quantum (n)	passivate (v), passivated (adj)
tunnel (v, n)	defect resistant	float (v)
spintronics (n)	refractive index	preserve (v)
implication (n)	magnetic deflection	alloy (n)
spin current	electron population	permalloy (n)
ferromagnetic	dot pitch	dopant (n)
inject (v), injection (n)	spin-filtering effect	saturate (v), saturation (n)
size scaling	hurdle (v)	plane (n)
advance (v, n)		

b. Give definitions to the following terms:

tunnel barrier, oxide barrier, refractive index, magnetic deflection, saturation.

Task 2.Match the parts of the text with the headings. There is an extra heading which you don't need to use.

a. Beyond Moore's Law
b. The spintronics challenge
c. Low-energy switching
d. Enter the graphene tunnel barrier

Graphene tunnel barrier makes its debut

Researchers in the US have found yet another use for the "wonder material" graphene. Instead of exploiting the material's exceptional ability as an electrical conductor, the team has found a way to use graphene as an extremely thin "tunnel barrier" to conduction. The team says that this new application is particularly suited to developing spintronics – a relatively new technology that exploits the spin of an electron as well as its charge.

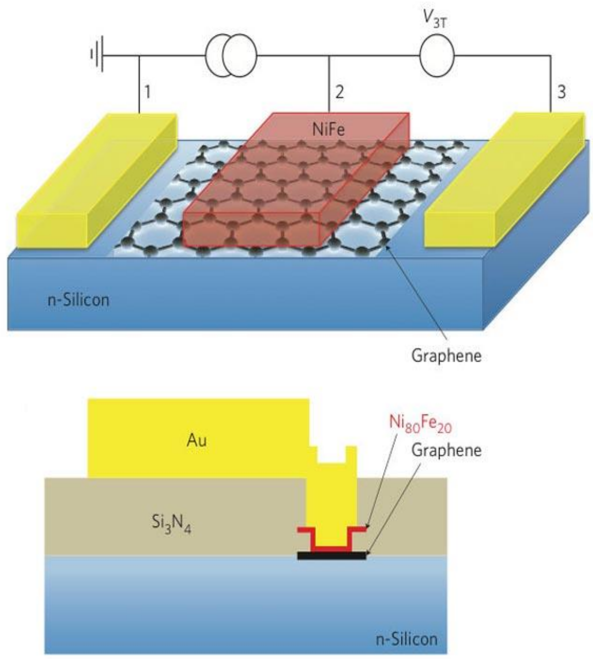
Graphene is a sheet of carbon just one atom thick and ever since the material was first isolated in 2004, researchers have been trying to create electronics devices that make use of its unique properties. Most of this effort has focused on how electrons flow in the plane of the sheet – which can behave both as a conductor and semiconductor. But now Berry Jonker and colleagues at the US Naval Research Laboratory (NRL) have shown that graphene can serve as an excellent tunnel barrier when current is directed perpendicular to the plane of carbon atoms. The spin polarization of the current is also preserved by the tunnel barrier, a finding that could have important implications for spintronics.

I

The spin of an electron can point in an "up" or "down" direction and this property could be used to store and process information in spintronics devices. Circuits that employ a spin current – electrons with opposite spins moving in opposite directions – could, in principle, be smaller and more efficient than conventional electronic circuits that rely on switching charge alone. This is because switching spins from up to down can be done using very little energy.

Spintronics devices are typically made from ferromagnetic materials and semiconductors. Ferromagnetic metals, such as iron or permalloy, have intrinsically spin-polarized electron populations – that is, different numbers of up-spin and down-spin electrons – and thus make ideal contacts for injecting spins into a semiconductor. However, ferromagnets and semiconductors have a large conductivity mismatch, so spin is injected via a tunnel barrier – an electrically insulating barrier through which electrons tunnel quantum mechanically. The problem is that the oxide barriers normally employed as tunnel barriers introduce defects into the system and have resistances that are too high – factors that adversely affect device performance.

II



Diagrams show how graphene is used as a tunnel barrier in a spintronic device. The top image shows a layer of graphene serving as a tunnel barrier between the ferromagnetic metal contact and the silicon substrate. Contacts 1 and 3 are ohmic Ti/Au contacts. The bottom image shows that the contact is designed so that the edges of the graphene are embedded in the SiN insulator, preventing conduction through the graphene edge states, which would short out the tunnel barrier.

To overcome this problem, Jonker and colleagues decided to employ single-layer graphene as the tunnel barrier, because the material is defect resistant, chemically inert and stable. These properties can be exploited to make low-resistance graphene spin contacts that are compatible with both the ferromagnetic metal and semiconductor.

The researchers began by mechanically transferring graphene grown by chemical vapour deposition onto hydrogen-passivated silicon surfaces. They achieved this by floating the graphene on the surface of water and bringing the silicon substrate up from below. This common technique ensures that there is no oxide layer between the silicon surface and the graphene. The team then injected electron spins from a ferromagnetic nickel–iron alloy into the silicon via the graphene tunnel barrier. The voltage arising from the resulting spin polarization in the silicon was then measured using the Hanle effect, a method that is routinely employed by spintronics scientists.

III

"Our discovery clears an important hurdle to the development of future semiconductor spintronics devices – that is, devices that rely on manipulating the electron's spin rather than just its charge for low-power, high-speed information processing beyond the traditional size scaling of Moore's law," Jonker says. "These results identify a new route to making low-resistance-area spin-polarized contacts, which are key for semiconductor spintronics devices that rely on two-terminal magnetoresistance, including spin-based transistors, logic and memory."

Using graphene in spintronics structures may provide much higher values of the tunnel spin polarization thanks to so-called spin-filtering effects that have been predicted for selected ferromagnetic metal/graphene structures. Such an increase would improve the performance of semiconductor spintronics devices by providing higher signal-to-noise ratios and corresponding operating speeds, so advancing the technological applications of silicon spintronics.

Task 3.Choose the best sentence (A or B) to interpret the sentences.

1. … Ever since the material was first isolated in 2004, researchers have been trying to create electronics devices that make use of its unique properties.
   a. The researchers started creating electronics devices that use the properties of graphene in 2004.
   b. The researchers started creating electronics devices using carbon nanotubes before 2004, when graphene was first isolated.

2. The problem is that the oxide barriers normally employed as tunnel barriers introduce defects into the system and have resistances that are too high – factors that adversely affect device performance.
   a. Tunnel barriers made from oxides have some serious disadvantages like introducing defects into the system and high resistances which have bad effects on the effectiveness of the device.
   b. Oxide barriers badly affect the resistances and performance of the device.

3. Using graphene in spintronics structures may provide much higher values of the tunnel spin polarization thanks to so-called spin-filtering effects that have been predicted for selected ferromagnetic metal/graphene structures.
   a. Spin-filtering effects of selected ferromagnetic metal/graphene structures had been unknown but appeared to provide much higher values of the tunnel spin polarization.
   b. Due to spin-filtering effects of some ferromagnetic metal/graphene structures, which were supposed by some physicists, the tunnel spin polarization of devices has much higher values.

Task 4.Answer the questions on the text.

1. Why did researchers decide to use graphene as the material for tunnel barriers?
2. What advantages does the spin of an electron give to the device?
3. What are pluses and minuses of ferromagnets and semiconductors in spintronics devices?
4. What future do the researchers envision for their finding?
5. Put these stages of employing graphene into transistors:
   a. graphene is floated on the surface of water;
   b. voltage from spin polarization in the silicon is measured;
   c. silicon substrate is brought up from below the graphene;
   d. graphene is grown by chemical vapour deposition;
   e. electron spins are injected into the silicon via graphene tunnel barrier.

Task 5.Find synonyms to the following words:

1. to use (intro)
2. one-of-the-kind (intro)
3. to maintain (intro)
4. to feed into (part 1)
5. negatively (part 1)
6. damage (part 1)
7. to place (part 2)
8. to guarantee (part 2)
9. ordinarily (part 2)
10. out of bounds (part 3)
11. approach (part 3)

Task 6.Match the parts from A and B to make phrases from the text.

1. tunnel spin	a. electron populations
2. spin-polarized	b. deposition
3. low-resistance graphene	c. electrons
4. single-layer	d. polarization
5. down-spin	e. ratio
6. signal-to-noise	f. graphene
7. chemical vapor	g. spin contacts
8. hydrogen-passivated	h. nickel-iron alloy
9. ferromagnetic	i. silicon surfaces

Specialized reading

Task 7.Read and translate the text.

New Route to Electronics Inside Optical Fibers

1.In a step toward simpler, faster telecommunication systems, researchers at Penn State University and the University of Southampton, in England, have embedded high-performance electronic devices within optical fibers. Their technique involves depositing semiconductors inside ultrathin holes in the fiber. **1. …**

2.In modern telecom systems, light pulses blaze down hair-thin glass fibers carrying 40 gigabits of data per second. On either end of the fiber are semiconductor devices—lasers that create the light sent into the fiber, modulators that encode signals onto the light, and photodetectors that turn the light pulses back into electrical signals that can be routed to TVs, telephones, and computers. This setup requires coupling light from the micrometers-wide fiber core with the even narrower light-guiding structures on a semiconductor chip—an extremely difficult thing to do, says John Badding, a chemistry professor at Penn State.

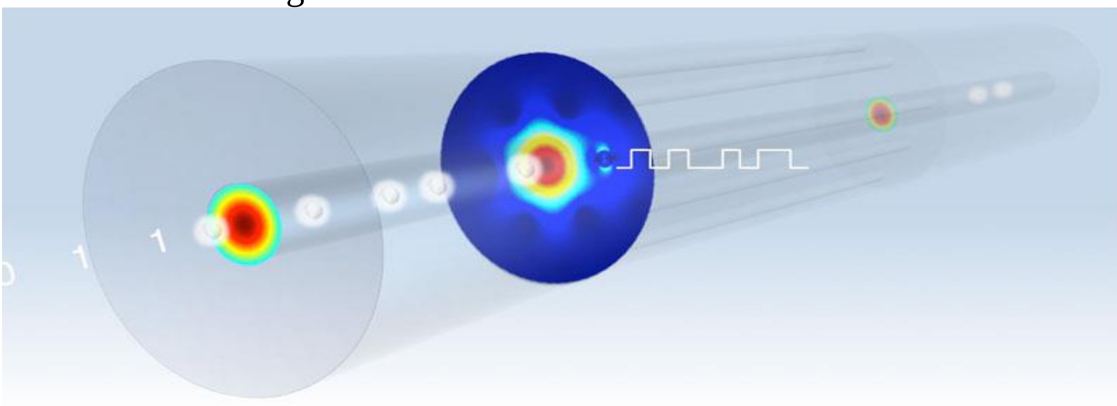
3.Integrating devices in the fiber would eliminate the need for such coupling, Badding says. "This is going to enable 'all-fiber optoelectronics,' a vision where you can do all the light processing for telecom or other applications in the fiber," he says.

4.It's a vision shared by other researchers. "Marrying electronics and optics inside the same structure would streamline fiber-optic systems, making them more efficient", says John Ballato, a materials science and engineering professor at Clemson University, in South Carolina. "Until 40 years ago, a fiber was pretty much a dumb window," Ballato says. "Now we're at the level of functionality and intelligence. If you can preprocess some of the information inside the fiber by adding brains to it, you can make the external electronics simpler, easier, and maybe even faster.”

5.Fiber-optic tools for spectroscopy, laser surgery, and remote sensing could all benefit from the advance, adds Badding’s colleague Pier Sazio, an optoelectronics researcher at the University of Southampton.

6.The researchers start with photonic-crystal fibers. **2. …** They pump a gas that contains chemical precursors of electronic materials—silicon, germanium, or platinum—into selected channels at high pressure while other channels are blocked with glue. Heating the fiber produces a thin, ring-shaped layer of crystalline material that coats the inside of the channels.

7.The researchers add a bit of boron or phosphorus gas to the precursor in order to make the p-type and n-type semiconductors required for most devices. By depositing semiconductor and platinum layers one at a time inside the same channels, they create concentric rings of material that act as circular diodes.



Signals: *A photodetector embedded in an optical fiber converts pulses of light in the core of the fiber into electricity.*

8.In a paper posted online this week in the journal Nature Photonics, the researchers reported metal-semiconductor junctions, called Schottky diodes. **3. …** “Right now, the researchers detect the electrical signals in a “primitive way,” Badding says, “by simply putting electrodes in contact with the platinum at the ends of the fiber. You would ultimately want to do it in a more refined fashion.”

9.Researchers at MIT were the first to create devices inside of a fiber, but they did so using a different method: they drew out fiber from a thick cylinder embedded with semiconductor wires. **4. …** The Penn State approach, meanwhile, yields only meters of fiber but “seems to have very nice chemical control with doping,” he says. “What’s particularly nice is they’re using the inside of a hollow fiber as a substrate chip almost to build these things up. So they inherently have a nice smooth surface. It’s thin, and it’s flexible.”

10.Another advantage of the Penn State scheme is that Badding and his colleagues can use many different materials and dope them to precise levels, which is something that has not been proved yet using MIT’s method. In addition to silicon, germanium, and platinum, the group has been able to deposit compound semiconductors such as zinc selenide, which is used in blue laser diodes and light-emitting diodes, as well as in infrared lasers and detectors. And they're working on embedding still other materials and refining the devices.

Task 8.Insert the following sentences into the text.

a. The diodes function as photodetectors, converting light pulses in the fiber into electrical signals.
b. Using this scheme, they built a detector that converts optical data into electrical signals at frequencies as high as 3 gigahertz.
c. These are fibers that contain arrays of nanometer-scale hollow channels running along their length.
d. Ballato's group at Clemson takes a similar approach: their method produces kilometers of fiber but is limited in the kinds of semiconductors that can be used.

Task 9.Answer the questions on the text.

1. What devices have been embedded within optical fibers?
2. How would these combinations improve fiber-optic systems?
3. What spheres of science would particularly benefit from intelligent fiber-optic systems?
4. How is the process of making photodetectors inside the fiber carried out at the Southampton University?
5. What method has been used by the researchers at MIT and Clemson?

Task 10. a. Translate the words from the text.

deposit, blaze, coupling, light-guiding structure, eliminate, vision, streamline, intelligence, spectroscopy, laser surgery, remote sensing, photonic-crystal fiber, precursor, concentric ring, circular diode, ultimately, refined, draw out, yield, doping, hollow, inherently, refine, embed

b. Which words are verbs, nouns, adjectives, adverbs?

Task 11. Match the parts of phrases from the text.

A	B
1.benefit from	a. selected channels
2. pump into	b. into electrical signals
3. put electrodes in contact	c. to precise level
4. embed devices within	d. the advance
5. dope materials	e. per second
6. work on	f. embedding and refining the devices
7. turn the light pulses back	g. with the platinum
8. carry some amount of data	h. optical fibers

Task 12. Find synonyms and opposites to the following words and phrases.

Synonyms

1. a method (para 1)
2. connection (para 3)
3. a dream (para 3)
4. to combine (para 4)
5. to modernize (para 4)
6. to cover (para 6)
7. finally (para 8)
8. a manner (para 8)
9. especially (para 9)
10. intrinsically (para 9)

Opposites

1. wide (para 2)
2. to lose (para 5)
3. full (para 9)
4. different (para 9)
5. inaccurate (para 10)
6. to make worse (para 10)

Task 13. Write out hyphenated compound adjectives from the text into the relevant column in the table.

noun+adjective	**noun, adj., adv.+Part.I**	**noun, adj.+noun(ed)**	**noun, number, pron., etc.+noun**
e.g.: meter-long	e.g.: long-lasting	e.g.: blue-eyed	e.g.: p-type
…	…	…	…

Task 14. Report the sentences in Direct Speech from the text into Reported Speech.

1. "This is going to enable 'all-fiber optoelectronics,' a vision where you can do all the light processing for telecom or other applications in the fiber," he said.
2. "Until 40 years ago, a fiber was pretty much a dumb window," Ballato said.
3. "What's particularly nice is they're using the inside of a hollow fiber as a substrate chip almost to build these things up," said Ballato.

Task 15. What are the words from the text?

1./spek'trɔskəpi/		8./prɪ'kə:sə/	
2./maɪ'krɔmɪtə/		9./'ʌltɪmətli/	
3./ə'reɪ/		10./ski:m/	
4./'faɪbə/		11./ji:ld/	
5./'saɪəns/		12./'kemɪk(ə)l/	
6./gaɪd/		13./smu:ð/	
7./zɪŋk/		14./'daɪəʊd/	

Recommended function

Read

<u>**Function 13 "HOW TO comment on a visual aid"**</u>

and prepare a comment on the diagrams from two texts in this Module.

Listening

You are going to watch a video about **Ferroelectric memory.**

Task 16. Match the following terms with their definitions.

1. ferroelectric material	a. diverting an electrical current from one state to another
2. electric polarization	b. computer memory that can retain stored information even when not powered
3. non-volatile memory	c. a dielectric which, in a certain temperature range, has its own spontaneous electric dipole moment
4. switching	d. the vector field that expresses the density of permanent or induced electric dipole moments in a dielectric material

Task 17. Watch the video and underline the words you hear.

electrical field, theoretical prediction, electroresistance, longterm stability, microscope, switching, permittivity, pyroelectric material, bias, simulation, phenomenon, thermistor, tip, thin film, transition temperature, piezoelectric, electrode, nanoscale

Task 18. Answer the questions on the video.

1. What does professor Xiaoqing Pan tell about in this video?
2. How does the process of switching occur in the materials?
3. Where are these materials especially important?

Task 19. Report on the following questions of the editor and write the answers of the professor in Reported Speech.

1. Can you explain what ferroelectric material is?
2. What do you still not understand about ferroelectric memory?
3. Did your model have different behavior from what you predicted?
4. What does all of that mean for making very small ferroelectric memory?

Task 20. Complete the text with the words from the box.

piezoelectric materials, charge polarization, storage capacity, electricity, magnetic computer drives, nanometer scale, switching, capacitors and thermistors, lead titanate, operating systems

Ferroelectric materials are materials that possess a natural 1. … that can be reversed by an external electric field, known as the process of 2. … . The property of ferroelectricity has been known since 1921 and, as of 2011, over 250 compounds have been shown to display such characteristics. Research has focused on 3. … , PbTiO3, and related compounds. Of the ferroelectric materials studied as of 2011, all have been shown to be 4. … . This means that if mechanical pressure or other forms of energetic stress from audio or light energy are applied to such compounds, they will generate 5. … .

The applications of ferroelectricity span a wide spectrum of electronics devices, from circuit components like 6. … to devices with electro-optics or ultrasound capabilities. One of the most actively researched arenas for ferroelectric materials is that of computer memory. Engineering the materials at a 7. … produces what is known as vortex nanodomains that don't require an electric field to switch polarization. Several state university systems in the United States working together through 2011 with the Lawrence Berkeley National Laboratory are perfecting the material, which would require much less electrical power than traditional 8. … do. It would also be a solid state form of data memory that functions much faster and with greater 9. … than the flash memory currently on the market, with the potential to one day store entire 10. … and software, making computer start up and processing speeds much greater.

Task 21. Decode one of the following parts.

Part 1 - 00.39 "So, I guess, to start off, I was wondering …" – 01.16 "… non-volatile memory devices."

Part 2 - 01.17 "What would you say, you still …" – 02.02 "… we can design better memory."

Part 3 - 02.03 "Maybe we can start …" – 03.52 "… switch between 0 and 1."

Part 4 - 03.53 "Was this surprising to see?" – 04.35 "… the creation of the ferroelectric switching."

Part 5 - 04.36 "What does all of this mean…" – 05.22 "… who design future memories."

Speaking

Prepare a talk about **some new achievement in designing a component**. Include a comment of a visual aid – a diagram, a picture or a graph.

Writing

Study

Function 14 "HOW TO describe a process"

and write how some process proceeds inside a component.

Theme 4. PHOTONIC DEVICES

Reading, Vocabulary and Listening objectives: photonic and opto-electronic devices
Speaking and Writing objectives: telling about a photonic or opto-electronic device, describing the process inside it
Recommended Grammar: Present Simple and Past Simple Passive

Task 1.Lead in and Reading

Can you answer the following questions?

1. What is photonics?
2. And why is it called "photonics"?
3. Why should we do research on photonic systems?
4. How does it work?
5. And is it useful?

Task 2.Read the text and match these questions with the paragraph. Check your answers with the text.

What are Photonic Systems?

A. Photonics is the use of light to obtain, convey or process information. "Light" here includes infrared and ultraviolet radiation, as well as the light that is visible to our eyes.

B. Everyone knows of the widespread prevalence of electronics in modern life (for example, in our televisions, mobile phones and computers) - but relatively few people are aware of the increasing use of photonics. In fact, probably without realizing, many of us already use photonics in our everyday lives. It is found in compact disc and DVD players, office printers, supermarket checkouts, as well as in hospitals and numerous other places. Most important of all, photonics is the underlying technology supporting today's worldwide telecommunications networks and the Internet. Increasingly photonics is also being used in the most powerful computers.

C. In photonic systems, information signals are conveyed as pulses of light, rather than electricity, and these optical signals are transmitted by sending them along optical fibres - strands of special glass around 100 μm in diameter (about the thickness of a human hair). One of the great advantages of photonics is that these fibres can carry thousands of times more information than electrical wires. Photonic devices are used to convert electrical signals into optical signals and back again where necessary, when they enter and leave the fibres. Photonic devices are also beginning to be used to manipulate and 'process' optical signals directly, without the need for conversion. Photonic devices can be fabricated from a wide variety of materials, including semiconductors (which are already well known for their use in making electronic devices), and even optical fibres themselves.

D. In recent years there have been important advances in research labs around the world to develop increasingly sophisticated ways of using these photonic devices in systems for telecommunications, computing, security, and many other applications.

By using photonics, these systems can work more effectively - with much greater speed or information capacity - or might simply be smaller and easier to make. These advantages - as well as the growing numbers of practical applications - make photonics an important field both for research and commercial development. Photonic systems research is a truly cross-disciplinary activity, involving physics, electrical engineering, computer science and other fields of science.

E. The flow of electricity in a wire consists of the combined movement of tiny fundamental particles of charge, called "electrons". The devices and systems used to generate and manipulate electrical signals are widely known as "electronics". Albert Einstein and other scientists working at the beginning of the 20th century, showed that light consists of a different kind of tiny fundamental particles, called "photons". And so the word "photonics" has been coined to describe devices and systems used to generate and manipulate optical signals.

Task 3.Look through the text again and decide if the statements are True or False.

1. Photonic devices are really new type of devices which only appeared in our life some years ago.
2. Greatest benefits from photonics can be obtained by communications networks and Internet.
3. Optical fibers can’t carry as much information as electric wires.
4. Photonic devices can be made mostly from semiconductors.
5. Photonic systems have a lot of advantages over electronic systems.

Vocabulary

Task 4.a. What do these words and phrases mean?

convey (v)	discrete device	bandwidth (n)
process (v, n)	align (v)	attenuate (v),
visible (adj)	packaging (n)	attenuation (n)
prevail (v), prevalence (n)	viable (adj)	afford (v), affordable (adj)
underlying technology	unify (v)	ubiquitous (adj)
increasingly (adv)	impact (v, n)	counterpart (n)
convert (v), conversion (n)	functional (adj),	monolithic integration
manipulate (v), manipulation (n)	functionality (n)	assemble (v)
capacity (n)	value-added (adj)	coupling (n)
cross-disciplinary activity	ill-suited (adj)	integrated circuit
fundamental particle	intrinsic (adj)	
	wavelength (n)	
	waveguide (n)	

b. Give definitions to the following terms from the text:

- infrared radiation
- optical signal
- ultraviolet radiation
- optical fiber
- telecommunications network
- information capacity
- photonic system
- photon

Task 5.Which words in A can't be used with the words in B?

	A	B
1.	to convey, to collect, to fabricate, to obtain, to transmit, to process	information
2.	telecommunications, optical, global, visible, local area, photonic	network
3.	to process, to convert, to develop, to manipulate, to amplify, to send	signal
4.	photonic, electrical, digital, optical, visual, resulting, analogue	signal

Task 6.Find synonyms to the following words in the text.

1. to receive (para A)
2. common (para B)
3. a lot of (para B)
4. more and more (para B)
5. to transmit (para C)
6. a thread (para C)
7. to transform (para C)
8. success (para D)
9. complex (para D)
10. to think up (para E)

Specialized Reading

Task 7.Read and translate the text. What do these phrases mean?

photonic integrated circuit, optical component, hybrid integration, monolithic integration, optical coupling, sub-micron tolerance, thermal characteristics, packaging consolidation, reduction in space, value-added photonic integration, disparate functions, band-gap, telecom window, arrayed waveguide gratings, high-yield batch manufacturing process, optical transport system, wavelength multiplexing, variable optical attenuation, dispersion compensation, system-on-a-chip, multi-wavelength optical transport network, economic threshold, digital optical network, traffic management flexibility, engineering simplicity, bandwidth stability, on-chip waveguide, OEO conversion

Task 8.Answer the questions on the text.

1. What is a Photonic Integrated Circuit?
2. What is a hybrid PIC? What are its advantages and disadvantages?
3. What is a monolithic PIC? What its advantages and disadvantages?
4. What materials are used for the substrate of a PIC?
5. Which material is the best? Why?
6. What is OEO conversion? Why is it important?

<u>Photonic Integrated Circuit</u>

A Photonic Integrated Circuit (PIC) is conceptually very similar to an electronic IC. While the latter integrates many transistors, capacitors and resistors, a PIC integrates multiple optical components such as lasers, modulators, detectors, attenuators, multiplexers/de-multiplexers and optical amplifiers. Large-scale PICs, like their electronic counterparts, extend the scope of integration so that upwards of dozens or more distinct optical components are integrated into a single device.

As in electronics, photonic integration can include both hybrid and monolithic integration. In a hybrid PIC, multiple single-function optical devices are assembled into a single package, sometimes with associated electronic ICs, and inter-connected to each other by electronic and/or optical couplings internal to the package. Many integrated photonic devices available today utilize hybrid integration to consolidate packaging. However, the assembly of hybrid integrated components can be highly complex, as many discrete devices must be interconnected internal to the package with sub-micron tolerances required for aligning optical components. Adding to the packaging challenge is the fact that different materials may require different packaging designs due to differences in optical, mechanical and thermal characteristics, which has limited hybrid PICs to integrating at most three to four optical components into a common package.

In contrast, monolithic integration consolidates many devices and/or functions into a single photonic material. As in electronic ICs, the fabrication of monolithic PICs involves building devices into a common substrate so that all photonic couplings occur within the substrate and all functions are consolidated into a single, physically unique device. Monolithic integration provides the greatest level of benefits, including significant packaging consolidation, testing simplification, reduction in fiber couplings, improved reliability and maximum possible reduction in space and power consumption per device.

The next challenge to achieving viable value-added photonic integration then becomes the choice of the substrate material used. Today, optical components are built using many materials including Indium Phosphide (InP), Gallium Arsenide (GaAs), Lithium Niobate (LiNbO3), Silicon (Si), and Silica-on-Silicon. Photonic integration derives its value from the ability to unify as many disparate functions into a single material platform, and thereby deliver maximum impact on system cost and functionality.

Lithium Niobate offers little practical promise as a material platform for integration since it cannot be used to practically implement active opto-electronic components like lasers and detectors. In addition, complex processing requirements make it economically ill-suited to large-scale photonic integration.

Although active opto-electronic devices can be implemented in Gallium Arsenide, the intrinsic band-gap of GaAs generally only allows operation in the 850nm telecom window, limiting its usefulness to local area network applications and curtailing its use in wide-area telecom networks.

More recently, Silicon has shown promise as a materials platform for the large-scale integration of passive optical devices such as arrayed waveguide gratings (AWGs), optical switches and VOAs. In addition, silicon photonic integrated circuits can be built using standard CMOS processes and therefore hold promise for enabling both optical and electronic integration.

To date, only Indium Phosphide has demonstrated the ability to marry the reliable integration of both active and passive optical devices operating in the

1310nm or 1550nm telecom windows with the capability of cost-effective mass production using standard high-yield, batch semiconductor manufacturing processes. Since InP supports light generation, amplification, modulation and detection, it enables all the key high-value opto-electronic functions required in an optical transport to be integrated on a single substrate, and maximizes potential cost reduction in optical transport systems.

Passive optical functions such as wavelength multiplexing, de-multiplexing, variable optical attenuation, switching and dispersion compensation can also be implemented in InP. Since devices can be monolithically interconnected by “on-chip” waveguides, InP-based PICs enable the fabrication of an optical “system-on-a-chip” that can provide substantial benefits versus the use of discrete devices.

A fundamental benefit of monolithic InP photonic integrated circuits is their ability to enable affordable OEO conversion in multi-wavelength optical transport networks. By removing the cost penalty traditionally imposed to access and manipulate bandwidth in the electronic domain, system designers can now embrace the use of OEO conversions as a means for affordably implementing the feature-richness and functionality provided by electronic ICs and the digital signal processing they enable. The use of PICs fundamentally changes the economic threshold for implementing ubiquitous OEO conversion across an optical network. This enables the design of a new architecture, a “Digital” Optical Network that combines the traffic management flexibility and engineering simplicity of digital transport systems with the bandwidth scalability of WDM and the affordability of large-scale photonic integration.

Task 9.In the text find the terms that match these definitions.

1. a passive two-terminal electrical component that is used to store energy electrostatically in an electric field;
2. an interaction between two electrical components by electromagnetic induction, electrostatic charge or optical link;
3. an allowable amount of variation of a space quantity in the dimensions of a packaging;
4. a material which provides the surface on which something, for example, integrated circuits, is manufactured;
5. the range of operations that can be run on a computer or other electronic system;
6. a device for making or breaking the connection in an electric circuit;
7. a range of frequencies within a given band in particular that used for transmitting a signal.

Task 10. The text mentions some photonic devices. What are they? Give definitions to them.

For example: **A laser** is a photonic device which emits light through a process of optical amplification based on the stimulated emission of electromagnetic radiation.

Task 11. a. Check the pronunciation of these compounds:

- Indium Phosphide
- Gallium Arsenide
- Lithium Niobate

b. How are these compounds pronounced?

SiGe, AlGaN, GaN, ITO, GaAsP, InGaN, ZnSe, SiC, ZnS, ZnSe

Task 12. Match the words from two columns to make phrases from the text.

1. feature	a. platform
2. passive	b. integration
3. wide-area	c. optical devices
4. substantial	d. telecom network
5. reliable	e. richness
6. single	f. benefit
7. materials	g. design
8. improved	h. device
9. complex	i. processing
10. packaging	j. reliability

Task 13. Which words in B (two in each case) can't be used with the words in A?

	A	B
1.	optical	component, network, signal, coupling, packaging, consolidation, transport, modulation, attenuation
2.	light	amplification, pulse, detection, functionality, generation, detector, display, substrate
3.	packaging	consolidation, detection, design, requirements, challenge, conversion, simplicity
4.	system	photonic, functionality, cost, analysis, integration, effectiveness, coupling, fabrication
5.	fiber	coupling, optics, amplifier, counterpart, efficiency, waveguide, benefit, failure, glass,

Task 14. ***Find the words in the text to match this phonemics.***

1./fə'tɒnik/		8./ˈhʌɪbrɪd/	
2. /ˈθɜːm(ə)l/		9./əˈsəʊʃieɪtɪd/	
3. /kəˈpæsɪtə/		10./ˈdɪsp(ə)rət/	
4. /juːˈniːk/		11./ˈkʌplɪŋ/	
5./ˈvʌɪəb(ə)l/		12./kənˈsʌm(p)ʃn/	
6./dɪˈspɜːʃ(ə)n/		13./dɪˈskriːt/	
7./juːˈbɪkwɪtəs/		14./jiːld/	

Task 15. ***Match the words and phrases in A with their synonyms from the text in B.***

A
available, stand-alone, limit value, inherent, combine, use (v), with additional advantages, unsuitable, strengthen, throw out, extensive, widely used, fit (v), equivalent, influence

B
counterpart, distinct, utilize, consolidate, align, value-added, merry (v), impact (n), ill-suited, intrinsic, curtail, threshold, ubiquitous, affordable, large-scale

Listening

You are going to watch the video about **LEDs.** Before watching the video, answer the following questions:

1. What is a diode?
2. What are the specific characteristics of LEDs?
3. What do you know about OLEDs? Polymer LEDs and Quantum dot LEDs?

Task 16. ***Match the words from two boxes to make phrases. Watch the video and underline the ones which are not used in it.***

A
consumer, production, electrical, conduction, p-type, LED, light, light, pressure and temperature, PC, high-power, refractive, production, wire, manufacturing, electroluminescent, performance

B
capabilities, extraction, light applications, band, semiconducting material, package, output, control, connection, capabilities, board, characteristics, devices, index, bonds, facilities, material

Task 17. ***Are the following statements True or False?***

1. There are many technologies for manufacturing LEDs.
2. All of these technologies are used to create the same colour LEDs.
3. A photon is formed when an electron comes into contact with a hole.
4. The colour of LEDs only depends on the type of material used in the substrate.
5. AlInGaP LEDs and InGaN LEDs have the same material in their substrate.
6. Epi growth is the process of making p-layer and n-layer.
7. In Luxeon LEDs the chip is protected by the silicon inside the package.

8. Luxeon LEDs are supplied separately and customers need to arrange them in arrays by themselves according to their specific needs.

Task 18. Use the appropriate verb forms (singular or plural Passive) from the box to complete the sentences. Check them with the video.

is/are combined, is/are defined, is/are used, is/are connected, is/are recorded, is/are released, is/are forced, is/are created, is/are grown, is/are added, is/are attached

1. Not all LEDs … using the same technologies.
2. AlInGaP technology … to create LEDs in red, orange and yellow spectra.
3. P-type semiconducting material … with n-type semiconducting material.
4. When the current … to the diode, the negatively charged electrons … to move in one direction.
5. The energy of electrons … in the form of a photon.
6. Layers of different materials … on a substrate.
7. After the epi-growth process, LED chips … under wafer.
8. The exact colour and all the electrical characteristics … .
9. A lens … to direct the light.
10. Silicon … to protect the LED chip.

Task 19. Use the verbs from the list in Passive or Active Voice to complete the text.

to dope (2), to create (2), to increase (2)

Doping is a technique used to vary the number of electrons and holes in semiconductors. Doping 1. … N-type material when semiconductor materials from group IV 2. … with group V atoms. P-type materials 3. … when semiconductor materials from group IV 4. … with group III atoms. N-type materials 5. … the conductivity of a semiconductor by increasing the number of available electrons; P-type materials 6. … conductivity by increasing the number of holes present.

Task 20. Decode one of the following parts.

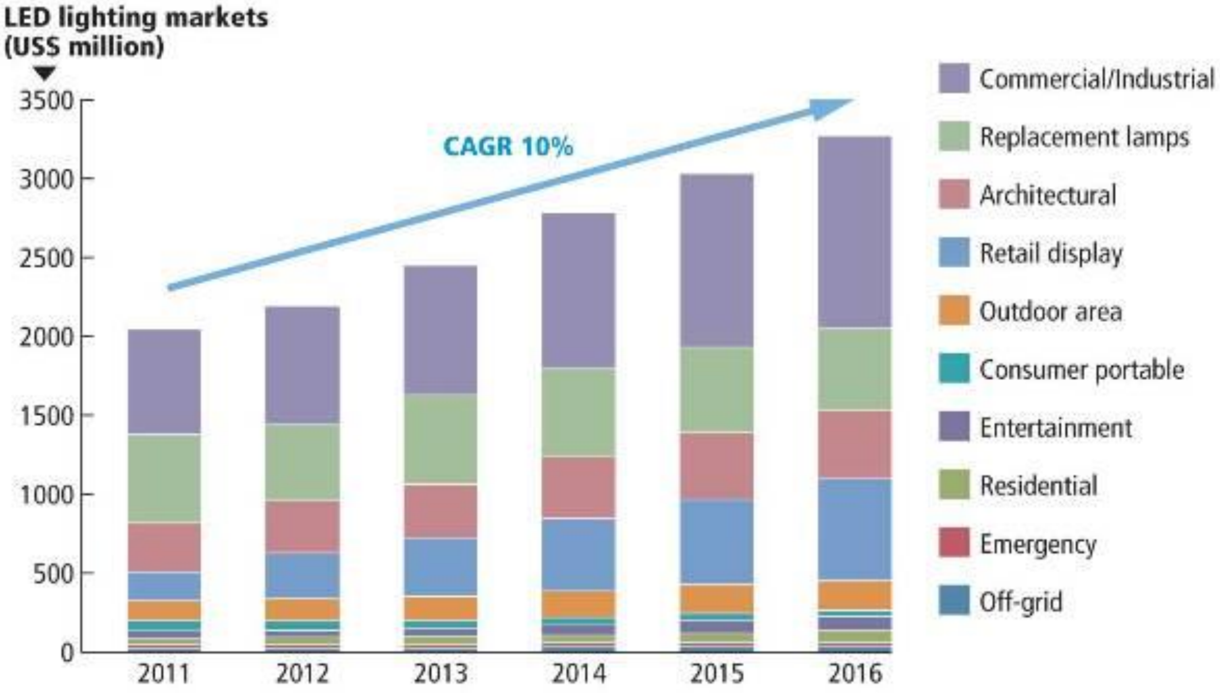
00.30 “Light- emitting diodes or LEDs …” – 01.27 “… around the globe.”
01.28 “There are two technologies …” - 02.10 “… and nitrogen.”
02.10 “In simple terms …” – 03.20 “… in the desired direction.”
03.28 “Producing a Luxeon LED starts with …” – 04.19 “… are recorded.”
04.20 “Finally, the LED is installed …” – 05.01 “… designed for a specific application.”

Recommended function

Read

Function 13 “HOW TO comment a visual aid”

and comment on the following table:



Speaking

Prepare a talk about **some photonic device.** Include the information when it was created, what its structure is, where it is used and how it is manufactured.

Recommended function and Writing

Read

Function 14 "HOW TO describe a process"

and write about some process involved in manufacturing a photonic device.

Theme 5. MICROPROCESSORS

Reading, Vocabulary and Listening objective: how microprocessor works ***Speaking and Writing objective:*** telling about a microprocessor ***Recommended Grammar:*** Reported Speech

Lead-in

Which of these definitions mean **"microprocessor"?** Which of them correspond to the following terms: **processor, IC, chip**?

1. a tiny wafer of semiconducting material used to make an integrated circuit
2. an integrated circuit that contains all the functions of a central processing unit of a computer
3. an electronic circuit formed on a small piece of semiconducting material, which performs the same function as a larger circuit made from discrete components
4. the part of a computer in which operations are controlled and executed

Reading and Vocabulary

Task 1.a. These are the most important words from the text. Make sure you know them.

sliver	awe-inspiring	delight
linear predictive coding	op-amp	propel
alter	monochrome	audio amplifier
emerge	impact	timer
deem	waveform generator	external data bus
support chip	ancestor	FPGA
cutting-edge	earthshaking	speech synthesizer
speech-synthesis chip	image sensor	microcode bug
compatibility	decoder	DRAM
artwork	UART	convey

b. Which of the words and phrases from Task 1are adjectives, verbs, and devices?

Task 2.The text is about 25 unique microchips. Read the beginning of the text and look at the list of them. Can you tell anything about any of them?

25 microchips that shook the world

In microchip design, as in life, small things sometimes add up to big things. Dream up a clever microcircuit, get it sculpted in a sliver of silicon, and your little creation may break free a technological revolution. Among the many great chips that have emerged from fabs during the half-century reign of the integrated circuit, a small group stands out. Their designs proved so cutting-edge, that we can't find any stronger words to describe them. Suffice it to say (достаточно сказать) that they gave us the technology that made our brief, otherwise tedious existence in this universe worth living.

We focused on chips that proved unique, intriguing, and awe-inspiring. We wanted chips of varied types, from both big and small companies, created long ago or more recently. Above all, we made a search for ICs that had an impact on the lives of lots of people--chips that became part of earthshaking gadgets, symbolized technological trends, or simply delighted people.

Signetics NE555 Timer (1971)

Texas Instruments TMC0281 Speech Synthesizer (1978)

If it weren’t for the TMC0281, E.T. would’ve never been able to ”phone home.” That’s because the TMC0281, the first single-chip speech synthesizer, was the heart (or should we say the mouth?) of Texas Instruments’ Speak & Spell learning toy. In the Steven Spielberg movie, the flat-headed alien uses it to build his interplanetary communicator.

The TMC0281 conveyed voice using a technique called linear predictive coding; the sound came out as a combination of buzzing, hissing, and popping. It was a surprising solution for something deemed ”impossible to do in an integrated circuit,” says Gene A. Frantz, one of the four engineers who designed the toy and is still at TI. Variants of the chip were used in Atari arcade games and Chrysler’s K-cars. In 2001, TI sold its speech-synthesis chip line to Sensory, which discontinued it in late 2007. But if you ever need to place a long, very-long-distance phone call, you can find Speak & Spell units in excellent condition on eBay for about US $50.

- MOS Technology 6502 Microprocessor (1975)
- Texas Instruments TMS32010 Digital Signal Processor (1983)
- Microchip Technology PIC 16C84 Microcontroller (1993)
- Fairchild Semiconductor μA741 Op-Amp (1968)
- Intersil ICL8038 Waveform Generator (circa 1983*)
- Western Digital WD1402A UART (1971)
- Acorn Computers ARM1 Processor (1985)
- Kodak KAF-1300 Image Sensor (1986)
- IBM Deep Blue 2 Chess Chip (1997)
- Transmeta Corp. Crusoe Processor (2000)
- Texas Instruments Digital Micromirror Device (1987)
- Intel 8088 Microprocessor (1979)

Was there any one chip that propelled Intel into the Fortune 500? Intel says there was: the 8088. This was the 16-bit CPU that IBM chose for its original PC line, which went on to dominate the desktop computer market.

In an odd twist of fate, the chip that established what would become known as the x86 architecture didn’t have a name added with an ”86.” The 8088 was basically just a slightly modified 8086, Intel’s first 16-bit CPU. The new chip’s main innovation wasn’t exactly a step forward in technical terms: The 8088 processed data in 16-bit words, but it used an 8-bit external data bus.

Intel managers kept the 8088 project under wraps until the 8086 design was mostly complete. ”Management didn’t want to delay the 8086 by even a day by even telling us they had the 8088 variant in mind," says Peter A. Stoll, a lead engineer for the 8086 project who did some work on the 8088--a "one-day task force to fix a microcode bug that took three days."

It was only after the first functional 8086 came out that Intel shipped the 8086 artwork and documentation to a design unit in Haifa, Israel, where two engineers, Rafi Retter and Dany Star, altered the chip to an 8-bit bus.

The modification proved to be one of Intel's best decisions. The 29 000-transistor 8088 CPU required fewer, less expensive support chips than the 8086 and had "full compatibility with 8-bit hardware, while also providing faster processing and a smooth transition to 16-bit processors," as Intel's Robert Noyce and Ted Hoff wrote in a 1981 article for IEEE Micro magazine.

The first PC to use the 8088 was IBM's Model 5150, a monochrome machine that cost US $3000.Now almost all the world's PCs are built around CPUs that can claim the 8088 as an ancestor.

- MP3 Decoder (1997)
- Mostek MK4096 4-Kilobit DRAM (1973)
- Xilinx XC2064 FPGA (1985)
- Zilog Z80 Microprocessor (1976)
- Sun Microsystems SPARC Processor (1987)
- Tripath Technology TDA2020 AudioAmplifier (1998)
- Amati Communications Overture ADSL Chip Set (1994)
- Motorola MC68000 Microprocessor (1979)
- Chips & Technologies AT Chip Set (1985)
- Computer Cowboys Sh-Boom Processor (1988)
- Toshiba NAND Flash Memory (1989)

Task 3.Read Part 2 and 14. Write SS for Speech Synthesizer and IM for Intel Microprocessor next to the following statements.

1. This chip was used in several games and toys.
2. It was a modification of another chip.
3. The construction of this chip started even before the old one went into the market.
4. Two companies fabricated these chips.
5. This chip was initially used in black and white PCs.
6. You can still find these chips on sale, though they are not produced now.
7. This chip showed faster processing power than its predecessor.

Task 4.In the text find the words or phrases to match the following explanations.

1. to be the best or most important in a particular area or domain (intro)
2. a device for connection between planets (part 2)
3. different kinds of noise, made by a device (part 2)
4. a type of computer game played on a coin-operated entertainment machine, usually installed in public businesses, such as restaurants, bars (part 2)
5. an online auction and shopping website in which people and businesses buy and sell a broad variety of goods and services worldwide (part 2)

6. the irony of circumstances (part 14)
7. under seal of secrecy (part 14)
8. engineering company (part 14)
9. great-grandparent (part 14)

Task 5.Give definitions to the following terms:

speech synthesizer, digital signal processor, operational amplifier, microcontroller, waveform generator, image sensor, data bus, support chip, MP3 decoder, audio amplifier, chip set, flash memory

Specialized Reading

Task 6.Read and translate the text.

Microprocessors

1. A microprocessor -- also known as a CPU or central processing unit -- is a complete computation engine that is fabricated on a single chip. The first microprocessor was the Intel 4004, introduced in 1971. The 4004 was not very powerful -- all it could do was add and subtract, and it could only do that 4 bits at a time. But it was amazing that everything was on one chip. Prior to the 4004, engineers built computers either from collections of chips or from discrete components (transistors wired one at a time). The 4004 powered one of the first portable electronic calculators.

2. The first microprocessor to make it into a home computer was the Intel 8080, a complete 8-bit computer on one chip, introduced in 1974. The first microprocessor to make a real splash in the market was the Intel 8088, introduced in 1979 and incorporated into the IBM PC (which first appeared around 1982). If you are familiar with the PC market and its history, you know that the PC market moved from the 8088 to the 80286 to the 80386 to the 80486 to the Pentium to the Pentium II to the Pentium III to the Pentium 4. All of these microprocessors are made by Intel and all of them are improvements on the basic design of the 8088. The Pentium 4 can execute any piece of code that ran on the original 8088, but it does it about 5,000 times faster!

3. Since 2004, Intel has introduced microprocessors with multiple cores and millions more transistors. But even these microprocessors follow the same general rules as earlier chips.

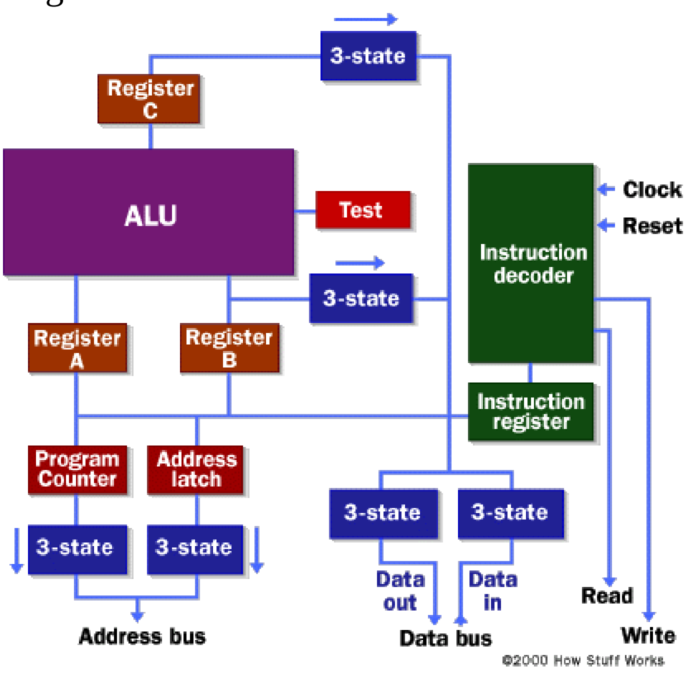
4. A microprocessor executes a collection of machine instructions that tell the processor what to do. Based on the instructions, a microprocessor does three basic things:

Using its ALU (Arithmetic/Logic Unit), a microprocessor can perform mathematical operations like addition, subtraction, multiplication and division. Modern microprocessors contain complete floating point processors that can perform extremely sophisticated operations on large floating point numbers.

A microprocessor can move data from one memory location to another.

A microprocessor can make decisions and jump to a new set of instructions based on those decisions.

5. The following diagram shows an extremely simple microprocessor capable of doing those three things:



This microprocessor has:

An address bus (that may be 8, 16 or 32 bits wide)

A data bus (that may be 8, 16 or 32 bits wide)

An RD (read) **and WR** (write) **line**

A clock line

A reset line

6. The address and data buses, as well as the RD and WR lines, connect either to RAM or ROM -- generally both. In our sample microprocessor, we have an address bus 8 bits wide and a data bus 8 bits wide. That means that the microprocessor can address 256 bytes of memory, and it can read or write 8 bits of the memory at a time. Let's assume that this simple microprocessor has 128 bytes of ROM starting at address 0 and 128 bytes of RAM starting at address 128.

7. ROM stands for read-only memory. A ROM chip is programmed with a permanent collection of pre-set bytes. The address bus tells the ROM chip which byte to get and place on the data bus. When the RD line changes state, the ROM chip presents the selected byte onto the data bus.

8. RAM stands for random-access memory. RAM contains bytes of information, and the microprocessor can read or write to those bytes depending on whether the RD or WR line is signaled. One problem with today's RAM chips is that they forget everything once the power goes off. That is why the computer needs ROM.

9. By the way, nearly all computers contain some amount of ROM (it is possible to create a simple computer that contains no RAM -- many microcontrollers do this by placing a handful of RAM bytes on the processor chip itself -- but generally impossible to create one that contains no ROM). On a PC, the ROM is called the BIOS (Basic Input/Output System). When the microprocessor starts, it begins executing instructions it finds in the BIOS. The BIOS instructions do things like test the hardware in the machine, and then it goes to the hard disk to fetch the boot sector. This boot sector is another small

program, and the BIOS stores it in RAM after reading it off the disk. The microprocessor then begins executing the boot sector's instructions from RAM. The boot sector program will tell the microprocessor to fetch something else from the hard disk into RAM, which the microprocessor then executes, and so on. This is how the microprocessor loads and executes the entire operating system.

10. Even the incredibly simple microprocessor will have a fairly large set of instructions that it can perform. The collection of instructions is implemented as bit patterns, each one of which has a different meaning when loaded into the instruction register. Humans are not particularly good at remembering bit patterns, so a set of short words are defined to represent the different bit patterns. This collection of words is called the assembly language of the processor. An assembler can translate the words into their bit patterns very easily, and then the output of the assembler is placed in memory for the microprocessor to execute.

11. The number of transistors available has a huge effect on the performance of a processor. A typical instruction in a processor like an 8088 took 15 clock cycles to execute. Because of the design of the multiplier, it took approximately 80 cycles just to do one 16-bit multiplication on the 8088. With more transistors, much more powerful multipliers capable of single-cycle speeds become possible.

12. More transistors also allow for a technology called pipelining. In a pipelined architecture, instruction execution overlaps. So even though it might take five clock cycles to execute each instruction, there can be five instructions in various stages of execution simultaneously. That way it looks like one instruction completes every clock cycle.

13. Many modern processors have multiple instruction decoders, each with its own pipeline. This allows for multiple instruction streams, which means that more than one instruction can complete during each clock cycle. This technique can be quite complex to implement, so it takes lots of transistors.

Task 7.Check the meaning of the following words from the text.

chip, powerful, introduce, introduction, complete, improve, improvement, execute, execution, multiple, sophisticated, sample, assume, assumption, permanent, pre-set, signaled, fetch, incredibly, particularly, performance, perform, multiplier, overlap, simultaneously, pipelining, computation engine, floating point, boot sector, bit pattern, clock cycle

Task 8.In which paragraph can you find this information?

- about pipelining
- the history of microprocessors
- about ROM and RAM
- their main functions
- about how the microprocessor loads and executes the operating system

Task 9.Insert these parts into the 5th paragraph next to the terms in bold.

1. an internal channel that can send data to memory or receive data from memory
2. a part of a microprocessor that lets a clock pulse sequence the processor
3. an internal communication channel that sends an address to memory
4. a part of a microprocessor that resets the program counter to zero (or whatever) and restarts execution
5. the line which tells the memory whether it wants to set or get the addressed location

Task 10. Match these terms with their definitions.

1.	pipelining	a.	a combination of integers and their various multipliers, which are used to show the number of operations that computer can perform;
2.	discrete component	b.	a region of a data storage device that is designed to boot process of a computer to load a program (OS) stored on the same storage device;
3.	floating point number	c.	a basic indivisible electronic component that is available in a singular form;
4.	boot sector	d.	A technology used in processors which allows overlapping execution of multiple instructions with the same circuitry;
5.	assembly language	e.	a low-level programming language for any programmable device, in which each statement corresponds to a single machine code instruction.

Task 11. Write definitions to the following terms.

ALU, ROM, RAM, BIOS, computation engine, clock cycle, multiplier.

Task 12. There are some good structures in the text. Learn them and translate sentences with them.

❖ <u>either … or …</u>

1.Prior to the 4004, engineers built computers **either** from collections of chips **or** from discrete components.

2. The address and data buses, as well as the RD and WR lines, connect **either** to RAM **or** ROM -- generally both.

❖ <u>for + noun … + to Infinitive …</u>

3.An assembler can translate the words into their bit patterns very easily, and then the output of the assembler is placed in memory **for the microprocessor to execute**.

❖ <u>It's + adjective … + to Infinitive …</u>

4. **It is possible to create** a simple computer that contains no RAM.

5. But **it's generally impossible to create** one that contains no ROM.

Task 13. Look how these phrases are used in the text and write you own sentences.

be prior to	some amount of
a splash in the market	a handful of
be capable of	be good at
to stand for	to have a huge effect on
to depend on	to allow for

Task 14. Write the words from the text to the following transcriptions.

1./’mʌltɪplaɪə/		8./ə’sju:m/	
2./pə’tɪkjələli/		9./’paʊəfʊl/	
3./’endʒɪn/		10./dɪ’sɪʒ(ə)n/	
4./ɪm’pru:vm(ə)nt/		11./’praɪə/	
5./waɪə/		12./sə’fɪstɪkeɪtɪd/	
6./’pə:m(ə)nənt/		13./sɪm(ə)l’teɪnɪəsli/	
7./kəm’pəʊnənt/		14./’saɪkl/	

Recommended function

Read

<u>Function 12 “HOW TO define a thing and explain its use and structure”</u>

and write full sentences with terms in tasks 4 and 5.

Listening

You will watch a video from Texas Instruments about their **Sitara ARM Microprocessors.**

Task 15. Check the meaning of these words. Watch the video and underline the words that you hear.

innovation	available	investment
performance	ecosystem	advantage
dedicated	appliance	interface
integration	hardware	portfolio
touchscreen	automation	pin-for-pin
programming	platform	peripheral
reference code	commitment	compatible
connectivity	cutting-edge	transition
strength	offering	emerge
data terminal	scalability	decoder
robust	solution	application
impact	acceleration	

Task 16. What do these abbreviations mean?

DMIPS, OpenGL, OpenVG, DSP, PROFIBUS, USB OTG, SATA, BSP, WinCE, GUI

Task 17. Answer the questions on the text.

1. What does TI offer in this video?
2. What are the advantages of these microprocessors?
3. What is the speed of chips?
4. What standards does graphics interface support?
5. What options do TI devices have?
6. What does Sitara ARM peripheral support include?
7. What sort of software support do they provide?
8. Where are these microprocessors ideal in use?
9. What are the key applications?
10. What does ecosystem of Sitara ARM MPUs include?

Task 18. Complete the part of the talk with necessary words.

First and foremost, we deliver 1. _____, optimized for performance. TI is the first to offer Cortex A8 at speeds of up to 1.5 GHz achieving 2. _____ of 3000 DMIPS. Knowing performance is more than MHz, many of our devices include dedicated 3. _____ that supports industry standards, such as OpenGL ES 1.1, OpenGL ES 2.0 and OpenVG 1.0 to deliver rich 3D graphics for superior 4. _____.

The second advantage of Sitara ARM Microprocessors is 5. _____ of the platform. We have the largest software compatible 6. _____ in the industry across the Sitara products and our devices have pin-for-pin and software 7. _____ options to the Integra and DaVinci product lines. This enables our customers 8. _____ from ARM-only offerings in the Sitara family to ARM+DSP offerings in the Integra family, to ARM + video acceleration offerings in the DaVinci family; all 9. _____ from TI. This enables maximum software and hardware reuse, easiest 10. _____, and speeds time to the market.

Task 19. Decode the part of the video:

Part 1 - 02.14 “Finally, I’d like to discuss…” – 02.37 “… your product to market.”

Task 20. Watch the video again and write the words to the transcriptions.

1./kənek’tɪvɪtɪ/		9./skeɪlə’bɪlɪtɪ/	
2./pə’rɪf(ə)r(ə)l/		10./træn’zɪʃ(ə)n/	
3./sə’lu:ʃ(ə)n/		11./ə’veɪləb(ə)l/	
4./streŋθ/		12./ə’plaɪəns/	
5./’ɪntəfeɪs/		13./əkselə’reɪʃ(ə)n/	
6./kəm’pætɪb(ə)l/		14./’ɔf(ə)rɪŋ/	
7./kə’mɪtm(ə)nt/		15./rə(ʊ)’bʌst/	
8./pɔ:t’fəʊlɪəʊ/		16./’ɪ:kəʊsɪstəm/	

Speaking

Prepare a talk about ***one of the most remarkable microprocessors***. Find information about when, who and where it was made; describe it and tell about its use and advantages over similar ones.

Writing

Read

<u>Function 11 “HOW TO describe a thing”</u>

and write about ***one of the devices*** which you deal with. Write about when, who, where it was made; describe it and tell about its use and advantages/disadvantages.

Theme 6. NANOTECHNOLOGY

Reading, Vocabulary and Listening objectives: some achievements in nanotechnology ***Speaking and Writing objectives:*** telling about a latest example of the use of nanotechnology, writing an abstract ***Recommended Grammar:*** Going to and Future Simple

Lead-in

Read the statement. Do you agree with the author? Prove your answer.

"Nanotechnology is the base technology of an industrial revolution in the 21st century. Those who control nanotechnology will lead the industry."
-- Michiharu Nakamura, Executive VP at Hitachi

Reading and Vocabulary

Task 1.You will read the text about Nanotechnology. Make sure you know these words and word combinations.

arrange (v), arrangement (n)	further (v, adj)	precise (adj)
property (n)	eradicate (v)	incomprehensibly (adj)
cast (v)	endeavor (v, n)	superior (adj)
grind (v)	substance (n)	emerge (v)
mill (v)	break (v), breakable (adj)	encompass (v)
lithography (n)	crude (adj)	envision (v)
fabricate (v), fabrication (n)	analogue (n), analogous (adj)	physician (n)
comprise (v)	essential (adj)	precursor (n)
fulfill (v)	permit (v)	fascinating (adj)
multitask (v)		

Task 2. Read the text and answer the questions after it.

Nanotechnology

1.Today, most airplanes are made from metal despite the fact that diamond (which is very expensive and breakable) is over 50 times stronger than aerospace aluminium. Nanotechnology allows us to inexpensively make unbreakable diamond in exactly the shapes we want. This would let us make a *Boeing 747* fifty times lighter but just as strong as we can make today. Beyond inexpensively providing remarkably light and strong materials for airplanes, even space ships, nanotechnology will also provide extremely powerful computers with which to operate both those airplanes and space ships and a wide range of other activities.

2.Today's manufactured products are made from atoms. The properties of those products depend on how those atoms are arranged. For example; if we rearrange the atoms in coal we can make diamond. If we rearrange the atoms in sand we can make computer chips. Today's manufacturing methods are very crude at the molecular / nanotechnological level. Casting, grinding, milling and lithography move atoms in huge quantities. It's like trying to make things out of sugar cubes with boxing gloves on your hands; you can push the sugar cubes into heaps and pile them up, but you can't really make anything with them in the way you'd like to.

3.In the future, nanotechnology will let us remove the boxing gloves. This will allow us to make shapes from the sugar cubes (analogous to the fundamental building blocks of nature) easily, inexpensively and in most of the ways permitted by the laws of physics. This will be essential if we are to continue the current technological revolution, and will also let us fabricate an entirely new generation of products that are cleaner, stronger, lighter, and more precise than any we can produce today.

4.Nanotechnology is technology that deals with matter on the nano-scale, between one and one hundred nanometers. Imagine working on a structure 100,000 times smaller in diameter than a human hair! This is the rapidly expanding world of nanotechnology engineering, a field where a human hair is incomprehensibly large and an ant is a behemoth at 500,000 nm; a field where a nano is a billionth of a meter–a meter being approximately 39 inches long–and it takes more than 25 million nanos to comprise an inch.

5.Researcher *K. Eric Drexler* was the first person to popularize this technology in the early 1980’s. Drexler was interested in building fully functioning robots, computers, and motors that were smaller than a cell. He spent much of the 80’s defending his ideas against critics that thought this technology would never be possible.

6.Today, the word nanotechnology means something a bit different. Instead of building microscopic motors and computers, researchers are interested in building superior machines atom by atom. Nanotech means that each atom of a machine is a functioning structure on its own, but when combined with other structures, these atoms work together to fulfill a larger purpose.

7.*The U.S. National Nanotechnology Initiative* has large plans for nanotech. *Mihail Roco*, who is involved in this organization, explains the group’s future plans by dividing their goals into four generations.

8.The first generation of nanotech is defined by passive structures that are created to carry out one specific task. Researchers are currently in this generation of the technology. The second generation will be defined by structures that can multitask. Researchers are currently entering this generation and hoping to further their abilities in the near future. The third generation will introduce systems composed of thousands of nanostructures. The last generation will be defined by nanosystems designed on the molecular level. These systems will work like living human or animal cells.

9.The emerging field of nanotechnology engineering encompasses all fields of science: biology, physics, chemistry, health and medicine, among others. Subdivisions of nanotechnology engineering include instrument development, materials engineering and bio-systems. Nanotechnologies involve constructing equipment and tools that work at the molecular level; this requires researching both the technologies with which to do this and improvements that can be made to existing methods.

10.Scientists envision a day when cancer will be treated at the genetic level by using nanotechnology to develop a treatment regimen based on an individual’s genetic code. Nanotechnology will also enable physicians to isolate substances in the body that have been identified as precursors to cancer, so that eventually the disease will become eradicated.

11.The career field of nanotechnology engineering is filled with possibilities limited only by the imagination of mankind. For those individuals who are passionate about making a difference, this fascinating new career field offers unlimited potential, both for humanitarian endeavors and for professional achievements.

1. Diamond is stronger than metal; so why aren't planes made out of diamond?
2. How can nanotechnology allow us to make lighter aircraft?
3. What does 'trying to make things out of sugar cubes with boxing gloves on your hands' mean?
4. What are the things nanotechnology deals with?
5. What are the goals of nanotechnology in the future?

Task 3.Finish the sentences.

1. The properties of today's manufactured products depend on…
2. Researcher K. Eric Drexler was the first person …
3. Instead of building microscopic motors and computers, nanotech researchers …
4. The field of nanotechnology engineering encompasses …

Task 4.Find the synonyms for the following words in the text.

1. fragile (para1)
2. features (para 2)
3. inaccurate (para 2)
4. to alter (para 2)
5. to create (para 3)
6. sphere (para 4)
7. to carry out (para 6)
8. to promote (para 8)
9. current (para 9)
10. to imagine (para 10)

Task 5.Complete the table with the appropriate words.

Noun	Verb	Adjective	Adverb
break	1.	2. 3.	-
expense	-	4. 5.	6.
7.	function	8.	9.
10.	popularize	11.	12.
13.	14.	improvable	-

Task 6.Look at these phrases from the text and make your own sentences with them.

1. … both … and …
2. It takes … to do smth…
3. … on its own
4. … permitted by the laws of physics.
5. … something a bit different…

Specialized reading

Task 7.Read and translate the text.

Huge Potential of nanotechnology in medicine

Nanotechnology, the manipulation of matter at the atomic and molecular scale to create materials with remarkably varied and new properties, is a rapidly expanding area of research with huge potential in many sectors, ranging from healthcare to construction and electronics. In medicine, it promises to revolutionize drug delivery, gene therapy, diagnostics, and many areas of research, development and clinical application.

The ability to manipulate structures and properties at the nanoscale in medicine is like having a sub-microscopic lab bench a. … .

Therapies that involve the manipulation of individual genes or the molecular pathways that influence their expression are increasingly being investigated as an option for treating diseases. One highly sought goal in this field is the ability to tailor treatments according to the genetic make-up of individual patients. This creates a need for tools that help scientists experiment and develop such treatments.

Imagine, for example, being able to stretch out a section of DNA like a strand of spaghetti, so you can examine or operate on it, or building nanorobots that can "walk" and carry out repairs inside cell components. Nanotechnology is bringing that scientific dream closer to reality.

For instance, scientists at the *Australian National University* have managed to attach coated latex beads to the ends of modified DNA, and then using an "optical trap" comprising a focused beam of light to hold the beads in place, b. … .

Meanwhile chemists at *New York University (NYU)* have created a nanoscale robot from DNA fragments that walks on two legs just 10 nm long. One of the researchers, *Ned Seeman*, said he envisages it will be possible to create a molecule-scale production line, where you move a molecule along till the right location is reached, and a nanobot does a bit chemistry on it, rather like "spot-welding" on a car assembly line. *Seeman's lab* at *NYU* is also looking to use DNA nanotechnology to make a biochip computer, and to find out how biological molecules crystallize an area that is currently linked with challenges.

The work that *Seeman* and colleagues are doing is a good example of "biomimetics", where with nanotechnology they can imitate some of the biological processes in nature, such as the behavior of DNA, to engineer new methods and perhaps even improve them.

DNA-based nanobots are also being created to target cancer cells. For instance, researchers at *Harvard Medical School* in the US reported recently in Science how they made an "origami nanorobot" out of DNA to transport a molecular payload. The barrel-shaped nanobot can carry molecules containing instructions c. … . In their study, the team successfully demonstrates how it delivered molecules that trigger cell suicide in leukemia and lymphoma cells.

Nanobots made from other materials are also in development. For instance, gold is the material scientists at *Northwestern University* use to make "nanostars", simple, specialized, star-shaped nanoparticles that can deliver drugs directly to the nuclei of cancer cells. They describe how drug-loaded nanostars behave like tiny hitchhikers that after being attracted to an over-expressed protein on the surface of human cervical and ovarian cancer cells, deposit their payload right into the nuclei of those cells.

The researchers found giving their nanobot the shape of a star helped to overcome one of the challenges of using nanoparticles to deliver drugs: how to release the drugs precisely. They say the shape helps to concentrate the light pulses used to release the drugs precisely at the points of the star.

Scientists are discovering d. … . But the problem with conventional delivery of such drugs is that the body breaks most of them down before they reach their destination.

But what if it were possible to produce such drugs in situ, right at the target site? Well, in a recent issue of Nano Letters, researchers at *Massachusetts Institute of Technology (MIT)* in the US show how it may be possible to do just that. In their proof of principle study, they demonstrate the feasibility of self-assembling "nanofactories" that make protein compounds, on demand, at target sites. So far they have tested the idea in mice, by creating nanoparticles programmed to produce either *green fluorescent protein (GFP)* or luciferase exposed to UV light.

The *MIT* team came up with the idea while trying to find a way to attack metastatic tumors, e. … . Over 90% of cancer deaths are due to metastatic cancer. They are now working on nanoparticles that can synthesize potential cancer drugs, and also on other ways to switch them on.

There are also nanofibers which are fibers with diameters of less than 1,000 nm. Medical applications include special materials for wound dressings and surgical textiles, materials used in implants, tissue engineering and artificial organ components.

Nanofibers made of carbon also hold promise for medical imaging and precise scientific measurement tools. But there are huge challenges to overcome, one of the main ones being how to make them consistently of the correct size.

But last year, researchers from *North Carolina State University*, revealed how they had developed a new method for making carbon nanofibers of specific sizes. They describe how they managed to grow carbon nanofibers uniform in diameter, f. … .

Nickel nanoparticles are particularly interesting because at high temperatures they help grow carbon nanofibers. The researchers also found there was another benefit in using these nanoparticles, they could define where the nanofibers grew and by correct placement of the nanoparticles they could grow the nanofibers in a desired specific pattern: an important feature for useful nanoscale materials.

Lead is another substance that is finding use as a nanofiber. The lead product is a synthetic polymer comprising individual strands of nanofibers, and was developed to repair brain and spinal cord injuries, but *MacEwan* thinks it could also be used to mend hernias, fistulas and other injuries.

Every thread of the nanofiber mesh is thousands of times smaller than the diameter of a single cell. The idea is to use the nanofiber material not only to make operations easier for surgeons to carry out, g. … .

Recent years have seen an explosion in the number of studies showing the variety of medical applications of nanotechnology and nanomaterials. In this article we have glimpsed just a small cross-section of this vast field.

Task 8.Insert the following parts of sentences into the text.

1. … they have stretched out the DNA strand in order to study the interactions of specific binding proteins.
2. … that make cells behave in a particular way.
3. … by using nickel nanoparticles coated with a shell made of ligands, small organic molecules with functional parts that bond directly to metals.
4. … on which you can handle cell components, viruses or pieces of DNA, using a range of tiny tools, robots and tubes.
5. … those that grow from cancer cells that have migrated from the original site to other parts of the body.
6. … that protein-based drugs are very useful because they can be programmed to deliver specific signals to cells.
7. … but also so there are fewer post-op complications for patients, because it breaks down naturally over time.

Task 9.Answer the questions.

1. What scientific dream is being achieved with the help of nanotechnology?
2. What does such term as "biomimetics" mean?
3. What nanotech innovations in medicine are described in the article? Describe each of them filling in the table.

What is it?	Who was it created by?	What was it created for?
…	…	…

Task 10. Are the following sentences True (T) or False (F)?

1. Nanotechnology is the area of research which is aimed at healthcare and electronics.
2. The researchers at NYU have created the production line for fabricating nanorobots.
3. In Harvard Medical School the nanorobot can help to destroy leukemia and lymphoma cells.
4. The studies show that in the future it will be possible to produce protein-based drugs at the place of an affected organ.
5. Nanofibers are only made of carbon.

Task 11. Give Russian equivalents to the following words and pronounce them with the correct stress and pronunciation.

atomic scale, rapidly expanding area, healthcare, to revolutionize, gene therapy, sought, to tailor treatments, coated latex beads, stretched out, binding proteins, to envisage, biomimetics, molecular payload, cell suicide, leukemia, lymphoma, nuclei, a hitchhiker, feasibility, self-assembling, luciferase, metastatic tumor, to synthesize, wound dressings, surgical textiles, tissue engineering, an artificial organ component, carbon nanofiber, a synthetic polymer, spinal cord injury, a hernia, a fistula, ligand

Task 12. Match the terms with their definitions.

1. to manipulate	a. a small piece of glass, stone or similar material
2. bead	b. a thread or filament from which a vegetable tissue, mineral substance, or textile is formed
3. biochip	c. handle or control smth in a skillful manner
4. fiber	d. a thing implanted in something else, especially a piece of tissue, prosthetic device, or other object
5. thread	e. a microchip designed or intended to function in a biological environment, especially inside a living organism
6. implant	f. a long, thin strand of cotton, nylon, or other fibers

Task 13. Write definitions to the following words.

DNA, nanoparticles, nanofibers, nanobots, nanomaterials.

Task 14. Write the words from the text to the following transcriptions.

1./ig'zæmın/		6./wu:nd/	
2./'hə:nıə/		7./maıkrə'skɔpık/	
3./prı'saıslı/		8./'s(j)u:ısaıd/	
4./ın'vızıdʒ/		9./dı'zi:z/	
5./'tıʃu:/		10./'sə:dʒık(ə)l/	

Recommended function

Study

<u>Function 2 "HOW TO distinguish a predicate".</u>

Write out examples of different predicate forms from the text, define and translate them.

Listening

You are going to hear a talk **Invisible Science.**

Task 15. Match the following words from the recording with their synonyms.

1.	closer	a.	appear
2	cloak	b.	financed
3.	artificial	c.	enormous
4.	seem	d.	cover
5.	compared	e.	very
6.	huge	f.	synthetic
7.	concealing	g.	smaller
8.	extremely	h.	nearer
9.	funded	i.	hiding
10.	tinier	j.	likened

Task 16. Listen to the recording and match the phrases to make longer ones. Sometimes more than one variant is possible.

1.	developing materials that could	a.	flowing around a rock
2	materials that redirect	b.	in developing this idea
3.	measured in	c.	step forward
4.	absorb or reflect	d.	billionths of a meter
5.	They compared the light to water	e.	to the battlefield
6.	The new discovery is a huge	f.	how viruses are formed
7.	The U.S. military is extremely interested	g.	light around things
8.	bring the technology	h.	make people invisible
9.	look more closely at living cells and	i.	light
10.	scientists could look at	j.	even tinier objects

Task 17. Answer the questions on the recording.

1. What uses could an invisibility cloak have?
2. What does Professor Zhang research?
3. What did old technology allow scientists?
4. What can new technology lead to?
5. Do you think other countries will worry about America's invisibility technology?

Task 18. Decode one of the parts of the recording:

Part 1 - 00.05 "Scientists in the USA…" – 01.04 "… water flowing around a rock."
Part 2 - 01.04 "The new discovery …" – 01.56 "… and how they grow."

Task 19. Write your ideas about years, decades, centuries or "never" in respect to the possibility of the following things.

_____ Invisibility clothing	_____ Talent downloads into the brain
_____ Time travel	_____ An eternal youth pill
_____ Holidays to Mars	_____ A cure for all diseases
_____Carbon-zero cars and factories	_____Personal backpack jets / helicopters

Speaking

Prepare a talk about ***an achievement in nanotechnology***.

Writing

Study

Function 16 "HOW TO write an abstract"

and write an abstract to the article Huge Potential of nanotechnology in medicine. **OR** Write an abstract for one of your articles or any Russian articles of your colleagues.

Theme 7. HOLOGRAPHY

Reading, Vocabulary and Listening objectives: the process of making analog holography and photography, touchable holograms
Speaking and Writing objectives: telling about a latest example of holography
Recommended Grammar: Conditional Sentences

Lead in

QUIZ: C☺k how many correct answers you can give.

Q1: In principle, it is possible to make a hologram for any ________.
a. Light   b. Wave   c. Wavelength   d. Optics

Q2: A ________ is a structure with a repeating pattern.
a. Diffraction grating   b. Dispersion (optics)   c. Optics   d. Holography

Q3: Light rays travelling through it are bent at an angle determined by λ, the ________ of the light and d, the distance between the slits and is given by $\sin\theta = \lambda/d$.
a. Wavelength   b. Electromagnetic radiation
c. Diffraction   d. Electron

Q4: This method relied on the use of a large table of deep sand to hold the ________ rigid and damp vibrations that would destroy the image.
a. Transparency and translucency   b. Anti-reflective coating
c. Optics   d. Optical fiber

Q5: The material used to make embossed copies consists of a ________ base film, a resin separation layer and a thermoplastic film constituting the holographic layer.
a. Polyester   b. Rayon   c. Cotton   d. Nylon

Q6: The most common materials are photorefractive crystals, but also in ________ or semiconductor heterostructures (such as quantum wells), atomic vapors and gases, plasmas and even liquids it was possible to generate holograms.
a. Quantum mechanics   b. Classical mechanics
c. Condensed matter physics   d. Semiconductor

Q7: The first holograms that recorded 3D objects were made in 1962 by Yuri Denisyuk in the Soviet Union and by Emmett Leith and Juris Upatnieks at ________, USA.
a. Ohio State University   b. University of Michigan
c. MichiganState University   d. Wayne State University

Q8: According to ________ theory, each point in the object acts as a point source of light.
a. Wave   b. Wavelength   c. Diffraction   d. Holography

Q9: The recording medium has to convert the interference pattern into an optical element which modifies either the ________ or the phase of a light beam which is incident upon it.
a. Amplitude   b. Electrical engineering

c. Measuring instrument *d. Crest factor*

Q10: A better analogy is ________ where the sound field is encoded in such a way that it can later be reproduced.

a. Synthesizer *b. Sound recording and reproduction*

c. Mixing console *d. Audio format*

Reading and Vocabulary

Task 1.a. Read and translate the following words.

beam (n)	maintain (v)
refraction (n), refractive (adj)	coherence (n), coherent (adj)
illuminate (v), illumination (n)	dimensions (n)
recording medium	intensity (n), intensify (v)
angle (n)	shortcoming
distort (v), distortion (n)	shutter (v, n)
haptic technology	magnify (v), magnification (n)
tactile (adj)	software package
air jet	forgery (n), forge (v)
ultrasonic (adj)	eliminate (v), elimination (n)
interfere (v), interference (n)	bypass (n)
prevalence (n)	swirl (n)
dispersion (n)	accurate (adj)
transparency (n), transparent (adj)	translucency (n), translucent (adj)
diffraction (n)	diffraction grating

b. Explain what these terms mean:

refraction, diffraction, distortion, interference, dispersion

Task 2.Read the text and name technologies which help to create the feeling of touching.

Touchable hologram: is it real?

The word "holography" comes from the Greek term for "whole drawing." The holographic process was developed by physicist Dennis Gabor in 1947. It was not until 1962, however, that three-dimensional viewable holograms became practical to create. This depended on expensive equipment and expert knowledge in the early years of its development. The prevalence of cheap lasers and other supplies in the early 2000s has made holography available to hobbyists on a budget.

Holography is the creation of three-dimensional images called holograms. In order to start the process, two beams of light are created by the refraction of one light beam directed at a mirror. One beam is directed at the object to be documented, while the other illuminates the recording medium. The interference between these two beams creates a ghostly 3D image when it is illuminated with a laser beam.

Each of the beams used in the process of holography have a name. The ray that lights up the item to be captured is called the object beam. It is offset by the reference beam which shines on the recording medium. Once the hologram has been developed, it is displayed by shining a laser beam through the image. It is placed in the opposite direction and at an angle identical to the reference beam.

Holography images are recorded on photographic plates. As the light beams used in holography only focus on certain objects, the surroundings are not included in the captured image. The photographic plate records the visual interference that results from the light hitting the object. It does not capture the object as it appears to the naked eye.

In order for holography to work correctly, the light beams must be stable throughout the image capture process, a state known as coherence. For this reason, lasers tend to be the most frequently used source because they are easier to keep completely still. Other sources of light can be used, however. It is possible to use any two light sources to create a hologram as long as they can maintain a sufficient coherence length.

For a hologram to be properly displayed, light must be shined through the captured image precisely where the reference beam was originally directed. Otherwise, the image will be distorted. Once the beam is in place, the plate with the captured image can be moved to show other sides of the object as if it is still present.

If to speak about a touchable hologram it is a combination of three dimensional light projection, a sensor array and some type of tactile feedback.

This type of projection can be viewed from any angle just like a physical object even though it is composed of nothing but light. Since holograms are made of light and lack any physical substance, they cannot be touched or interacted with through any traditional means. In order to create a touchable hologram, at least two different techniques must be employed.

In order for a hologram to be felt, some type of haptic technology must be used. One way to create tactile feedback is to attach physical devices to a person's hands or body, though this can interfere with the illusion of touching a hologram. High powered air jets are another option, though ultrasonic devices can provide a similar effect. In either case, the haptic technology is used to impart a physical sensation to some part of a person's body in order to provide the illusion of touch.

The other main component necessary for creating a touchable hologram is some type of sensor apparatus. In order for the haptic technology to activate at the correct time, a computer must know where a person's hand or other body part is located. This can be accomplished through the use of a camera and specialized software, though reflective tape and other markers can make the process more accurate. Once the computer knows where a person's hand is located, it can activate the haptic technology at the correct time to create the illusion of touch.

These types of sensors can also allow a person to interact with a hologram. Since the computer responsible for generating and controlling the image and the haptic feedback knows where the person is located, it can respond accordingly. An example of this type of touchable hologram is a ball that is capable of bouncing off of someone's hand. The computer can track the location of the hand, project the hologram in the correct place, and activate the tactile feedback accordingly. If the hand is moved, the ball can be allowed to drop realistically.

Task 3.Are the following sentences true (T) or false (F)?

1. The creation of holograms involves the collision of several beams of light.
2. All sorts of light sources can be used to create a hologram even those which can't provide a sufficient coherence length.
3. The hologram image can't be distorted.
4. Touchable holograms emit smell and can be touched.
5. The usage of haptic technology in creation of holograms allows a person to touch the holograms and interact with them.

Task 4.Finish the phrases:

- ✓ The object beam is …
- ✓ The reference beam is …
- ✓ Touchable hologram is …

Task 5.Match the words and their definitions.

1. haptic	a. the change in direction of a propagating wave, such as light or sound, in passing from one medium to another
2. dimension	b. a measurement of the size of something in a particular direction, such as the length, width, height, or diameter
3. angle	c. the propagation distance over which a coherent wave (e.g. an electromagnetic wave) maintains a specified degree of coherence
4. refraction	d. a physical material that holds data expressed in any of the existing recording formats
5. coherence length	e. the space between two straight lines that diverge from a common point
6. recording medium	f. relating to or based on the sense of touch

Task 6.Match words from the text with their synonyms.

1. accomplish	a. visible
2. accurate	b. ray
3. illuminate	c. light up
4. sufficient	d. support
5. viewable	e. misrepresent
6. beam	f. achieve
7. precisely	g. correct
8. maintain	h. fix
9. distort	i. exactly
10. capture	j. adequate

Task 7.Fill in the gaps with appropriate prepositions from the text.

1. The word "holography" comes … the Greek term … "whole drawing."	**through**
2. It depended … equipment and expert knowledge.	**on**
3. Holography is the creation … three-dimensional images.	**in**
4. It is placed … the opposite direction and … an angle identical to the reference beam.	**from**
5. This can be accomplished … the use of a camera and specialized software.	**at**
	for
	of

Specialized reading

Task 8.Before reading the text check the meanings of the following words and phrases.

intensity, stereoscope, polarized glasses, photographic emulsion, imaging, dimensions, to magnify, light-sensitive compound, reflected light, a lens, to bypass, to develop a film, transmission hologram, reflection hologram, silver halide, holographic plate, random pattern

Task 9.Read the text and insert the parts which are missed.

<u>Holograms and Photographs</u>

1. The commonly and widely used way of imaging of the reality is the photography. A photograph is basically the recording of the differing intensities of the light reflected by the object and imaged by a lens. However, information about dimensions of the object is contained not only in amplitude (intensity), but also in a phase of light waves.

2. A great difference between holography and photography is the information recorded. This difference is why photographs are two dimensional (2-D) images while holograms are three dimensional (3-D) images. Photographs contain only one view point of an object. Our eyes need a minimum of two viewpoints in order to see depth. Vision using two viewpoints of an object is called stereoscopic vision. Each eye receives a slightly different view point of an object, our brain combines the two and we perceive depth. We can fool our eyes into seeing photographs in three

dimensions **a. …** We can do this with a stereoscope (for pictures) or with polarized glasses (for movies). The shortcoming of stereoscopic images is that when we move our head from side to side or up and down, we still only see the same two view points, whereas we should be seeing continuously changing viewpoints of the object. The image therefore doesn't quite appear to be three dimensional. In order to make a record of a three dimensional object we need to record this continuous set of viewpoints of the object.

3. When you take a picture with a film camera, **b. …**:

a. A shutter opens.
b. Light passes through a lens and hits the photographic emulsion on a piece of film.
c. A light-sensitive compound called silver halide reacts with the light, recording its amplitude, or intensity, as it reflects off of the scene in front of you.
d. The shutter closes.

4. You can make lots of changes to this process, like how far the shutter opens, how much the lens magnifies the scene and how much extra light you add to the mix. But no matter what changes you make, the four basic steps are still the same. In addition, regardless of changes to the setup, the resulting picture is still simply a recording of the intensity of reflected light. When you develop the film and make a print of the picture, your eyes and brain interpret the light that reflects from the picture as a representation of the original image.

5. Like photographs, holograms are recordings of reflected light. Making them requires steps that are similar to what it takes to make a photograph:

a. A shutter opens or moves out of the path of a laser. (In some setups, a pulsed laser fires a single pulse of light, eliminating the need for a shutter.)
b. The light from the object beam reflects off of an object. The light from the reference beam bypasses the object entirely.
c. The light from both beams comes into contact with the photographic emulsion, where light-sensitive compounds react to it.
d. The shutter closes, blocking the light.

6. Just like with a photograph, the result of this process is a piece of film that has recorded the incoming light. However, when you develop the holographic plate and look at it, what you see is a little unusual. Developed film from a camera shows you a negative view of the original scene – **c. …** When you look at the negative, you can still get a sense of what the original scene looked like.

7. But when you look at a developed piece of film used to make a hologram, you don't see anything that looks like the original scene. Instead, you might see a dark frame of film or a random pattern of lines and swirls. Turning this frame of film into an image requires the right illumination. In a transmission hologram, monochromatic light shines through the hologram to make an image. In a reflection hologram, monochromatic or white light reflects off of the surface of the hologram to make an image. Your eyes and brain interpret the light shining through or reflecting off of the hologram as a representation of a three-dimensional object. The holograms you see on credit cards and stickers are reflection holograms.

8. If you want to see a hologram, **d. …** There are holograms on most driver's licenses, ID cards and credit cards. If you're not old enough to drive or use credit, you can still find holograms around your home. They're part of CD, DVD and software packaging, as well as just about everything sold as "official merchandise."

9. Unfortunately, these holograms -- which exist to make forgery more difficult -- aren't very impressive. You can see changes in colors and shapes when you move them back and forth, but **e. …** . Even the mass-produced holograms that feature movie and comic book heroes can look more like green photographs than amazing 3-D images.

10. On the other hand, large-scale holograms, illuminated with lasers or displayed in a darkened room with carefully directed lighting, are incredible. They're two-dimensional surfaces that show absolutely precise, three-dimensional images of real objects. You don't even have to wear special glasses or look through a View-Master to see the images in 3-D.

11. If you look at these holograms from different angles, **f. …** Some holograms even appear to move as you walk past them and look at them from different angles. Others change colors or include views of completely different objects, depending on how you look at them.

12. Holograms have other surprising traits as well. If you cut one in half, each half contains whole views of the entire holographic image. The same is true if you cut out a small piece -- even a tiny fragment will still contain the whole picture. On top of that, if you make a hologram of a magnifying glass, the holographic version will magnify the other objects in the hologram, just like a real one.

1. … areas that were light are dark, and vice versa.
2. … by taking two slightly different views of an object and allowing each eye to see only one image, the right image for the right eye and the left image for the left eye.
3. … you don't have to look much farther than your wallet.
4. … four basic steps happen in an instant
5. … they usually just look like sparkly pictures or smears of color.
6. … you see objects from different perspectives, just like you would if you were looking at a real object.

Task 10. Answer the questions.

1. What is the difference between photography and holography?
2. What does ***stereoscopic vision*** mean?
3. How can we see pictures in three dimensions?
4. Can you describe the process of taking pictures with a film camera?
5. What do we see unusual when we develop a holographic plate?
6. Where do we use holograms nowadays?
7. What are divisible properties of a hologram?

Task 11. Find the synonyms for the following words in the text.

1. various (para 1)
2. to comprise (para 1)
3. to get (para 2)
4. to unite (para 2)
5. to sense (para 2)
6. a defect (para 2)
7. to enlarge (para 4)
8. to remove (para 5)
9. completely (para 5)
10. fake (para 9)
11. shining (para 9)
12. exact (para 10)
13. a feature (para 12)
14. very small (para 12)

Task 12. Match the words from the text with their opposites.

1. available
2. illuminate
3. impart
4. receive
5. shortcoming
6. magnify
7. add
8. eliminate
9. precise
10. tiny

a. darken
b. transmit
c. subtract
d. inaccessible
e. enormous
f. deprive
g. create
h. inaccurate
i. diminish
j. advantage

Task 13. Complete the tables. Use the words from the text. Pay attention to the part of speech. Translate all words.

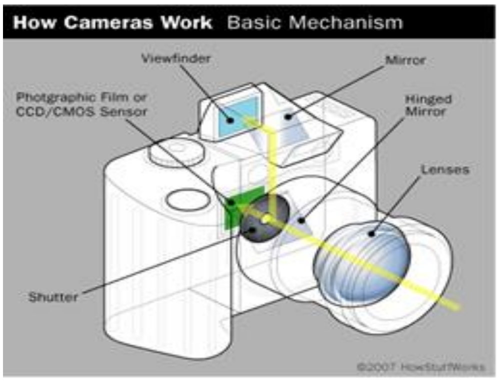
Noun	Adjective
reality	1.
2.	intense
reflection	3.
4.	different
practice	5.
6.	prevalent
refraction	7.
8.	dimensional
accuracy	9.
responsibility	10.

Noun	Verb
11.	add
magnification	12.
13.	interfere
illumination	14.
elimination	15.
16.	develop
creation	17.
18.	direct
reflection	19.
maintenance	20.
21.	distort
composition	22.
interaction	23.
location	24.
generation	25.

Task 14. Underline stress in the following words and practice reading them correctly.

- a photograph – photography – photographic
- a hologram – holography – holographic
- a stereoscope – stereoscopic

Task 15. This is the picture of a camera with its main parts. Tell about the camera describing its parts and their functions.



Recommended function

Study

<u>Function 8 “HOW TO make comparison and contrast”</u>

and write sentences comparing ***3D holography*** with ***2D photography***.

Listening

You are going to watch a video **Fun properties of Hologram**.

Task 16. Make sure you know these words. Then watch the video and check your knowledge.

a fringe pattern, a laser pointer, to appreciate, a semicircular line, a film, swirls, interference, diffraction, width, a slit, a gap, scaling, grains of sand, to propagate, wavelength, path length, to polarize, phase difference, coherent light, to split, reflection, value, to line up

Task 17. Match the terms and their definitions.

1. fringe pattern	a. various phenomena which occur when a wave encounters an obstacle or a slit
2. diffraction	b. the picture which shows the behavior of interference
3. coherent light	c. the relationship in time between the cycles of a light or sound wave and either a fixed reference point or the cycles of another system with which it may or may not be in synchrony
4. interference	d. light waves that are "in phase" with one another

5. phase — e. the combination of two or more electromagnetic waveforms to form a resultant wave in which the displacement is either reinforced or cancelled
6. pathlength — f. the overall length of the path followed by a light ray or a sound wave.

Task 18. Watch the video again and match the parts of the sentences based on the video.

1. If the light is in-phase,
2. If the light is out-of-phase,
3. If you change the pathlength,
4. If you don't have a stable base for the hologram,
5. If you change the width of the slit,
6. If you move the laser pointer around,
7. If I pull the plate back,

a. we'll see less light reflecting.
b. the image gets bigger.
c. we'll see brighter reflections.
d. you'll see that image is moving around for different angles.
e. fringe patterns will be moving.
f. you change the properties of interference patterns.
g. the phase will change too.

Task 19. Complete the table with appropriate words from the video.

1./ə'pri:ʃɪeɪt/		7./semi'sə:kjələ(r)/	
2./'pɑ:θleŋθ/		8./'pəʊləraɪz/	
3./kə(ʊ)'hɪər(ə)nt/		9. /vju:/	
4./vaɪ'breɪʃ(ə)n/		10./bleɪd/	
5./frɪn(d)ʒ/		11./'æŋg(ə)l/	
6./swə:l/		12./'prɔpəgeɪt/	

Task 20. Decode one of the following parts of the recording.

Part 1 - 00.01 "Kids today probably don't appreciate holograms…" – 01.01 "… we'll see less light reflecting."
Part 2 - 01.02 "On the bottom left there's a green laser pointer …" – 02.07 "… on vibration damping tables."
Part 3 - 02.08 "This is a configuration …" – 02.54 "… how we view them with diffraction."
Part 4 - 02.55 "To demonstrate diffraction …" 03.43 "… you can see the image."
Part 5 - 03.44 "For the longest time I didn't understand …" – 04.28 "… I can project clear across the room."

Speaking

Prepare a talk about one use of **Holographic technology**.

Writing

Study

<u>Function 7 "HOW TO deal with neologisms"</u>

and write out all neologisms you have come across in your study and work.

Theme 8. SIMULATION SOFTWARE

Reading, Vocabulary and Listening objectives: simulating different processes and devices, simulation programs **Speaking and Writing objectives:** telling about own experience in simulating **Recommended Grammar:** Conditional Sentences

Lead in

We are going to start with **simulating a circuit**. Are the following statements about simulating a circuit True or False?

- It is much faster to build the circuit in the simulator than in real life.
- If it doesn't work at first, you have to start the simulation again.
- It doesn't simulate components with complete accuracy. There are always some differences between the simulation and the reality.
- You can try components that you don't physically have.
- If it works, you don't need to make a real circuit. Just send the simulation result to the manufacturer.

Reading and Vocabulary

Task 1.There are some types of circuit simulation. Match their names and descriptions.

1. Analog	a. In this type of simulation the circuits are written in RTL (Register-Transfer Level) language, such as Verilog or VHDL. These languages describe the circuit through links or through events. Either way, the simulation of this type of language only looks for changes in the digital signals, and it is therefore event-driven.
2. Digital	b. The not so well known type of simulation consists in changing between analog models at certain conditions. In power electronics, where nowadays switching circuits are dominant, the switching alters the topology of the circuit. The advantage is that, given the flexibility to change the analog model, it can be made linear, which improves speed and stability.
3. Mixed-signal	c. This type is what usually referred as circuit simulation due to the nature of the circuit. It is simulated, while registering and displaying the voltages at the nodes and currents flowing through the components.
4. Piecewise linear	d. The purpose of this type of simulation is to combine analog and digital types. They integrate both types of signals, but keep the digital blocks event-driven (faster simulation) and the analog blocks as linear.

Task 2.a. Make sure you know these words and phrases from the text.

optimization technique	fluctuate (v),	topology
piecewise linear simulation	fluctuation (n)	netlist
switching circuit	superimposed (adj)	event-driven
reference value	sinusoid (n),	mimic (v)
optional value	sinusoidal (adj)	node
initial condition	bode plot	ground (n)
operating point	respond (v), response (n)	terminal (n)
bias point	uncorrelated (adj)	affect (v), effect(n)
quiescent point	deviation (n)	equation
transient analysis	mean (v, n, adj)	parameter
designate (v), designation (n)	debugging	

b. can you explain what these terms mean?

* topology * oscilloscope
* netlist * bode plot
* reference value * operating point

Task 3.Read the text and insert sentences a. to d. into the text.

How does circuit simulation work?

Circuit simulators are complex pieces of code that rely heavily on optimization techniques. They start with models of the components, which mimic their behavior with a certain level of accuracy. The drawn schematic provides not only the components to be used but also how they connect to each other.

Both of these combined allow the generation of a netlist, **1. …** . More complex models may be built by grouping simpler models.

Back to the netlist, the first column is the name of the component, attributed sequentially or user defined. The next columns are the nodes it is connected to (two for voltage sources, resistances and capacitors, but can be more; 0 always refers to the reference or ground). Names started with "r" are resistances, with "c" are capacitors and with "v" are independent voltage sources. Other letters mean other standard components. The remaining columns are component-specific information: "dc 5" means 5V DC, while for resistances and capacitors the only necessary information is their value. As you can see, with these 3 parts:

- Designation
- Connecting nodes
- Component-specific information

you can basically describe any circuit.

How each component behaves is provided by models. Each component has a model, with its own parameters. **2. … .** This could be added to the netlist as such:

c1 2 0 10u ic=0

Finally, commands that describe what type of analysis to run and its specific options are appended to the netlist. For example **.OP** is a DC analysis and requires no parameters.

.AC lin NP SF EF

requests an AC analysis and requires the starting (SF) and ending (EF) frequencies and the number of frequencies to be analyzed in between (NP), among others.

Types of analysis

A circuit simulator runs different types of simulations. Each gives different information about the circuit.

DC Operating point

Analog circuits are usually built to process signals. They are operated at a steady condition (the DC operation point, bias point or quiescent point) and the AC signals fluctuate around that operating point. The most basic analysis is to keep only the DC signals and calculate where the circuit stabilizes. This analysis provides the DC voltages at every node and the DC currents of all terminals.

AC transfer function

Apart from some basic components, such as resistances, capacitances or inductors, most of the components are not linear. They can, however, be linearized around some point. The DC operating point analysis gives the point where the circuit will operate, hence, where it can be linearized. This will affect the sensitivity of each component to their parameters. Having a linear circuit, with the small-signal models of each component, all AC signals applied to the circuit can be superimposed to measure the resulting effect on each node. **3. …** . Since the circuit is now linear, if sinusoidal signals are applied to the circuit, only sinusoids with the same frequency must exist in any node.

Therefore, the AC analysis performs these measurements and takes the amplitude and phase of a sinusoid at a certain node for a range of frequencies. The simulation then plots the amplitude and phase for that range, resulting in a bode plot.

Transient analysis

The transient analysis simulates the response of the circuit to a transient input, in the time domain. This analysis comes naturally, as it is the one that most resembles what you see when you turn on the circuit, apply signals and read a voltage in the oscilloscope. This is the simulation that takes the longest, **4. …** , and the nonlinear equations need to be calculated.

Noise analysis

Every component generates noise, even a simple resistance. Noises have known spectrums and are uncorrelated. They can be seen as unpredictable, unwanted small signals. Similarly to the AC analysis, the circuit can be linearized around its operating point and the sources of noise can be superimposed. The noise analysis measures the noise at a given node.

Monte Carlo analysis

Fabricated components have deviations from sample to sample. The reason is that, due to the fabrication process, every parameter of a component can be in a range of values (with its corresponding mean), instead of a single value. Nominal circuit simulation (all of the above) uses the average value of the parameters for simulation.

Monte Carlo is not a different analysis *per se*, but uses other analysis instead. Parameters usually follow a Normal distribution (although others can be used), with a given mean and standard deviation. Each trial from the Monte Carlo simulation takes a value out of the distribution and runs the simulations explained above with that parameter value.

a. For instance, the resistance model needs the resistance value, while a capacitance model has the initial condition (ic) optional value (the voltage at the capacitance when the simulation starts).
b. … as the circuit needs to be traced during a certain period of time, …
c. … a piece of text that describes each component used in the circuit and to where they connect.
d. Furthermore, given the frequency dependent behavior of capacitances and inductances, the result also changes with the frequency of the AC signals.

Task 4.Answer the questions to the text.

1. What does a model describe?
2. Which type(s) of analysis allow the circuit to be linearized around an operating point?
3. What does Monte Carlo analysis allow to do?

Task 5.Participle 1 and 2 as adjectives. Can you remember what these adjectives referred to in the text? Match them with the nouns and translate them.

* drawn * attributed * user-defined
* remaining * connecting * operating
* resulting * known * unwanted
* fabricated * corresponding * given

nodes, mean, signals, point, name, schematic, columns, effect, spectrums, components

Task 6.What phrases can you make with the words from A and B?

A	**B**
voltage, digital, quiescent, analog, mixed-mode, optional, switching, component-specific, circuit, operating, reference, bias, linear, sinusoidal, transient, non-linear, noise, average	value, circuits, analysis, sources, signals, information, point, equations, simulators, input,

Specialized reading

Task 7.a. Read the text and complete the table.

	Text A	Text B	Text C	Text D
1.What is the challenge to be solved?				
2.What institution is involved into the research?				
3.What do/did they use simulation for?				
4.What was/will be the result of their simulation?				

b. can you give some more examples of using COMSOL Multiphysics for simulation?

COMSOL Multiphysics®

The Platform for Physics-Based Modeling and Simulation

COMSOL Multiphysics® is a general-purpose software platform, based on advanced numerical methods, for modeling and simulating physics-based problems. With COMSOL Multiphysics, you will be able to account for coupled or multiphysics phenomena. With more than 30 add-on products to choose from, you can further expand the simulation platform with dedicated physics interfaces and tools for electrical, mechanical, fluid flow, and chemical applications. Additional interfacing products connect your COMSOL Multiphysics simulations with technical computing, CAD, and ECAD software.

Here you will find success stories from leading high-tech organizations and research institutions from around the world.

A. Keeping LEDs Cool Gets More Manageable Through Simulation

Light-emitting diodes (LEDs) offer many benefits over incandescent lighting, such as long life spans and high luminous efficiency, and they are environmentally friendly. One of the drawbacks, however, is that LEDs need to operate at the lowest possible temperatures and this must be carefully regulated. Researchers at Business and Innovation Development Technology at the University of Turku in Finland have focused their attention on designing an efficient and inexpensive heat sink to regulate temperature. Simulation was crucial to their process as building prototypes is an expensive and time-consuming process.

Large manufacturing companies, such as Philips and Hella Lighting, use simulation to improve their LEDs as well. Simulation in COMSOL Multiphysics allows companies to determine the effect of new materials on the thermal behavior of the LED lighting device before a sample of that new material is even required for testing.

B. Pushing the Limits of Chip Density

Chip manufacturers have been adhering to Moore's law, a law stating that the number of transistors that can be economically placed on an integrated circuit doubles every year, since 1965. As the number of transistors increases, however, the process of manufacturing integrated circuit, called photolithography, becomes more difficult. Each device requires approximately 200 cleaning and photolithography steps and any failures in this process can cost millions. Tokyo Electron America (TEL), a producer of manufacturing tools vital to the processing of integrated circuits, used simulation to understand a type of failure called pattern collapse. Pattern collapse occurs when cleaning fluid between two features evaporates and the changing surface tension occurring during the evaporation causes the features to bend. Ideally, those features return to their normal shape, but sometimes they are permanently deformed.

Using COMSOL Multiphysics, researchers at TEL created a 2D structural mechanics model based on a series of steady-state calculations with the surface tension forces as boundary conditions. They compared those results with experimental data from literature and found that the model accurately predicted the critical aspect ratio for collapse.

C. Nanoresonators Get New Tools for Their Characterization

Nanoresonators, or optical nanoantennas, manage the concentration, radiation, and absorption of light at the nanometer scale and show stunning promise for future improvements to technology, such as sensors, computers, and other electronics. However, the ways that these devices scatter light and interact with their surrounding environment are not well understood, nor are the electromagnetic properties of the complex metal shapes that comprise them. Numerical approaches to calculating the resonance modes and excitations in nanoresonators have historically been cumbersome and error-prone.

Now, researchers and engineers at Institut d'Optique d'Aquitaine (Paris, France) are using COMSOL Multiphysics simulations to rapidly and precisely determine physical properties, calculate the resonance modes, and analyze the electromagnetic fields and scattering that occur due to excitation. They expect that their new approach to modeling these nanoresonators will lead to advancements in the development and use of nanoelectromechanical devices (NEMS) for a wide range of applications such as photovoltaics, spectroscopy, and improved electronic systems.

D. Meeting High-Speed Communications Energy Demands Through Simulation

The information and communication technology industry needs new energy-efficient devices that can keep up with the explosive growth in data traffic of the last few years. Bell Labs, the research arm of Alcatel-Lucent, is taking the lead in an initiative to reduce the carbon footprint of high-speed communication devices and platforms by investing in new methods for cooling electronics and harvesting energy.

The team at Bell Labs used COMSOL Multiphysics to simulate the optical, thermal, and electrical performance of laser systems with integrated microthermoelectric coolers; they used their results to optimize designs of photonic devices and take advantage of the thermoelectric effect. They also simulated the structural, magnetic, and electrical behavior of electromechanical systems to investigate the best design for converting mechanical vibrations into electricity, which will reduce the need for frequent battery replacements for wireless sensors. With their continued research into these topics and the power of simulation, many new technologies for improving energy efficiency are on the horizon.

Task 8.Read and translate the text into Russian.

Task 9. a. What are the Russian equivalents for the following words and phrases?

numerical methods, physics-based problems, add-on products, incandescent lighting, luminous efficiency, heat sink, thermal behavior, integrated circuit, pattern collapse, surface tension, evaporation, steady-state calculations, boundary conditions, critical aspect ratio, stunning promise, surrounding environment, resonance mode, excitation, nanoelectromechanical device, photovoltaics, energy-efficient device, data traffic, carbon footprint, cooling electronics, harvesting energy, wireless sensor

b. Give definitions to the following terms in English:

luminous efficiency, heat sink, steady-state calculations, photovoltaics, data traffic, harvesting energy, wireless sensor

Task 10. a. Complete the following verb combinations with the phrases from task 3.

- to show … for future improvements
- to be based on …
- to calculate …
- to change …
- to predict … for collapse
- to design … to regulate temperature
- to reduce …
- to model and simulate …

b. Use these verbs to make your own sentences.

Task 11. Find synonyms to the following words and phrases

1. latest (intro)
2. explain (intro)
3. highly specialized (intro)
4. problem (text A)
5. important (text A)
6. to find (text A)
7. bad luck (text B)
8. to happen (text B)
9. irreversibly (text B)
10. to control (text C)
11. amazing (text C)
12. to diffuse (text C)
13. tedious (text C)
14. unreliable (text C)
15. success (text C)
16. overwhelming (text D)
17. improve (text D)
18. to take hold of (text D)

Task 12. ***Task 6 .a. What are the adverbs for these adjectives? Translate them into Russian.***

electrical, mechanical, environmental, careful, efficient, inexpensive, economic, ideal, experimental, accurate, historic, frequent

b. Use some of them – adjectives or adverbs - in the following sentences.

1. The aim is to design a package the size of a mobile phone that will run on batteries, and to … stimulate the patient's own muscles.
2. This experiment should be a reasonably … one and could be done in one day.
3. Numerical methods are … suited for modern simulation technologies.
4. This book is … inaccurate.
5. These channels establish on-demand or … virtual channels for user traffic between the switches.
6. His passion was … powered vehicles.
7. Now that is the most significant … impact that humans can have on the planet.
8. More powerful processors are demanded all the time in order to more … read seismic data.

Task 13. ***What words do these phonemics examples refer to?***

1./’Ɵɜːməl/		8. /ˈkʌp(ə)ld/	
2./ɪnkənˈdes(ə)nt/		9. /ˌfəʊtə(ʊ)lɪˈθɒgrəfi/	
3./ɪˌvæpəˈreɪʃ(ə)n/		10. /ˈluːmɪnəs/	
4./əbˈsɔːpʃ(ə)n/		11. /ˈfeɪljə/	
5./mʌltiˈfɪzɪks/		12. /mɪˈkænɪks/	
6./ˈkʌmbəs(ə)m/		13. /ˌfəʊtə(ʊ)vɒlˈteɪɪks/	
7./vʌɪˈbreɪʃ(ə)n/		14. /ɪˈnɪʃətɪv/	

Recommended function

Read

<u>**Function 4 “HOW TO deal with non-finite forms of the verb”**</u>

and find examples of Participle I, II, Gerund and Infinitive in text 2.

Listening

We are going to watch a video called **LDMOS TCAD simulation Tutorial.**

LDMOS stands for ***Laterally Diffused Metal Oxide Semiconductor*** and it’s a type of power MOSFET, used in microwave/RF power amplifiers. They are now widely used in transmitters with power levels up to about 50 kW thanks to continuous and dramatic advancements in their output power, efficiency, and ruggedness.

Task 14. Look at the words and phrases used in the video and make sure you know what they mean.

laterally diffused, channel, compatible, integrated power circuit, cross section, substrate, electrode, source, drain, gate, n-well, design mask, mask layer, pre-set parameter, trench, oxide isolation, photo-resist layer, polysilicon layer, via hole, mesh, grid line, mesh plane, mix-coordinate system, electrical boundary, electrode definition, angle degrees, impact ionization, breakdown, conversion, field distribution, potential distribution, current-density distribution, mesh plane cut

Task 15. Watch the video and answer the questions.

1. What sort of MOSFET is LDMOS transistor?
2. Where are LDMOS mostly used?
3. Why is 3D TCAD simulation of LDMOS difficult to do?
4. What did Crosslight company develop to take into account the special structure of LDMOS transistor?
5. What does this tutorial show?
6. What program is used to design masks?
7. What program is used for the final process of file input?
8. What are possible units for the Z coordinate in mix-coordinate system?
9. What program is used for device simulation?
10. Which parameters of the pre-set input file were mentioned?
11. What are the results of the simulation?

Task 16. These are some verbs from the video. Match the nouns they were used with.

1. to sustain	a. a special symmetry of LDMOS
2. to implant	b. boron or phosphorous
3. to take into account	c. the substrate material and thickness
4. to ground	d. the bottom side of the substrate
5. to deposit	e. a layer of metal
6. to enhance	f. a thin oxide layer
7. to enable	g. the p-type
8. to assign	h. breakdown physics
9. to launch	i. high power and high current
10. to activate	j. a number for each electrode
11. to grow	k. a programme
12. to etch	l. the simulation
13. to set	m. a polysilicon

Task 17. Complete the part from the video with the words and phrases from the list. Then watch it again and check.

channel, source electrode, boron oxide, cross-section, drain electrode, electrical current, different materials, original substrate

The basic structure of LDMOS can be seen from this schematic 2D 1. … extracted from a 3D structure. This is a net-doping plot. We use red line to indicate 2. … in the device. The region below y=0 is the 3. … with some parts replaced by the oxide during device process. Part of the substrate region has been implanted with 4. … . Metal is used to form electrodes. The metal piece on the left is the 5. … . The piece on the right is the 6. … . Polysilicon is used for the gate. And the bottom side of the substrate is usually grounded. The blue region below the silicon is the 7. … , which is controlled by the poly gate. 8. … flows from the drain, along silicon oxide interface and the p-channel on the left side, all the way to the source electrode. We'll discuss more detailed steps later in this tutorial.

Task 18. Decode one of the following parts from the video.

1. 02.29 "Let's start with the design masks for the device." – 04.06 "… after using the mask layer."
2. 04.08 "… the next mask layer is used for…" – 05.23 "… will remain as oxide isolation."
3. 05.25 "The next mask layer consists of two parts." – 06.33 "Again it consists of two parts."
4. 06.34 "A layer of metal is deposited …" – 07.55 "… to select the mix-coordinate system cuts."
5. 09.10 "To run the device simulation…" – 10.40 "… we click Save and Generate."
6. 10.47 "Now, let's start Apsys device simulation." – 11.59 "Now we are ready to launch the simulation."
7. 12.02 "Let's just quickly check out the simulation results." – 13.48 "… that concludes our tutorial."

Speaking

Prepare a talk about application for simulation any process or device. Talk about the following:

1. What is its name and who is its developer?
2. What sort of simulation is it designed for?
3. What types of simulation can it perform?
4. What did you use it for? Tell about it in detail.
5. What are its advantages and disadvantages?

Writing and Recommended function

Write a paragraph comparing the application you told with its analogues. Use **Function 8 "HOW to make comparison and contrast".**