Министерство науки и высшего образования Российской Федерации
Федеральное государственное бюджетное образовательное
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«Томский государственный университет систем управления и радиоэлектроники»

КАФЕДРА ИНОСТРАННЫХ ЯЗЫКОВ

ENGLISH FOR EMI/EMC GRADUATE STUDENTS

Учебное пособие

Томск 2019

Шпит Е.И.

English for EMI/EMC Graduate Students (Английский язык для студентов магистратуры, изучающих вопросы ЭМС). Учебное пособие/ Шпит Е.И. - 2019.
Министерство науки и высшего образования Российской Федерации, Федеральное государственное бюджетное образовательное учреждение высшего образования «Томский государственный университет систем управления и радиоэлектроники», Кафедра Иностранных языков. – Томск: ТУСУР. 2019 – 55 с.

Аннотация

Данное пособие является основным учебным пособием для студентов магистратуры, обучающихся по направлению 11.04.01 Радиотехника и 11.04.02 Инфокоммуникационные технологии и системы связи, по профилям подготовки «Электромагнитная совместимость радиоэлектронной аппаратуры», «Электромагнитная совместимость в топливно-энергетическом комплексе», «Защита от электромагнитного терроризма».

Пособие состоит из 6 тем, в рамках которых изучаются как общие аспекты обучения в академической магистратуре, так и специализированные, а именно, касающиеся вопросов электромагнитных помех и электромагнитной совместимости. Каждая тема содержит два текста и видеоматериал для формирования и совершенствования знаний, умений и навыков, обозначенных рабочей программой по дисциплине, и направленных на формирование универсальных компетенций, обозначенных ФГОС 3++ (УК - 4, 5, 6).

С точки зрения языкового содержания, пособие призвано формировать и совершенствовать языковые навыки обучающихся для осуществления ими задач академического и профессионального взаимодействия. С точки зрения методических и педагогических подходов, пособие направлено на развитие навыков образовательной самостоятельности и самооценки.

СОДЕРЖАНИЕ

Theme 1. EARNING A DEGREE

Reading, Vocabulary and Listening objectives: basic academic language, learning and research activities, graduate degree program
Speaking and Writing objectives: tell and write about doing a Master's program
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 Master's programs 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 processing	innovation
media compression	communications network	seamless
embedded system	industrial studies	sophisticated
spoken language processing	individual project	enhanced
image interpretation	be designed to	advance
3D environment	equip	linkage
communications engineering	research	requirement
advanced digital design	development	qualify
		secure

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

Task 2. Read the text and complete the table after the text with the information about the University of Birmingham.

UNIVERSITY OF BIRMINGHEM

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 used in 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.

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 3. Complete the column for your university and compare with your partner.

Task 4. 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

Read and translate the text.

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 degrees 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 1. 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 have 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 2. 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 3. Match the following terms with their Russian equivalents.

1.coursework	a) квалификационный (комплексный) экзамен
2.comprehensive examination	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, по специальности
6.thesis	g) итоговая работа, включающая результаты использования знаний в процессе производственной практики

Task 4. Match the verbs in box A with the nouns in box B to make phrases and translate them.

A	B
do, include, receive, earn, pursue, hold, accomplish, accept, offer, complete	coursework, research work, a degree, a program, a thesis, the aim

Task 5. Find synonyms to the following words and phrases in the text.

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

Task 6. Match the following colloquial phrases with their Russian equivalents and use them in your own sentences.

1.to boil down to smth
2.as a basic rule of thumb
3.to have a firm grasp
4.to be a step above smb
5.in consider smth versus smth

a) быть на голову выше кого-либо
b) сводиться к чему-либо
c) рассматривая что-либо против чего-либо
d) в качестве общего правила
e) хорошо представлять себе

Task 7. 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 **Function A1 “HOW TO deal with sentence parts”** and **A2 “HOW TO translate an English sentence”.** Prepare the analysis of 3 different sentences from the text with respect to the syntax.

Video

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

Task 1. 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 2. Answer the questions on the video.

1. Why did he decide to do a Master's program at 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 3. Decode one of the parts of the video:

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

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 are you expected 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

Write a short paragraph about **your studies**. Use the questions from Speaking task and the following phrases in your text:

…be designed to/for… …be free to do smth…

…equip smb with the knowledge and skills…
…develop ideas…
…rapid advances in technology…
…continuing advances in smth…
…play a leading part in…
…a wide range of choices…
…be vital to smth…
…provide an opportunity for you to do smth…
…a topic related to smth…
…meet the requirements…
…pass examinations at the first attempt…
…provide training…
…guarantee a placement…
…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	constant
arithmetic series	integer	magnitude
regular polygon	straightedge	angle
natural number	compass	plane
triangular number	heptagon	mid-plane
parallel postulate	heptadecagon	equation
non-Euclidean geometry	polynomial	argument
differential geometry	prime	curvature
conformal map	congruence	circle
method of least squares fitting	treatise	theorem
product	surveying	area

b) Check the pronunciation:

mathematician	straightedge
geometry	compass
geodesy	theorem

geophysics	observation
astronomy	plagiarism
analysis	treatise
integer	successful
heptadecagon	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 Friedrich Gauss (30 April 1777 - 23 February 1855) was a German mathematician, who is sometimes called the "prince of mathematics", and physical scientist who contributed significantly to many fields, including number theory, statistics, analysis, differential geometry, geodesy, geophysics, electrostatics, astronomy and optics.

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, **1)** … . 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 (**2)** … .)

Gauss proved the fundamental theorem of algebra, **3)** … . In fact, he gave four different proofs, the first of which appeared in his dissertation. In 1801, he proved the fundamental theorem of arithmetic, **4)** … .

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). **5)** … .

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 **6)** … . 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.* **7)** … . 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 **8)** … . 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.

a) … which states that every polynomial has a root of the form *a+bi.*
b) … which states that every natural number can be represented as the product of primes in only one way.
c) … it would look like a circle.
d) … Gauss immediately wrote down the correct answer 5050.
e) Gauss proved that every number is the sum of at most three triangular numbers and developed the algebra of congruencies.
f) … with William Weber measured the intensity of magnetic forces.
g) … a heptagon, for example, could not be constructed.
h) 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 of 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. What are the people working in these fields called? Complete the table.

Fields	People
mathematics	
physics	
astronomy	
optics	
chemistry	
biology	
geography	
ecology	

Specialized reading

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:

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

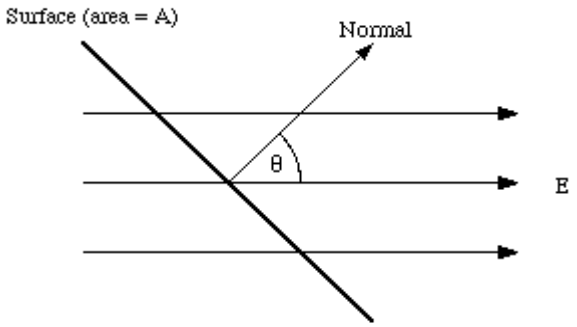


Fig.1 Electric flux through surface area A.

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

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

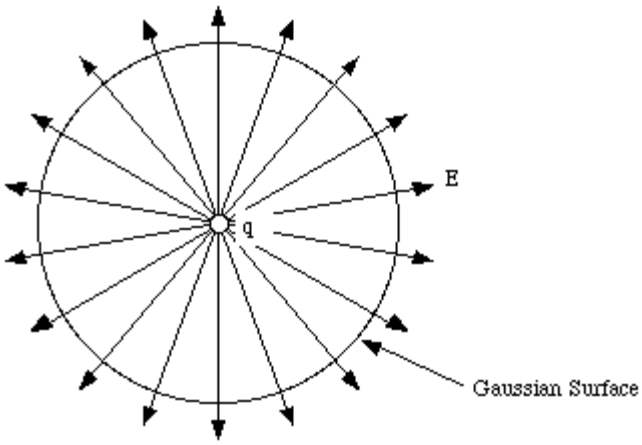


Fig.2 Electric field generated by point charge q.

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 field at a distance **x** from the mid-plane?

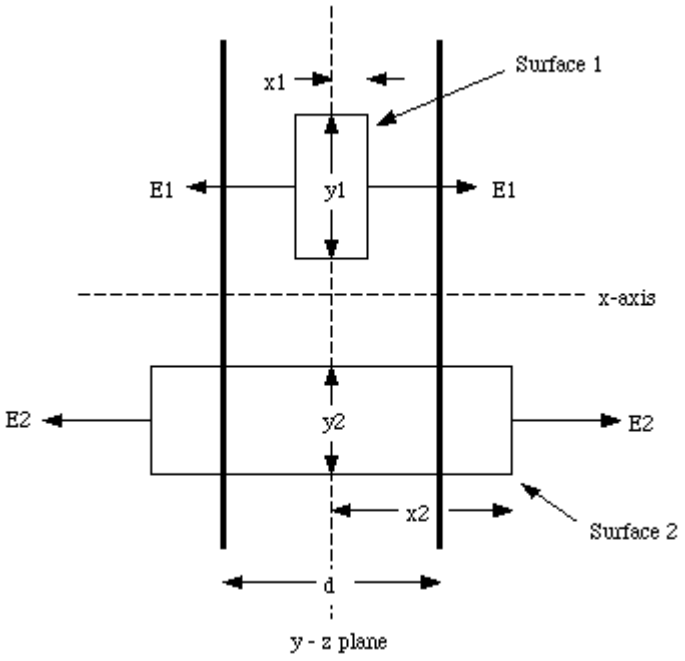


Fig.3 Problem 16.

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 field. 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

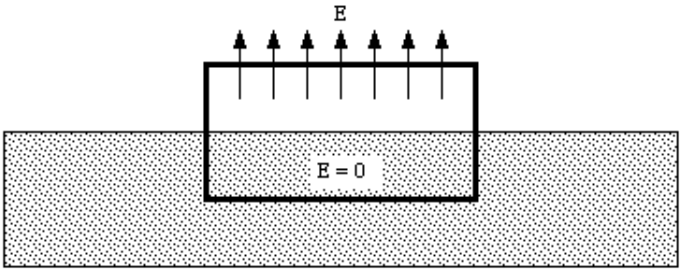


Fig.4 Electric field of a conductor.

$$Q = A\sigma$$

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

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

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

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

Task 1. 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 2. Put these words into the groups: nouns, adjective and adverbs, and translate them.

complicated, 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. 3. How do you pronounce these symbols and what do they mean?

Symbol	Pronunciation	Meaning
Φ		
ε		
θ		
π		
ρ		
σ		

Task 4. 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 5. Write the words from the text to the following phonemics.

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

Task 6. 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 **Function B4 “HOW TO say numbers and formulas”** and pronounce all the formulas in the text.

Video

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

Task 1. 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
одноименные заряды	знак (+, -)
разноименные заряды	ноль
притягиваться	числитель

отталкиваться	знаменатель
сильный	произведение
слабый	удваивать

Task 2. 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 3. Pronounce all the formulas from the video.

Task 4. Translate the following sentences into English.

1. Предметы с одинаковыми электрическими зарядами отталкиваются, а с противоположными – притягиваются.
2. Если разноименно заряженные объекты приближаются, то электрическая сила между ними становится сильнее.
3. Стрелочки показывают, насколько сильна электрическая сила между зарядами.
4. Когда мы увеличиваем расстояние между объектами в два раза, электрическая сила уменьшается в четыре раза.
5. Нейтрально заряженный объект не взаимодействует с другими объектами.

Task 5. Decode one of the parts of the video:

Part 1 – 00.28 “Matter can be …” – 01.12 “… with electrically charged objects.”
Part 2 – 01.13 “The closer two charges …” – 01.57 “… 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 **Function D3 “HOW TO make a presentation”** and prepare a mini-presentation about a scientist and a law 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.

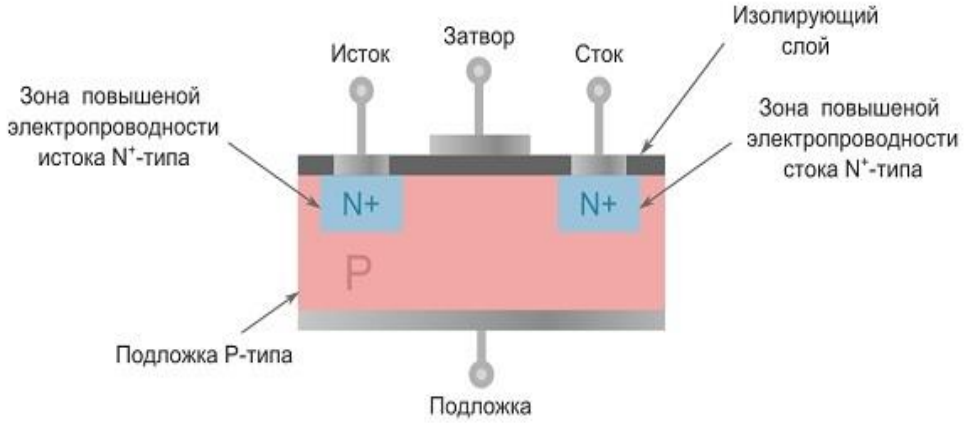
Theme 3. INSIDE A COMPONENT

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
Recommended Grammar: Future Simple and "be going to"

Lead-in

Work in pairs and answer the questions about **a transistor**.

1. Do you know who created the first transistor and when?
2. What is the transistor used for?
3. Look at the picture and name its parts in English.
4. What materials are used to make it?



Reading and Vocabulary

Task 1. a) What do these words mean? Give their Russian equivalents.

inductor (n), inductance	perform (v), performance	resist (v), resistance
stray inductance	address (v)	excess (n, v)
capacitor (n), capacitance	minimize (v)	choke (n)
amplifier (n), amplify (v)	power supply	winding (n)
switch (n, v)	differential mode	propagate (v)
approach (n, v)	common mode	saturate (v), saturation
circuit (n)	suppress (v), suppression	bill of materials

circuit designer	cause (v, n)	open-frame
noise (n)	solve (v), solution (n)	enclosure (n)
line frequency	conduct (v)	enhance (v)
distinct (adj)	unrelated (adj)	yield (v, n)
considerable (adj)	savings (n)	ratings (n)
require (v), requirement	value (n)	differ (v), different (adj)

b) Do you know these types of noise:

internal, external, RF, line frequency, differential mode, common mode

Task 2. a) You are going to read the text about a choke. What do you know about chokes? b) Read the text and choose the best name for it:

A) Differential Mode (DM) filters address common mode noise issues
B) Common Mode (CM) filters can cope with differential mode noise
C) Dual-function Chokes address DM and CM noise in a Single Compact Component

***

Circuit designers must deal with many types of noise: internal, external, RF, line frequency and more. Regardless of type or source, noise can be a limiting factor in system performance and so must be addressed and minimized.

Even the widely-used switched-mode power supply (SMPS) has noise issues. Due to its efficiency and small size, this architecture is widely used in applications including LED drivers and electronic ballasts. Unfortunately, SMPS units also are subject to differential mode (DM) noise and common mode (CM) noise, both of which must be suppressed for both performance and regulatory reasons.

Understand the Noise Mechanisms and Solutions

DM and CM noise have different causes and thus different solutions.

DM noise is noise that is conducted on the line and neutral (ground) in opposite directions. The basic DM filter uses a single-winding choke (inductor) inserted into the line path, along with a capacitor from line to neutral, thus blocking noise from propagating through the system. It must be designed to provide the needed inductance but do so with low DC resistance (DCR) to handle both the RMS current and the peak line current without saturating.

CM noise is conducted on both the line and neutral in the same direction. The basic CM filter uses a dual-winding inductor in both line and neutral paths, plus a capacitor from line to ground. The CM filter choke only needs to have the required inductance along with sufficiently low DCR for the RMS current.

A Better Implementation from Triad Magnetics

Since the DM and CM noise mechanisms are largely unrelated, their solutions require two different chokes and arrangements. It would be fortunate if the two noise-

suppressing approaches could be implemented by a single choke — saving space, simplifying the bill of materials (BOM) and reducing cost.

A new component series from *Triad Magnetics* combines both chokes into a dual-function, open-frame design that provides the features of both chokes in a single, smaller, more cost-effective package. These CMF Series Common Mode Chokes (Figure 1) are more than an ordinary co-packaging of two distinct devices into a single enclosure. Instead, their mechanical design enhances the combined electrical performance, while yielding considerable savings in size and cost.

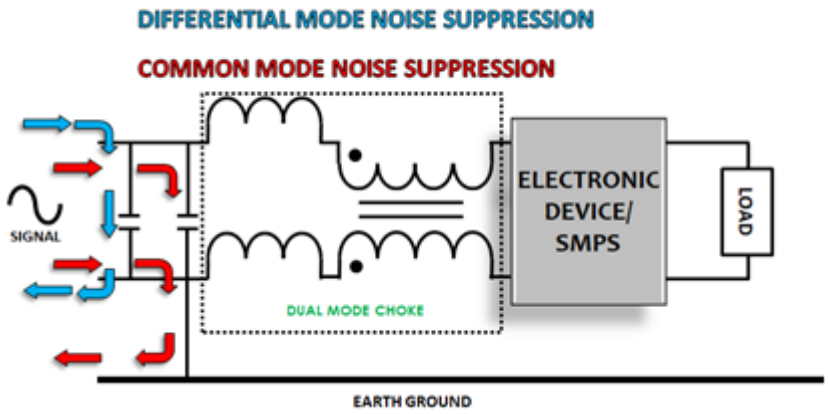


Fig.1

There are 21 unique models in the CMF Series with current ratings ranging from 0.45 to 2.3 A with inductances from 10 to 100 mH, and stray inductances from 200 to 2100 mH. DC resistances are between 188 to 2930 mΩ, depending on the specific model. They are an excellent choice for most designs, unless the CM and DM filter inductance values differ significantly.

Task 3. Read the text again and answer the questions.

1. Why is it important to minimized noise effects?
2. Why are switched-mode power supplies widely used in LED drivers and electronic ballasts?
3. What is the difference in the mechanism of DM and CM noises?
4. What is the difference in requirements for chokes for different mode noises?
5. What are the advantages of a choke from *Triad Magnetics*?
6. What is the main condition which should be followed in the circuits to use these chokes?

Task 4. The text mentions some parameters. Can you explain what they mean?

- system performance
- inductance
- DC resistance
- RMS current
- peak line current
- saturation
- stray inductance
- architecture

Task 5. Work with your partner and describe the picture. Tell the class.

Specialized reading

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.

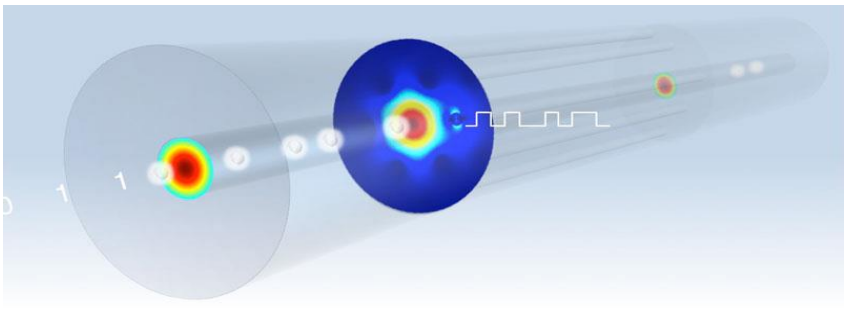
3.Integrating devices in the fiber would eliminate the need for such coupling, Badding says. "This is going to enable 'all-fiber optoelectronics,' a vision where you can do all the light processing for telecom or other applications in the fiber," he says.

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 1. 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 2.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 diodes inside the fiber carried out at the Southampton University?
5. What method has been used by the researchers at MIT and Clemson?

Task 3. 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 4. Match the parts of phrases from the text and translate them.

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 5. Find synonyms and opposites to the following words and phrases.

Synonyms	**Opposites**
1. a method (para 1)	1. wide (para 2)
2. connection (para 3)	2. to lose (para 5)
3. a dream (para 3)	3. full (para 9)
4. to combine (para 4)	4. different (para 9)
5. to modernize (para 4)	5. inaccurate (para 10)
6. to cover (para 6)	6. to make worse (para 10)
7. finally (para 8)	
8. a manner (para 8)	
9. especially (para 9)	
10.intrinsically (para 9)	

Task 6. 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 7. What are the words from the text?

1./spek'trɔskəpi/		8./prɪ'kə:sə/	
2./maɪkrɔ'mɪtə/		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 **Function C4 "HOW TO comment on a visual aid"** and prepare a comment on the diagrams from two texts in this Theme.

Video

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

Task 1. Match the following terms with their definitions.

1. ferroelectric material
2. electric polarization
3. non-volatile memory
4. switching

a) diverting an electrical current from one state to another

b) computer memory that can retain stored information even when not powered

c) a dielectric which, in a certain temperature range, has its own spontaneous electric dipole moment

d) the vector field that expresses the density of permanent or induced electric dipole moments in a dielectric material

Task 2. Watch the video and underline the words you hear.

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

Task 3. Answer the questions on the video.

1. What does professor Xiaoqing Pan tell about in this video?
2. What is ferroelectric material?
3. How does the process of switching occur in this material?
4. What do the researchers still don't understand about ferroelectric memory?
5. Where are these materials especially important?

Task 4. 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 5. Decode one of the following parts.

Part 1 - 00.39 "So, I guess, to start off, I was wondering …" – 02.02 "… we can design better memory."

Part 2 - 02.03 "Maybe we can start …" – 03.52 "… switch between 0 and 1."

Part 3 - 03.53 "Was this surprising to see?" – 05.22 "… who design future memories."

Speaking and Recommended function

Study **Function C1 "HOW TO define a thing and explain its use and structure"** and 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 and Recommended function

Study **Function C2 "HOW TO describe a process"** and describe some process involved into your studies. Add a picture of it.

Theme 4. NOISE INTERFERENCE

Reading, Vocabulary and Listening objectives: different types of noise, their mechanism and measurement
Speaking and Wring objectives: telling about a type of noise in detail: its source, effect, measuring equipment, means to suppress it
Recommended Grammar: Present Simple Passive and Past Simple Passive

Lead-in

Are the following statements true or false?

1. Mobile phones interfere with important electrical equipment.
2. Mobile phone technologies cause cancer.
3. Mobile phones can put your pacemaker out of action.
4. Bluetooth interferes with Wi-Fi.
5. Bluetooth is bad for your health.

Reading and Vocabulary

You are going to read **three stories about accidents** which happened because of interference. First read the words and phrases and make sure you know them.

emit (v), emission (n)	vital functions
interfere (v), interference (n)	lethal threat
shield (v), shielding (n)	susceptible (adj), susceptibility (n)
vulnerable (adj), vulnerability (n)	long-range antenna
audible alarm	malfunction (v, n)
warn (v), warning (n)	put out of action (v)
decipher (v)	disrupt (v)
conducted emission	affect (v), effect (n)
radiated emission	power line
external source	noise source
ground-based radar	noise victim
electronic warfare exercise	circuit noise
digital circuit	amplify (v), amplifier (n)
analog circuit	equipment (n)
significantly (adv)	be exposed to (v)
damage (v, n)	result in (v)

Task 1. Read the text and formulate the reasons for the accidents based on the texts.

Story 1.

The British Columbian ferry operator demands at least $4 million in damages from SAM Electronics GmbH for the Dec. 20, 2011 crash at Duke Point, which injured seven passengers and nine crew members and required several months for repairs.

In its court document, BC Ferries states that an isolating amplifier in the bow propulsion pitch control system (механизм управления носовым выравниванием движения), which controls the angle of the propeller blades (лопасти винта), was not properly shielded against electromagnetic interference, resulting in the crash. In addition, the controls for the equipment were difficult to decipher and no audible alarm to warn the crew of danger was available.

The ferry struck the Duke Point dock at a speed of approximately 5.6 knots, resulting in damage to both the vessel and the dock. The ferry was reportedly out of service for 23 days, while the dock was closed for repairs for three months.

Story 2.

The airspace over the Atlantic Ocean immediately east of New York's John F. Kennedy International Airport is sort of a "Bermuda triangle" of electromagnetic interference (EMI). This is the clear conclusion of Harvard University researcher Elaine Scarry. In three articles, she suggests that EMI from external sources may have played a common role in the 1996 crash of TWA Flight 800, the 1998 crash of Swissair Flight 111, and the 1999 crash of EgyptAir Flight 990. All three airplanes departed from John F. Kennedy International Airport, flying through a region heavily covered by various ground-based radars and very near the areas where the U.S. military has been known to conduct operations, including electronic warfare exercises.

With jet airliners coming to depend ever more heavily on electronic systems for vital functions, Scarry believes their vulnerability to EMI poses a potentially lethal threat to air safety.

Story 3.

Susceptibility of medical equipment to conducted and radiated emission is a huge problem. In this case, a 93-year-old heart attack victim was in an ambulance car going to the hospital and the medical technician attached a monitor/defibrillator machine to the patient. Because the machine stopped working every time the technicians turned on the radio transmitter to request medical advice, the patient died. An investigation showed that the monitor/defibrillator was exposed to exceptionally high radiation emissions because the ambulance roof had been changed from metal to fiberglass and fitted with a long-range antenna. Reduced shielding combined with a strong radiated radio signal resulted in EMI to the vital machine.

Task 2. Read the texts again and answer the questions.

1. What was the result of the accident in the first story?
2. What area is considered to be "Bermuda triangle"?
3. Why did the ambulance car become more susceptible to external sources?

4. What electronic devices in the stories started to malfunction because of EMI?

Task 3. Match the following words and phrases from the texts with their Russian equivalents.

1. a ferry	a) экипаж судна
2. an angle	b) совет
3. a crew	c) паром
4. a vessel	d) мед. работник
5. airspace	e) судно
6. a jet airliner	f) угол
7. a victim	g) воздушное пространство
8. advice	h) стеклопластик
9. fiberglass	i) жертва
10. a medical technician	j) реактивный самолет

Task 4. Read the text again and deduce the meaning of the following verbs.

a) … is seeking … (story 1)
b) … struck … (story 1)
c) … departed … (story 2)
d) … heavily covered … (story 2)
e) … poses … (story 2)
f) … attached … (story 3)
g) … shut down … (story 3)
h) … fitted … (story 3)

Specialized reading

Read and translate the text.

NOISE SOURCE ORIGIN

There are various situations to cause an electric current that can be a noise source. We will look at the following three typical cases of noise sources to understand the mechanism of causing noise and the general coping strategies.

1. Signal
2. Power supply
3. Surge

1. In case that signal becomes a noise source or victim

Generally in order to transmit information through an electric circuit, some amount of electric current is required even if it is very small. Then, the current creates an electromagnetic field around it. When the current changes in accordance with the information, it emits radio waves to the surrounding, which in turn is causing noise. As the amount of information increases, the frequency of the electric current that goes through the signal line increases, or more lines may be required. 1)… Therefore, the higher the performance of electronic devices becomes, and the more information is processed, the more likely that the signal lines used in the electronic devices can easily cause noise

interference.

Electrical circuits that transmit information can be broadly classified into analog circuit and digital circuit, wherein analog signal and digital signal are respectively used. The general characteristics of those are described below from the viewpoint of circuit noise.

(1) Analog circuit ∨

(2) Digital circuit ∨

2. In case that power supply becomes a noise source

Since power supply is essentially a circuit that provides only direct current or commercial frequency, it should be unlikely to become a cause or pathway of electromagnetic noise. However, in many cases, it actually becomes a cause or pathway of noise. This is considered to be due to reasons as follows:

1. even though the voltage seems stable, its electric current may contain a large amount of high-frequency current flowing to operate the electric circuit
2. since the power line is a shared wire in the circuit, noise is circulated and affects the entire circuit
3. since the ground in particular is often shared throughout the equipment and provides a common voltage, it is hard to separate it
4. since it is the energy source for the equipment, the noise energy also becomes large.

Typical examples where the power supply causes noise are contact noise and switching power supply.

The contact noise is a type of noise 2)… Since a very high voltage occurs and the flow of transient but high-frequency current spreads radio waves, it can cause a circuit failure or can lead to malfunction of the surrounding electronic devices.

Switching power supply is a circuit 3)… Since the section of intermitting the electric current generates a high-frequency energy, it causes noise interference when it leaks out to the outside. This intermittent current contains high-frequency energy. Although most of this energy is usually absorbed by input capacitors and/or output smoothing circuit, even a small amount of leakage can be a noise source for the surrounding circuits. In order to eliminate noise in the switching power supply, a low-pass filter that uses L and C is used in addition to the input capacitors and/or output smoothing circuit (noise can also be suppressed by improving the performance of input capacitors and output smoothing circuit). Apart from DC-DC converter, an inverter that drives a motor is also a type of switching power supply that can generate noise.

In contrast, from the viewpoint of noise victim, power supply is a circuit that is relatively less likely to get affected. Since the amount of energy used internally is large, it will not be easily affected by interference. 4)… For example, when an electronic device is affected by noise, or when an electronic device emits noise, the AC power cable becomes a doorway for noise. Therefore, many electronic devices use EMI suppression filters in the power line. Since the EMI suppression filters used for power supply generally draw an electric current significantly larger than that of signals, parts that are capable of drawing a large current are required.

3. Noise occurrence due to surge

An unintended excessive voltage or current due to electrostatic discharge or on-off switching is called surge. Since the level of voltage and/or current is significantly larger than that of normal circuit operation, it can cause malfunction or damage to the circuit. 5)… Typical surges are electrostatic surge, switching surge and lightning surge etc. Surge is one of the major categories of EMC measures.

(1) Electrostatic surge ∨

(2) Switching surge ∨

(3) Lightning surge ∨

Task 1. Insert these sentences or sentence parts into the text.

a) … that occurs at a point of contact when the source current is turned on/off with a switch (it is particularly strong when turned off), which has the same meaning as the switching surge.
b) However, power supply can be a conduction path for noise.
c) In order to prevent this from happening, surge absorbers are used for the wiring, which surge can enter.
d) Generally the higher the current becomes, or the higher the number of lines becomes, the stronger the radio wave is likely to be emitted.
e) … that changes voltage and frequency by intermittently flowing the electric current with the use of semiconductor.

Task 2. Answer the questions on the text.

1. What are the reasons for a circuit to cause noise interferences?
2. Why can't switching power supply circuit theoretically become a noise source?
3. Why does it practically happen?
4. What is contact noise?
5. What is switching noise?
6. Why can't switching power supply actually become a noise victim?
7. What is surge?

Task 3. a) What do these words and phrases from the text mean?

noise interference, broadly, respectively, circuit noise, essentially, commercial frequency, electromagnetic noise, power supply, contact noise, particularly, switching surge, circuit failure, transient, eliminate, particularly, suppress, converter, inverter, internally, conduction path, leak, leakage, absorb, unintended, excessive, surge, wiring, EMC measures

b) Which of them are nouns, verbs, adjective and adverbs?

Task 4. Match the parts of phrases and translate them.

1. switching — a) filter

2. low-pass	b) surge
3. output	c) power cable
4. AC	d) path
5. EMI	e) power supply
6. conduction	f) smoothing circuit
7. surge	g) suppression filters
8. lightning	h) absorber

Task 5. Match the terms with their definitions.

1. noise	a) an electronic device or circuitry that changes direct current (DC) to alternating current (AC)
2. power supply	b) extra electrical or electronic signals that are not part of the signal that is being broadcast or transmitted and which may damage it
3. leakage	c) transient high voltage induced at the contact point during relaying or switch on-off
4. inverter	d) an electrical device that supplies electric power to an electrical load
5. switching surge	e) an unwanted transfer of energy from one circuit to another causing some noise

Task 6. Explain the following terms.

signal line, analog circuit, digital circuit, power line, ground, input capacitor, output smoothing circuit, conduction path, wiring, EMC measures

Task 7. Match the verbs from the text in box A with their synonyms in box B.

A

emit, handle, cause, contain, share, affect, generate, leak, eliminate, suppress

B

influence, manipulate, destroy, be a reason, , use together with smb, release, produce, escape, consist of, put an end to

Task 8. Pronounce the words from the text.

1./ sɔːs/		7. /ˈsɜːkɪt/	
2. /θruː/		8. /ˈfeɪljə(r)/	
3. /kɔːz/		9. /ˈliːkɪdʒ/	
4. /ˈvjuːpɔɪnt/		10. /ˌʌnɪnˈtendɪd/	
5. /ɪˈsenʃəli/		11. /sɜːdʒ/	
6. /pəˈtɪkjələli/		12. /ˈmeʒə(r)/	

Recommended function

Study **Function B2 "HOW TO deal with noun groups"** and find 10 terms which are noun groups. Give their correct translation.

Video

You are going to watch a video on the **ABCs of EMC**.

Watch the video once through and say which of the topics on EMC this video covers.

- *Types of interferences.*
- *EMC tests.*
- *Institutions which carry out EMC tests.*
- *Testing conditions.*
- *Compliance standards.*
- *Types of compliance tests.*

Task 1. Make sure you know these words and phrases. Which of them were not used in the video?

ensure, unintentionally, interfere with, compliance, pre-compliance, filtering, surge, discharge, immunity, release, anechoic room, broadcast, imperative, fail, disturbance, interconnecting cables, vulnerability, unwanted, be familiar with, shielding, conduct, antenna, avoid, chamber, disrupt, set-up, accurate, malfunction

Task 2. Answer the questions on the video.

1. What is emissions testing? Why is it important to do?
2. Why are tests on conducted and radiated emissions the most important?
3. What does radiated emissions test characterize?
4. What does conducted emissions test characterize?
5. What do FCC, CISPR and EN stand for? What do you know about them?
6. What local standards must be met by electronic equipment in Russia?
7. What do you need to perform pre-compliance conducted emissions tests?
8. What do you need to perform pre-compliance radiated emissions tests?
9. What are essential conditions for performing pre-compliance tests?
10. Who is this video designed for?

Task 3. Explain these terms.

- power line surge
- electrostatic discharge
- AC mains
- data cable
- transient limiter
- compliance standard
- Line Impedance Stabilization Network
- calibrated antenna
- spectrum analyzer

Task 4. Decode one of the parts of the video.

Part 1 – 01.05 "Radiated emissions tests characterize …" – 01.52 "… and low-frequency clocks."

Part 2 – 01.53 “Before doing any sort of EMC testing …” – 02.32 “… pre-compliance tests accurately.”
Part 3 – 02.33 “For pre-compliance conducted emissions testing …” – 03.12 “… outside the chamber.”

Speaking and Recommended function

Study advice from **Function A4 “HOW TO talk about cause and effect”** and prepare a talk about **one type of noise or interference**. Tell about

- the mechanism of its impact
- how it affects the neighboring elements or devices
- how it is measured
- how it can be suppressed

Use diagrams, pictures etc. You can tell about the noises which were not described in text 2: noises in different circuits, or different types of surges.

Recommended function

Study **Function A6 “HOW TO deal with non-finite forms of the verb”** and find examples of different verbals in the texts of this theme. Choose 4-5 sentences for the analysis.

Writing

Analyze an extract from a scientific article on your specialty with respect to non-finite forms of the verb. Translate this extract into Russian. Use **Function A6**.

Theme 5. ELECTROMAGNETIC COMPATIBILITY

Reading, Vocabulary and Listening objectives: general issues on EMC, filtering and shielding
Speaking and Writing objectives: talking about an example of shielding or filtering technique, writing an abstract to an article
Recommended Grammar: Modal verbs

Lead-in

1. What is Electromagnetic Compatibility?
2. When speaking about EMC, we should know the following basic terms – **emission, susceptibility, immunity and coupling**. Can you match these terms with their definitions? What are their Russian equivalents?

a) the tendency of electrical equipment, referred to as the victim, to malfunction or break down in the presence of unwanted emissions, e.g. electromagnetic interference (EMI);

b) *the generation of electromagnetic energy, whether deliberate or accidental, by some source and its release into the environment;*
c) *the mechanism by which emitted interference reaches the victim;*
d) *the ability of equipment to function correctly in the presence of EMI.*

Reading and Vocabulary

You are going to read the text about general issues of **Electromagnetic Compatibility**. Make sure you know the following words and phrases.

emit (v), emission	be exposed to (v)
susceptible (adj), susceptibility (n)	be affected by (v)
immune (adj), immunity (n)	mains-borne (adj)
couple (v), coupling (n)	path (n)
malfunction (v, n)	identify (v), identification (n)
interfere (v), interference (n)	achieve (v)
deliberate (adj) = intentional (adj)	ensure (v)
accidental (adj) = unintentional (adj)	mitigate (v), mitigation (n)
disturb (v), disturbance (n)	filter (v, n), filtering (n)
noise (n)	shield (v), shielding (n)
put out of action (v)	redesign (v, n)
disrupt (v)	vital (adj)
noise/interference source	significant (adj)
noise/interference victim	equipment (n)

Can you use them in your sentences or a paragraph about EMC?

Task 1. Read the text and give names to three parts of it.

EMC issues

In simple terms, EMC describes the ability of electronic and electrical systems or components to work correctly when they are close together. In practice this means that the electromagnetic disturbances from each item of equipment must be limited and also that each item must have an adequate level of immunity to the disturbances in its environment.

1) …

Any EM emission, natural or 'man-made', is potentially a disturbance to any other susceptible device in the environment. It may either put it out of action or, in many cases a worse problem, cause it to malfunction. So there are two sides to the EMC equation:

- source equipment whose controllable emissions must be limited; and
- equipment that needs to have adequate immunity to those disturbances in its environment to which it is exposed.

Typical sources include, for example, power lines, electronic circuits, electric motors, radio and radar transmitters. Equipment that is disturbed, often called 'victim' equipment by EMC specialists, can include virtually anything that uses or can detect EM energy, such as radio receivers, domestic appliances or electronic circuits (from the smallest hand-held

device or modem to the control circuits at an electricity generating plant serving an entire region).

EM disturbances may work in more than one direction, disrupting more than one device, or multiple sources may have a cumulative effect on a single piece of equipment. Thus an air traffic control radar may affect the display of a laptop computer being used in an aircraft as well as other vital devices in use on the ground. At the same time, emissions from the same laptop computer may combine with those from a mobile phone to disturb systems in the aircraft.

On the emissions side of the equation, therefore, the aim of EMC is to ensure that equipment does not disturb other equipment, radio services, power or other networks. On the immunity side, the aim is to ensure that equipment is not affected by, e.g., radio transmissions, mains-borne disturbances, electrostatic fields and other phenomena.

2) …

Solving EMC problems, by limiting controllable emissions and by improving the immunity of susceptible devices or systems, first of all involves trying to identify not only the victim equipment but also the source and the path of the disturbance between them. In practice, clear identification of the source or the path is often difficult and sometimes even impossible, but the way in which source and victim are coupled may be described in general terms as being through:

- an electric current or voltage;
- an electric field;
- a magnetic field;
- an electromagnetic field; or often
- some complex combination of these.

3) …

Once the potential problem areas have been sufficiently identified, EMC can be achieved in a number of ways. For example, the source or the victim equipment may be removed from an area by rule or regulation (e.g., no cellular phones permitted). Alternatively, if some equipment emits more EM fields than intended or desired, there is the possibility of reducing those emissions and therefore the level of disturbance for other equipment occupying the same area.

Since avoidance techniques may not always be successful, however, it may be more effective to mitigate the effect of a disturbance by filtering or shielding, thereby increasing the immunity, or by some degree of redesign that ensures the problem is no longer significant to the exposed equipment.

Task 2. Read the text again and decide if the following statements are true (T) or false (F)?

1. EMC involves the immunity of the device to different disturbances.
2. The examples of victim equipment are – power lines, electric motors, radio and radar transmitters, etc.

3. EM disturbances spread in lots of directions – from one device to multiple devices.
4. The avionics may be affected by all the devices on a plane – from one mobile phone to a laptop together with a mobile phone.
5. To solve the EMC problems it's necessary to find only a source of radiation.
6. Source and victim devices may be coupled in different ways.
7. EMC will be achieved if all the devices reduce their EM emission.
8. The main aim of EMC is to provide a sufficient functioning of equipment.

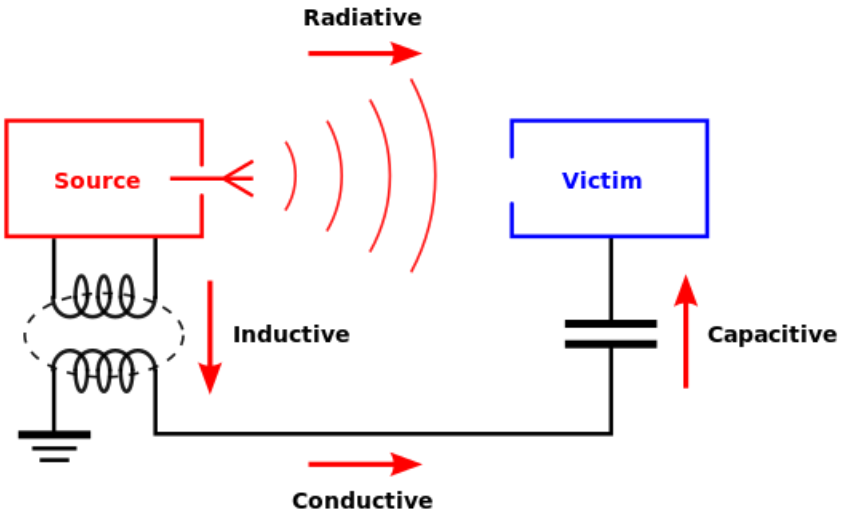
Task 3. Match the following terms with their definitions.

1. source equipment	a) processing something in order to reject unwanted things;
2. victim equipment	b) interference produced artificially not naturally;
3. man-made emission	c) electronic hardware device, or sometimes natural phenomenon, which produces interference;
4. controllable emission	d) screening something in order to protect it;
5. filtering	e) electronic hardware device which suffers from interference;
6. shielding	f) emission of radiation which can be regulated or limited.

Task 4. Which of the words in B can't make phrases with the words in A? In each case there should be only one word.

A	**B**
1. electromagnetic	compatibility, interference, deflection, field, effect, network, generator, immunity
2. electric	field, transmitter, circuit, appliance, diagram, motor, force, noise, coupling
3. electronic	circuit, device, equipment, efficiency, disturbance, network, system
4. radio	transmitter, receiver, effect, compatibility, window, intercept

Task 5. Describe the four electromagnetic interference coupling modes shown in this figure.



Recommended function

Study **Function A3 "HOW TO make a simple translation from Russian into English"** and translate the following text.

Основополагающим в области ЭМС является понятие электромагнитной совместимости технических средств (ТС), под которой понимается способность этих ТС работать в условиях определенной электромагнитной обстановки с сохранением качества и без создания другим техническим средствам недопустимых электромагнитных помех.

Электромагнитной помехой, или ЭМП, называется естественное или искусственное электромагнитное явление (процесс), из-за которого происходит сбой или возможно снижение качества работы технического средства.

Влияние ЭМП на оборудование может носить как непредсказуемый, но при этом временный характер (обратимый сбой характеристик канала передачи данных), так и необратимый характер, вплоть до физического повреждения технического средства (возгорание рабочей аппаратуры, ее кабелей и т.п.).

Specialized reading

Read and translate the text.

What is EMC Shielding?

EMC Shielding is any method used to protect a sensitive signal from external electromagnetic signals, or preventing a stronger signal from leaking out and interfering with surrounding electronics. It can cover PCB elements such as IC chips and active components, or connectors and cables between PCBs.

1. How does EMC Shielding work?

The main purpose of effective EMC Shielding is to prevent electromagnetic interference (EMI) or radio frequency interference (RFI) from impacting sensitive electronics. 1)… The shield effect is based on a principle used in a Faraday cage – the metallic screen completely surrounds either the sensitive electronics or the transmitting electronics. The screen absorbs the transmitted signals, and causes a current within the body of the screen. 2)…

By absorbing these transmitted signals before they reach the sensitive circuitry, the protected signal is kept clean of electromagnetic interference, maximizing shielding effectiveness.

2. What materials can be used for EMC Shielding?

Several techniques and materials can be used for EMC Shielding, and the materials used depend on the type of electronics and frequencies involved. This is because the amount of signal reduction/blocking depends on the material used, the size of the shielded volume, the material thickness – each of these factors affects the range and strength of frequencies that can be absorbed by the shielding.

Some examples include:

- Metallic foil or plaited braid to shield equipment wires. Coaxial cable has this EMC shield built into the wire construction, underneath an outer insulation layer. Other wire bundles can be wrapped in foil, or ready-made cable braid applied over the whole construction. 3)…
- For shielding on PCBs (known as Board Level Shielding or BLS), shielding typically consists of a PCB with a ground plane built into it, and a metal enclosure (known as a shield can) placed over the sensitive or transmitting elements. 4)…
- In devices such as audio speakers, an inner metallic casing would be used to successfully block EMI produced by nearby transmitting devices (such as microwaves and TVs).

Conductive paints and magnetic materials can also be used in environments where magnetic fields are below the 100 KHz range. Other methods can include sheet metal, metal foam, conductive plastics and mesh metal screening.

Depending on the frequency, the shielding does not have to be a solid screen, but can have regularly placed holes, or even just be wire fencing. 5)…

3. Example Applications of EMC Shielding

- EMC Shielding is used to protect medical and laboratory equipment, where it is vitally important and potentially life-saving to disrupt and prevent signal interference. 6)…
- EMC Shielding can prevent access to data stored on RFID chips or embedded in other devices.
- EMC Shielding can be used in combination with air-gapped systems to increase and complement existing security measures, such as those used in military, government and financial systems.

Ultimately, shielding is required where any sensitive electronic element requires isolation from the surrounding electromagnetic fields, or where a particular element is transmitting unwanted additional signals. In today's technologically-dependent environment, every item needs to be considered for EMI/RFI protection.

Task 1. Answer the questions on the text.

1. What is EMC shielding?

2. What is the principle behind a shielding screen?
3. What is important to take into account when choosing a shielding material?
4. What other materials can be used for shielding besides metal?
5. What are most important applications of EMC shielding? Can you give other examples?

Task 2. Insert the following sentences into the text.

a) The components are then completely surrounded by a Faraday cage arrangement.
b) This is achieved by using a metallic screen to absorb the electromagnetic interference that is being transmitted through the air.
c) It is therefore important to understand exactly which part of the electromagnetic frequency spectrum needs to be guarded against in any particular application.
d) The connectors on the ends of the wire would also require metal covers, and the braiding or foil needs to be attached to the metal to give total coverage.
e) Anything from AM/FM emergency service transmission and other telecommunications, to data communications, theatre and ward patient monitoring equipment, and even in-body medical devices such as pacemakers.
f) This current is absorbed by a ground connection, or a virtual ground plane.

Task 3. a) What do these words and phrases mean?

sensitive signal, leak out, interfere with, impact, absorb, Faraday cage, transmit, circuitry, metallic foil, plaited braid, cable braid, braiding, coaxial cable, insulation layer, wire, wire bundles, wire fencing, ground plane, shield can, casing, conductive paint, metal foam, mesh metal screening, solid, emergency service, theatre, ward, patient monitoring equipment, pacemaker, RFID chip, embed, air-gapped systems, complement, EMI/RFI protection

b) what do you know about the following things?

- Faraday cage
- coaxial cable
- emergency services
- patient monitoring equipment
- pacemaker
- RFID chips

Task 4. Complete the following sentences with the words or phrases from the list.

enclosure, RFID chips, Faraday cage, blocking,
coaxial screens, metal foam, cable braid, metal screen

1. EMI shielding is the practice of reducing the electromagnetic field in a space by … the field with barriers made of conductive or magnetic materials.
2. A conductive … used to block electrostatic fields is also known as a … .
3. Typical materials used for electromagnetic shielding include sheet metal,… , and … .
4. RF shielding is also used to prevent access to data stored on … embedded in various devices, such as biometric passports.

5. Some cables have two separate … , one connected at both ends, the other at one end only, to maximize shielding of both electromagnetic and electrostatic fields.

Task 5. Complete the following sentence parts and translate them.

1. to be built	a) from external EM signals
2. to depend	b) with surrounding electronics
3. to isolate	c) over the whole construction
4. to protect a sensitive signal	d) of a PCB and a metal enclosure
5. to be applied	e) on the material used
6. to prevent EMI or RFI	f) into the wire construction
7. to consist	g) from the surrounding EM fields
8. to interfere with	h) from impacting sensitive electronics

Task 6. Translate one of the parts of the following text into English.

1) Кле́тка Фарадéя - устройство, изобретённое английским физиком и химиком Майклом Фарадеем в 1836 году для экранирования аппаратуры от внешних электромагнитных полей. Обычно представляет собой заземлённую клетку, выполненную из хорошо проводящего материала.

Принцип работы клетки Фарадея очень простой — при попадании замкнутой электропроводящей оболочки в электрическое поле свободные электроны оболочки начинают двигаться под воздействием этого поля. В результате противоположные стороны клетки приобретают заряды, поле которых компенсирует внешнее поле.

Клетка Фарадея защищает только от электрического поля. Статическое магнитное поле будет проникать внутрь. Изменяющееся электрическое поле создаёт изменяющееся магнитное, которое, в свою очередь, порождает изменяющееся электрическое. Поэтому если с помощью клетки Фарадея блокируется изменяющееся электрическое поле, то изменяющееся магнитное поле генерироваться также не будет.

2) Однако в области высоких частот действие такого экрана основано на отражении электромагнитных волн от поверхности экрана и затухании высокочастотной энергии в его толще вследствие тепловых потерь на вихревые токи.

Способность клетки Фарадея экранировать электромагнитное излучение определяется:

- толщиной материала, из которого она изготовлена;
- глубиной скин-эффекта;
- соотношением размеров проёмов в ней с длиной волны внешнего излучения.

Для экранировки кабеля необходимо создать клетку Фарадея с хорошо проводящей поверхностью по всей длине экранируемых проводников. Для того чтобы клетка Фарадея эффективно работала, размер ячейки сетки должен быть значительно меньше длины волны излучения, защиту от которого требуется обеспечить.

Task 7. Write the words from the text to the following phonemics.

1. /ˈvɜːtʃuəl/		9. /əbˈzɔːb/	
2. /ˈmæksɪmaɪz/		10. /kəʊˈæksiəl/	
3. /ʃiːld/		11. /keɪdʒ/	
4. /ræp/		12. /streŋθ/	
5. /ˈpɜːpəs/		13. /tekˈniːk/	
6. /ˈwaɪə(r)/		14. /səkˈsesfəli/	
7. /fəʊm/		15. /ʃiːt/	
8. /ɪˈmɜːdʒənsi/		16. /ˈmeʒə(r)/	

Recommended function

Study **D2 "HOW TO write an abstract"** and translate the following abstract. Use advice from Function **A3 "HOW TO make a simple translation from Russian into English"** to help with word order in an English sentence.

Многопроводная микрополосковая линия как модальный фильтр для защиты от сверхкоротких импульсов

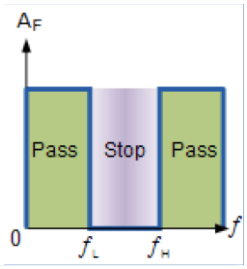
Предложено совершенствование защиты от сверхкоротких импульсов за счет добавления к связанной микрополосковой линии дополнительных проводников. Получены трех-, четырех- и пятипроводная микрополосковые линии, в которых максимальные амплитуды импульсов разложения в 3; 3,6 и 4,5 раза соответственно меньше уровня сигнала в начале линии. Результаты показывают перспективы исследования многопроводных модальных фильтров.

Ключевые слова: многопроводная микрополосковая линия, устройство защиты, модальная фильтрация.

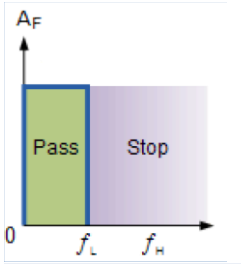
Video

The video part is devoted to filtering. Before watching a video about a **Low-pass filter**, can you name the types of filters based on these filter response curves?

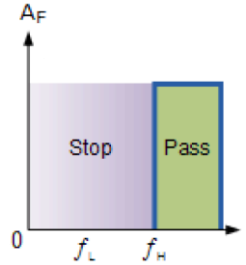
A)



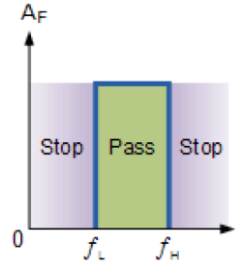
B)



C)



D)



Task 1. Match these terms with their definitions.

1. low-pass filter	a) a band of frequencies, between specified limits, through which a filter does not allow signals to pass
2. high-pass filter	b) the range of frequencies or wavelengths that can pass through a filter
3. cut-off frequency	c) a filter which passes low-frequency signals and blocks, or attenuates, high-frequency signals
4. frequency response	d) shows how the gain of the output responds to input signals at different frequencies
5. passband	e) a boundary in a system's frequency response at which energy flowing through the system begins to be reduced (attenuated or reflected) rather than passing through
6. stopband	f) a filter which passes high-frequency signals and blocks, or impedes, low-frequency signals

Task 2. Now watch the video and answer the questions.

1. Why is it important to have an understanding of frequency response of a filter?
2. What makes up a lab set-up of this video?
3. What are the settings for this demonstration?
4. How does the waveform change?
5. What does the yellow signal show?
6. How did he calculate the bandwidth and what was its value?

Task 3. Make sure you know these words. Which of them were not used in the video.

envelope, frequency response, logarithmic, amplitude, validate, purple, amplifier circuit, sparse, lab set-up, signal source, waveform, division, couple, feed, scope, trigger, retain, dense, sweep, run mode, rate, linear, achieve, filter out, calculate, significant, arbitrary

Task 4. Watch the video again and complete this part with the numbers you hear.

The peak to peak amplitude of the input signal is ___ V. The ___ dB point will be where the amplitude is ___ V. we can use the cursor to find the point at which the amplitude is ___ V. Now we need to calculate the frequency at this point. One sweep occupies 8 horizontal divisions on the scope with the frequency span of ___ MHz. so there are ___ MHz in each division. So what's the frequency at ___ dB frequency point? There are ___ divisions from the start of the sweep, so the bandwidth is ___ times ___ MHz, or ___ MHz.

Task 5. Decode this part of the video.

01.58 "Select the linear type…" – 02.48 "… to measure the bandwidth of the filter."

Task 6. Which words from the video corresponds to this phonemics?

1./'mɛgəhɜːts/		6./ kən'tɪnjuəslɪ/	
2./'æmplɪfaɪə/		7./ˌlɒgə'rɪðmɪk/	
3./'sɜːkɪt/		8./'bændwɪdθ/	

4./sɔ:s/		9. /spɑ:s/	
5./saɪn/		10./'æmplɪtju:d/	

Speaking and Recommended function

Study **Function D4 "HOW TO keep a discussion"** and prepare a talk about a **technique for protecting from EMI**. This could be an example of a filter, modal filtering technique, or shielding approach. Tell about:

- why it is important
- what sort of noise it suppresses
- how it works
- what are the main parameters
- how you can measure its efficiency
- has it got any analogues

Include visual materials and formulas into your presentation. Prepare 5 indirect questions to ask about this topic.

Writing

Look again at **Function D2 "HOW TO write an abstract"** and write an abstract to your article.

Theme 6. SIMULATION SOFTWARE

Reading, Vocabulary and Listening objectives: simulating different processes and devices, simulation programs
Speaking and Writing objectives: telling about an experience in simulation, comparing different programs
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
* netlist
* reference value
* oscilloscope
* bode plot
* 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 operating 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 description of a model include?
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, 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

Read and translate the text.

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 1. 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?

Task 2. 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, electronics cooling, energy harvesting, 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 3. a) Complete the following verb combinations with the phrases from task 2.

- 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 4. 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 5. 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 6. What words do these phonemics examples refer to?

1./ˈθɜːməl/		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 **Function B1 "HOW TO deal with word derivatives"** and find examples to different ways of forming new words. Analyze them.

Video

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 1. 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 2. 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 3. 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 4. 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 5. Decode one of the following parts from the video.

Part 1 - 04.08 "… the next mask layer is used for…" – 05.23 "… will remain as oxide isolation."

Part 2 - 05.25 "The next mask layer consists of two parts." – 06.33 "Again it consists of two parts."

Part 3 - 06.34 "A layer of metal is deposited …" – 07.55 "… to select the mix-coordinate system cuts."

Part 4 - 09.10 "To run the device simulation…" – 10.40 "… we click Save and Generate."

Speaking

Prepare a talk about **your experience in simulating any process or device**. Talk about the following:

1. What is the name of the program 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

Study **Function A5 "HOW to make comparison and contrast"** and write a paragraph comparing at least three software programs which you have ever used.