МИНИСТЕРСТВО НАУКИ И ВЫСШЕГО ОБРАЗОВАНИЯ РОССИЙСКОЙ ФЕДЕРАЦИИ

ФЕДЕРАЛЬНОЕ ГОСУДАРСТВЕННОЕ АВТОНОМНОЕ
ОБРАЗОВАТЕЛЬНОЕ УЧРЕЖДЕНИЕ ВЫСШЕГО ОБРАЗОВАНИЯ
«САМАРСКИЙ НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ
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СПОСОБЫ СЛОВООБРАЗОВАНИЯ В РАДИОТЕХНИЧЕСКОЙ ТЕРМИНОЛОГИИ В АНГЛОЯЗЫЧНЫХ ТЕКСТАХ (ДЛЯ СТУДЕНТОВ РАДИОТЕХНИЧЕСКИХ СПЕЦИАЛЬНОСТЕЙ)

Рекомендовано редакционно-издательским советом федерального государственного автономного образовательного учреждения высшего образования «Самарский национальный исследовательский университет имени академика С. П. Королева» в качестве учебного пособия для обучающихся по основным образовательным программам высшего образования по направлениям подготовки 11.03.01 Радиотехника, 11.03.03 Конструирование и технология электронных средств, 11.03.04 Электроника и наноэлектроника, 12.03.04 Биотехнические системы и технологии, 12.03.05 Лазерная техника и лазерные технологии и специальности 11.05.01 Проектирование, производство и эксплуатация ракет и ракетно-космических комплексов

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Целью учебного пособия является освоение словообразовательных моделей в терминологии для развития и совершенствования навыков чтения и перевода научной литературы, повышение языковой компетентности на основе материалов, соответствующих направлениям подготовки радиотехнического факультета.

Разработано в соответствии с требованиями программы по иностранному языку для неязыковых вузов на кафедре иностранных языков и русского как иностранного.

Предназначено для обучающихся 1 и 2 курсов дневного отделения радиотехнического факультета.

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ОГЛАВЛЕНИЕ

ВВЕДЕНИЕ

Термин – это стилистически нейтральное слово, словесный комплекс или аббревиатура, имеющие четкую сферу применения, логическую и предметную направленность, и характеризующиеся однозначностью и отсутствием экспрессивности. Термины в отличие от слов направлены на четкое отображение действительности. Они лишены эмоциональной окраски, объективны, строги, и устойчивы. По сравнению с основной массой слов, термин более точен. Он непосредственно соотносится с обозначаемым понятием.

Материалом для терминообразования издавна служили, в первую очередь, слова основного словарного запаса, давно живущие в языке, обозначающие жизненно важные, окружающие человека предметы и типичные явления. Основанием для сопоставления была явно ощутимая, несомненная похожесть и близость специального и общеупотребительного сближаемых понятий. Отличительной особенностью терминологии является то, что термин сужает значения производящего слова до условных рамок, соответствующих требованиям к научному термину, т.е. до одного понятия, максимально точного и полного значения. Например, *performance* – работа, рабочие характеристики; *photoreceptor life* – долговечность (ресурс) фоторецептора. Это так называемый семантический способ словообразования.

Морфологическое словообразование предполагает создание новых слов путем изменения формы уже существующих при помощи различных формальных средств, по определенным словообразовательным моделям. Наиболее интенсивное пополнение терминологического состава языка происходит за счет следующих процессов:

– Аффиксация, т.е. образование новых однословных терминов путем прибавления к корневым словам заимствованных из греческого и латинского языков префиксов и суффиксов. **Префикс** ставится в начале слова и изменяет значение корневого слова. К наиболее употребительным префиксам английского языка относятся: *a-, be - co-, counter-, de-, dis-, ex-, in-, inter-, out-, over-,* *post*-, *pre*-, *re*-, *sub*-, *super*-, *mega*-, *trans*-, *ultra*-, *under* - и другие: например: *de*(противоположное значение)+*actuate*=*deactuate*– выключать(ся), деактивизироваться; *pre* (до чего-либо)+*charge*=*precharge* – предварительная зарядка; *dis* (нет, раздельно)+*connect*=*disconnect* –разъединять.

Суффиксы имеют более широкое значение и указывают на категорию, к которой относится понятие. Наиболее употребительными для образования производных существительных являются следующие суффиксы: - *er,* - *or,* - *ant,* - *ent,* - *ion,* - *ment,* - *ture,* - *age,* - *ence,* - *ance,* - *ing,* - *ism,* - *ity,* - *ness,* - *ency,* - *ship,* - *ist,* - *ian* и другие: *duration* - продолжительность, *liquidation* – ликвидация, *numbering* – нумерация, i*nverter* – инвертер, обратный преобразователь, *investor* – инвестор. Производные прилагательные образуются путем прибавления следующих суффиксов: - *ive,* - *able,* - *uble,* - *ent,* - *ant,* - *ish,* - *y,* - *al,* - *ical,* - *ous,* - *ful,* - *less,* - *proof* и другие: *electric* - *electrical* (электрический), *help* - *helpful* (полезный), *conduct* – *conductive* (электропроводящий), *water* – *waterproof* (водонепроницаемый).

– **Словосложения –** это образование новой основы путем соединения двух уже существующих основ, обычно без изменения их формы, например: от гр. *logos* - слово, понятие + *typos* – отпечаток, форма = *logotype* – специально разработанная, стилизованная сокращенная форма названия фирмы, часто в оригинальном начертании, символическое наименование; торговая марка, знак; *broad* +*cast*= *broadcast* – радиовещание, *wave* + *guide*= *waveguide* – волновод, *wave* + *length* = *wavelength* – длина волны.

Целый ряд неологизмов образован путем стяжения, это так называемые «**телескопные слова**»: *stagflation (stagnation + inflation)* – стагфляция (застой при одновременной инфляции), *autorouter (automatic + router)* – программа автоматической трассировки печатных плат.

– **Конверсия слова** или термина, с помощью которой из существующего слова или термина образуется новый термин, относящийся к другой части речи, например: *to plan* – планировать, *a plan* – план; *to know + how = know how* (технология производства), *to monitor* – контролировать, следить, *a monitor* – средство контроля.

– **Сокращение** – это единица устной или письменной речи, созданная из отдельных (не всех) элементов звуковой или графической оболочки некоторой развернутой формы (слова или словосочетания), с которой данная единица находится в лексико-семантической связи. Сокращения могут состоять из одного *Co – Company*, двух *FM – frequency modulation* (частотная модуляция), трех *DIP – Dual In-line Package* (корпус с двухрядным расположением штыревых выводов), четырех *LISA – Lateral Integrated Silicon Accelerometer* (боковой интегральный кремниевый акселерометр), пяти *SMPTE – Society of Motion Picture and Television Engineers* (общество кино- и телеинженеров США) и более компонентов. Более чем пятикомпонентные сокращения встречаются редко. В настоящее время сокращения в английском языке образуются с особой легкостью, что приводит к дополнительным трудностям, которые усугубляются еще и тем, что некоторые сокращения имеют несколько десятков зарегистрированных значений.

Таким образом, знание и понимание основных словообразовательных моделей в терминологии является важным гарантом правильного перевода и интерпретации содержания научной литературы.

Unit 1 RADIO ENGINEERING

Tuning-in

1. Electronics has penetrated into all spheres of our life. It allows people to change radically their lifestyle, the way they work and study. Nowadays there are great varieties of activities that are impossible without electronic techniques. Achievements in electronics are of vital importance for human beings because electronic gadgets make our life more pleasant, comfortable and exciting.

Work in groups and brainstorm in which spheres and activities electronic technologies are indispensable. Try to explain what opportunities electronic techniques provide and what people benefit from using them.

2. Make a list of achievements and inventions in electronics you consider the most essential for its development (e.g. a vacuum tube, radio, a transistor, etc.).

Compare your ideas with those of your group mates. Are your views similar or different?

Vocabulary

1. Which of the following words would you expect to find in a text about history of electronics?

industry creative portable music
degree subject telephone advance
development invention transmission
commercial television researcher
disappointment competitor radio
practical information inspiration

Add some words related to electronic devices and systems, sort them out according to their part of speech and use some of them in your own sentences and situations.

2. Electronics deals with various specific notions and concepts. Some basic words are given below. Match them up with the definitions on the right.

1 engineering	A the radiation of waves by transmitting stations, their propagation through space, and reception by receiving stations
2 a transistor	B sending information from one point to another
3 feedback	C the activity of designing machines and devices
4 a vacuum tube	D a piece of electronic equipment that increases the strength of sounds
5 communication	E a device with three or more electrodes that controls the flow of electricity inside a piece of electronic equipment
6 radio	F a closed glass tube without air inside used for controlling current
7 an amplifier	G the high loud noise that electrical equipment makes when part of the sound it sends out goes back into it

Reading 1

1. You are going to read an article about history of electronic engineering. Before you begin decide which statements are probably true, which ones are probably false.

1. Electronic engineering and radio engineering are different subjects.

2. Prominent scientists and inventors made a great contribution to the development of electronics and laid the groundwork for modern electronic technologies.

3. Nowadays, students cannot do a degree in electronic engineering.

Now read the text and find terms formed by means of affixation. Give the Russian equivalents to them.

History of Electronic Engineering

Electronic engineering as a profession sprang from technological improvements in the telegraph industry in the late 1800s and the radio and telephone, in the early 1900s. People were attracted to radio by the technical fascination it inspired, first in receiving and then in transmitting.

In 1893, Nikola Tesla made the first public demonstration of radio communication and described its principles in detail. In 1896, Guglielmo Marconi developed and introduced a practical radio system. In 1904, John Ambrose Fleming, the first professor of electrical engineering at University College in London, invented the first radio tube, the diode. In 1906, Robert von Lieben and Lee De Forest independently developed the amplifier tube, called the triode.

Nevertheless, it is often considered that electronics began when Lee De Forest invented the vacuum tube in 1907. His device was widely used in radio transmitters and receivers as well as systems for long-distance telephone calls. In 1912, Edwin H. Armstrong invented the regenerative feedback amplifier and oscillator. He also invented the super heterodyne radio receiver and could be considered the “Father of Modern Radio”. Vacuum tubes remained the main amplifying device for 40 years, until researches at Bell Labs invented the transistor in 1947. In the following years, transistors made small portable radios and more powerful mainframe computers possible. Therefore, the modern discipline of electronic engineering was to a large extent born of telephone, radio, and television technologies and the development of radar, communications systems, and advanced weapon systems during the Second World War.

Prior to the Second World War, the subject was known as “radio engineering” and was restricted to aspects of communications and radar, commercial radio and early television. Students of electronics and related subjects such as radio and telecommunications had to enroll in the electrical engineering department of the university as no university had departments of electronics.

Later, in post war years, the field broadened to include modern TV, audio systems, Hi-Fi, computers and microprocessors. In the mid- to late 1950s, the term radio engineering gradually gave way to the name electronic engineering. In the UK, the subject of electronic engineering became distinct from electrical engineering as a university degree subject around 1960.

Comprehension

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

1. the process of making something better than it was before

2. to appear, to come from a particular place or situation

3. to give people the enthusiasm to do or create something or to give a particular feeling

4. the power to interest or attract people very strongly

5. to design or create a machine, device, process that did not exist before

6. having the same origins and belonging to the same group

7. to use only for a particular purpose, to keep something within strict limits

8. to join a group or organization officially

9. to make something include more things

10. separate and different in a way that is clear

11. slowly and in small stages or amounts

12. a course of study at a university, or the qualification that a person gets after completing the course

2. Complete the following sentences to summarize the text.

1. The area of electronic engineering started developing due to…. .

2. Outstanding scientists and inventors such as…. made radio communication possible.

3. One of the most important inventions in electronics was…. .

4. Before the Second World War, students of electronics had to take a degree in electrical engineering because…. .

5. The reason, why the name electronic engineering substituted for the term radio engineering, was…. .

Focus on Vocabulary and Language

1. We use the name radio engineering in relation to both the science and branch of technology.
Work with your partner and discuss with what processes and phenomena radio engineering deals. Summarize your views and try to suggest your own definition of radio engineering.
Compare your ideas with those of your group mates. Whose definition is more accurate?

2. To check your ideas read the passage below. While reading use the words from the box to complete the text.

wavelengths	number of divisions	transmitted signals
development	radio frequency range	velocity
advances	existence	scientific investigations
high-frequency	propagation	equations
information	electric and magnetic fields	

Radio Engineering

Radio engineering is the science dealing with electromagnetic oscillations and waves in the [1]------- , and a branch of technology concerned with the use of electromagnetic oscillations and waves for the transmission of [2]------- in such fields as radio communications and broadcasting, television, radar, radio navigation, control and regulation of machines, mechanisms, and technological processes, in various [3]------- . The radio frequency range encompasses electromagnetic waves with [4]------- from tens of thousands of kilometers to tenths of a millimeter.

The [5]------- of radio engineering has been closely associated with [6]------- in radio physics, electronics, the physics of semiconductors, electro-acoustics, the theory of oscillations, information theory, various branches of mathematics, as well as achievements in [7]------ measurements, vacuum and semiconductor technologies, and the manufacture of power-supply sources.

Radio engineering includes a [8]------, the generation, amplification, conversion, and control of electric oscillations are among them. Other divisions cover antenna technique, the [9]------- of radio waves in free space, in various media (ionosphere, soil) and in guiding systems (cables, waveguides), electromagnetic oscillation filtration, demodulation and reproduction of [10]------ (speech, music, images and other signals). Monitoring, control, and regulation through electromagnetic waves and oscillations (by means of electronic systems) are also divisions of radio engineering.

The history of radio engineering began with the work of M. Faraday, who laid the foundation for the doctrine of [11] ------- (1837-1846). Faraday advanced the idea that the propagation of electric and magnetic effects occurs with a finite [12]------ and constitutes a wave process. In 1864, J.C. Maxwell further developed Faraday's ideas by describing electric and magnetic phenomena mathematically through a system of [13]-------. These equations proved the possibility of the [14]------- of an electromagnetic field capable of propagating through space in the form of electromagnetic waves.

3. Match the words from the text with suitable words to make possible collocations (fixed expressions).

Verb + noun

deal with _____	constitute_____
lay_____	develop_____
advance_____	prove_____

Adjective + noun (noun + noun)

_____ investigation	_____measurement
_____ oscillation	_____source
_____ range	_____velocity
_____ space	____ effect

Noun + preposition + noun

transmission _____	number_____
advance _____	propagation _____
by means _____	

4. Three sentences have been removed from the extract below. Choose from the sentences (A-D) the one, which fits each gap. There is one extra sentence you need not use.

Heinrich Hertz, the famous German physicist, was the first to obtain and study electromagnetic waves in the radio frequency range (1886-89). Hertz was able to generate and radiate these waves with the aid of an oscillator excited by a spark discharge. 1_______. He showed that such waves, just as light waves, were capable of reflection, refraction, interference and polarization. Nevertheless, he did not foresee the possibility of using electromagnetic waves for information transmission.

The phenomenon of resonance, which was investigated by many scientists, played a major role in Hertz's experiments. A formula of great importance for determining the resonant frequency of an oscillatory circuit in the absence of damping (an ideal circuit) was devised by W. Thomson (Lord Kelvin) as early as 1853. 2_______.

O. Lodge (Great Britain) used this phenomenon to detect electromagnetic waves when reproducing Hertz's experiments in 1894. 3_______.

A. In 1890, E. Branley (France) discovered and studied the effect of decreasing the resistance of metal powder when acted upon by electric oscillations and the subsequent restoration of the powder's original high resistance when tapped back.

B. Although early radios used some type of amplification from electric current or battery, the crystal set was the most common type of receiver in the 1920s.

C. In this work, Lodge made use of a device, which he called a coherer, consisting of a glass tube filled with metal filings and electrodes at both ends.

D. Hertz was able to detect electromagnetic waves with the aid of a second oscillator, in which a spark could jump across a gap under the effect of a received wave.

5. Read the passage about inventions that contributed to the radio engineering development and decide which answer A, B, C or D best fits each space. There is an example at the beginning (0).

The development and use of electron *(0) A* brought fundamental changes to all areas of radio engineering. The first electron tube 1)…. was introduced by J.A. Fleming in 1904. This detector made use of the Edison 2)…., i.e. the unidirectional flow of electrons in a 3)…. from an incandescent filament (cathode) to a metal plate (anode). However, this detector, as well as L. De Forest's three-4)…. electron tube, was less 5)…. than the crystal detector. Crystal detectors were widely used until the mid-1920s and were replaced only after 6)…. tubes had been perfected.

The investigation into the use of various 7)…. ranges of radio waves represented another important step in the radio engineering development. The period from the 8)…. of radio to the introduction of arc oscillators and alternators was associated with a gradual increase in the 9)…. of radio waves from several decimeters to several kilometers. An increase in wavelength meant an increase of the 10)…. distance and an improved 11)…. of radio communication. This result was caused both by more favourable conditions for the 12)…. of radio waves and by increasing transmitted power. The use of radio tubes facilitated an efficient 13)…. of radio waves in a 14)…. from hundreds of meters to several kilometers.

The early 1920s saw the achievements in radiotelegraphy and radio 15)…. . Research on radio wave propagation in the shortwave range led to the use of these waves in communication and radio broadcasting. As a result special radio tubes for the short and ultra-short wavelength ranges, as well as special circuits and antennas, were 16)…. .

0. *A tubes* B lamps C bulbs D sets

1. A transformer B crystal C detector D equipment

2. A decision B effect C effort D efficiency

3. A space B charge C beam D vacuum

4. A plate B valve C electrode D grid

5. A successful B sensitive C substantial D significant

6. A receiving B detecting C operating D oscillating

7. A reception B transmission C frequency D interference

8. A description B demonstration C presentation D invention

9. A wavelength B distance C measurement D power

10. A connection B coupling C transmission D determination

11. A strength B stability C instability D quality

12. A navigation B location C introduction D propagation

13. A radiation B generation C amplification D selection

14. A spectrum B conduction C range D direction

15. A broadcasting B station C information D processing

16. A stimulated B identified C incorporated D devised

6. The text below is about the basic phenomena of electronics. Before you read it, try to explain the following terms and give their definition.

1) A subatomic particle
2) A charge carrier
3) Magnetism
4) Velocity
5) Current
6) Voltage
7) Energy conversion

Compare your ideas with those of your partner. Whose definitions are more accurate?

7. Read the text to check if your ideas were right. While reading use the words in brackets to form a word that fits in the gap in the sentence. There is an example at the beginning (0).

Electronics

Electronics is the field of science and engineering dealing with the release, transport, control, *(0) collection (collect)* and energy *1) (convert)* of subatomic particles that have mass and charge (such as electrons) and act in materials with known electromagnetic properties, e. g., vacuum, gases or semiconductors. The charged particles are called charge carriers.

The phenomena of electronics depend upon the number of charge carriers, their dynamic activity and the properties of the environment in which the charges act. The charge carriers are usually electrons, but holes, positive or negative ions may perform this function as well. The dynamic activity of charge carriers results from the force and *2) (recover)* energy needed to release them from atoms to produce their *3) (displace)*, velocity or acceleration. The properties of the environment depend on the changes in atom energy levels, *4) (compose)* and structure of the substance through which charge carriers pass.

The basic principles of electronics are the same as those of electricity and magnetism. Electricity is any *5) (manifest)* of energy transform of charge carriers that initiates forces producing shift, velocity or acceleration in the direction of their *6) (move)*. Magnetism involves the kinetic energy of charge carriers arising from or producing forces in a direction perpendicular to their motion. The principles of electronics and electromagnetism are built upon the physical entities of mass, length, time, electric charge (or current), temperature, amount of substance and luminous intensity.

The primary difference between electronics and electromagnetism lies in their *7) (apply)*. Electronics makes possible devices with much greater control over the *8) (instant)*, rather than average, motion of charges during transport, and the charge control can be *9) (exceed)* rapid. Active electron devices require an external source of power to maintain their electrodes at *10) (suit)* operating voltages and currents. Due to power from an external supply, electron devices can provide at their output terminals the amplified voltage, current or power supplied to their input terminals.

Originally, electronics dealt with the conduction of electricity in vacuum or *11) (gas)* tubes. Since the invention of the transistor in 1948, conduction through crystalline semiconductors (solid-state conduction) has virtually dominated the field, and thermionic electron tubes have played a diminishing role except for applications requiring high power.

Speaking

1. Evidently, advances in electronics would not be so remarkable without a valuable contribution of prominent scientists and inventors who made fundamental discoveries in the past centuries.

Work in groups and do research on the work of a scientist or inventor whose ideas from your point of view were historic, groundbreaking and vitally important for the development of electronics. Prepare a presentation in which you should emphasize the following points related to the chosen person:

- personal data (the date and place of birth, family)
- education (the qualification, degree)
- the area of activity, achievements, inventions, discoveries and the major contribution to the technological area
- recognition (awards, honours)

2. Imagine that your department hosts a conference on the history of electronics and its role in modern society. You are going to participate in the conference and make your presentation.

While speaking you should

- greet an audience
- introduce yourself and your talk
- present the outline of your talk (3-4 main points)
- summarize the main points
- invite listeners to ask questions

The following phrases might be of great help.

My purpose/objective/aim today is to analyze (present, review)…

The talk is divided into four main parts: firstly…

To start with/Firstly, I would like to look at…

Then/Secondly, I will be talking about…

Thirdly,…   My fourth point will be about…

Finally, I will be considering…

My presentation will take/last about 10 (15-20) minutes.

If you have any questions, please stop me at any time.

I will be glad to answer any questions you have at the end of my presentation.

Let us now move on to/turn to…

I would like to go on to…

To sum up/To summarize,…

I would like to finish by saying…

In conclusion, I would like to say (to emphasize)…

Thank you for attention/time/listening

Writing

1. You have been asked to write an article on the role of electronics in modern society and its perspectives for a popular scientific magazine.

Before you start writing, think of

- your target reader (who is going to read your article)

- the style that would be suitable for this article (formal, informal or neutral)
- information you should include
- features you can use to make the article interesting for your readers (e.g. an interesting title and beginning; questions to encourage the readers to think; strong opinions; a thought-provoking ending)

2. Write a plan for article. Write an article (120-180 words) following your plan.

Reading 2

1. Work in groups and discuss the following issue.

Why is it vital to make a right choice of career?

Think of the factors that influence career decisions and should be taken into consideration to succeed in the chosen area (e.g., personal qualities and abilities, creativity, good performance, zest (great enthusiasm and interest), satisfaction, a sense of achievement, status, promotion prospects).

2. You have already made your choice. Working individually, make a list of the criteria that you took into account when choosing your future occupation (e.g., a prestigious university with modern facilities; skilled teaching staff; career perspectives; an interesting, creative job in the future; a high salary and benefits, etc.).

3. Work in groups. Compare your list with those of your partners and discuss reasons for your choice. Decide on the criteria, which were significant for most students in the group.

4. A modern specialist cannot succeed without knowledge and skills. The best way to prepare for a career is to get a good education.

You are going to read a text about the faculty of Electronics and Instrument engineering of Samara National Research University. Work with your partner and discuss which of the following subjects are most likely to be touched upon in the text.

1. History of the department.
2. The role of electronics in modern life.
3. Teaching staff.
4. Specialties, lines of training.
5. Advice how to choose a specialty.
6. Facilities of the department.
7. Career opportunities the department provides.

5. Read the text to find out more about the radio-engineering faculty and check whether your predictions were correct.

Faculty of Electronics and Instrument Engineering

Electronics is a very promising branch of science and technology. It has opened a new era and has become a powerful means of progress. Electronic techniques and apparatus are indispensable in communication, aircraft and spacecraft designing, space exploration, industry, medicine, economics and business.

The rapid development of electronics and growing application of electronic technologies increase the demand for qualified engineers in this area. Such qualified specialists are trained at the faculty of Electronics and Instrument engineering of Samara National Research University. The faculty of Electronics and Instrument engineering was established in 1962. Nowadays the faculty is a large university department that trains skilled specialists for the most perspective areas of electronics.

The chairs of the faculty carry out research in the most promising and vital branches of electronics, namely, space radio electronics, microelectronics, automation of designing, nanoelectronics, laser technologies. The teaching staff includes professors, Doctors of Sciences, assistant professors, Candidates of Sciences, skilled lecturers.

The faculty trains engineers in the following specialties and lines of training: “Radio engineering”, “Designing and technology of electronic apparatus”, “Biotechnical systems and technologies”, “Electronics and nanoelectronics”, “Laser apparatus and laser technologies”, “Radio electronic systems and complexes”.

Students gain deep knowledge of circuitry and systems engineering of radio electronic devices and systems. They study the electromagnetic field theory, radio receiving and transmitting devices, radiolocation, radio control, amplifying devices, radio electronic system simulation. Future specialists master information technologies, programming, mathematical modeling, study fundamentals of electronics and microprocessor equipment, nanomaterials, optical materials, quantum electronics, computer-aided design and automation of technological processes of electronic apparatus manufacture.

Students specializing in biotechnical systems get necessary knowledge of such disciplines as biochemistry, biological processes simulation, biomaterials and fabrication techniques, electronics hardware components, system analysis, control in biotechnical systems, diagnostic research and therapeutic intervention techniques, biotechnical systems for medical purposes, digital devices, certification of medical products and devices, medical instruments and apparatus.

The course of study lasts four years. During this period, undergraduates are studying for their first degree. When they finish and pass their exams, they get a degree of a BSc (Bachelor of Science).

Some graduates who complete the first degree decide to do a second course called a postgraduate course/degree. Postgraduates study for a MSc (Master of Science) or a PhD (Doctor of Philosophy).

The faculty of Electronics and Instrument engineering provides the necessary facilities for studying and doing research including computer classrooms, laboratories equipped with modern devices and apparatus where students get practical skills. Students are given every opportunity for acquiring profound knowledge of their specialty to become competitive engineers.

Comprehension

1. Find words in the text that mean the same as the words and phrases below.

1. A perspective area
2. Necessary
3. Fast advancement
4. Increasing use
5. Skilled professionals
6. Was founded
7. Conduct an investigation
8. Experienced teachers
9. Qualify engineers
10. Obtain extensive knowledge
11. Supply essential means

2. What do you call

1. the qualification you get at the end of a university course?
2. the name of students doing their first course at university?
3. teachers at university?
4. students when they have completed their first course?
5. students studying for a second, higher degree?
6. the study of one subject in great depth and detail, often to get new information?
7. the lessons that students attend while they are at university?

3. Complete the following sentences.

1. The reason why the role of electronics is so enormous is that…
2. Qualified electronic specialists are needed because…
3. At present, the faculty of Electronics and Instrument engineering of Samara University is…
4. The most promising areas of electronics investigated by researchers of the faculty are…
5. Students gain profound knowledge of…
6. On completing the first degree, graduates may…
7. The facilities provided at the radio-engineering department allow students…

Speaking

1. Work in teams. Imagine that you are responsible for arranging a meeting for prospective students to inform them about your faculty. Your purpose is to persuade potential students to choose the radio- engineering faculty.

Make a presentation of your department focusing on the following items:

- the quality of training
- the degrees/qualifications students can take
- the teaching staff
- facilities
- opportunities and perspectives for students

Writing

1. Write an essay in which try to state your point of view and give your reasons and arguments. Choose any of three options. The opening sentences are given.

1. It is very difficult to get anywhere without some kind of qualifications nowadays. Nevertheless, people seem to want the kind of qualification more related to the job they are planning to do.

2. I do not think university degrees are important if you want to succeed. It is vital to leave school with a certificate but after that, a lot is up to the individual to be successful.

3. A well-educated person is not so much someone who knows a lot of facts but a person who knows where to find any information he needs and then understands how to use it intelligently.

Before you start, write a plan for your essay and think of its structure. An essay usually consists of three parts: the introduction, the main body, the conclusion. Each part may contain some or all of these ideas:

Introduction (normally one paragraph)

- Facts about the topic
- Common opinions
- A personal opinion

Main body (one or more paragraphs)

- Arguments in favour of a statement or topic
- Arguments against a statement or topic

You can write about only the arguments in favour, only the arguments against, or both.

Conclusion (normally one paragraph)

- A summary of the arguments
- A personal opinion
- A recommendation, question, warning or prediction

Unit 2 ELECTROMAGNETIC WAVES

Tuning-in

1. The discovery of electromagnetic waves is considered one of the greatest theoretical achievements of physics. It proved to be revolutionary due to a wide range of benefits electromagnetic waves could provide. They led to radio, television and mobile communication and eventually to a huge electronic industry.

Work in groups and brainstorm the most important features of electromagnetic waves.

2. Summarize your views and think of as many arguments as possible to prove the importance of electromagnetic waves for signal and energy transfer.

3. Work with another group and compare your ideas. Decide what properties make electromagnetic waves particularly useful.

Vocabulary

1. Match the terms from the list with the definitions given below.

1) charge
2) current
3) electromagnetic wave
4) induction
5) voltage

6) wavelength

7) frequency

8) oscillate

9) refraction

10) reflection

11) diffraction

A. The production of electrical or magnetic forces in an object by other electrical or magnetic forces near it.

B. The amount of electricity that something holds or carries.

C. Te distance that the wave moves during the time, it takes for one complete cycle of vibration.

D. The process by which waves change when they pass over an object or through a narrow space.

E. The flow of electricity.

F. To change frequently in size, strength, or direction between limits.

G. A wave comprising both electrical and magnetic components, which are in phase, have the same frequency and located at right angles to one another.

H. The number of cycles per second.

I. The process of throwing something (e.g., an image, sound) back.

J. The amount of energy per charge between two points measured in volts.

K. The process of changing the direction of light when it hits a surface.

2. Use the words in the box to complete the text below. Explain the type of derivation of these terms. Give the Russian equivalents to them.

electromagnetic waves frequency magnetism electric charges radio waves voltage current electromagnetic induction wavelength

The phenomena associated with electricity and 1) _____ were studied over most of the 19th century. In the early 1820s, Danish physicist and chemist Hans Christian Orsted discovered that the two fields were interdependent. Observing a reaction of a magnetic compass needle to a 2) _____ flowing through a wire placed near it, he learned that magnetism was caused by moving 3) _____.

Later on, the simultaneous but separate discoveries made in the 1830s by Michael Faraday and Joseph Henry concerning 4) _____ enabled James Clerk Maxwell to unite electricity, magnetism and optics into one grand theory of light that explained the nature of 5) _____.

In 1887, Heinrich Rudolf Hertz verified Maxwell's theory experimentally. Hertz built an induction coil device, which was essentially a step-up transformer. Its high output 6) _____ caused sparks to jump back and forth across an air gap between two metal plates. He placed a bent wire with an air gap between its ends near another wire. Hertz noticed sparks jumping across the ends of this wire at the same 7) _____ as sparks of the induction coil. He concluded that electromagnetic waves propagated through air from the coil to the bent wire. Those waves were 8) _____ of about 1 meter in 9) _____ and exhibited the typical properties of light, namely, they reflected, focused on parabolic mirrors and refracted through glass.

Further experiments demonstrated the existence of a wide range of electromagnetic wavelengths and frequencies and resulted in the technologies of radio, television and radar.

Reading 1

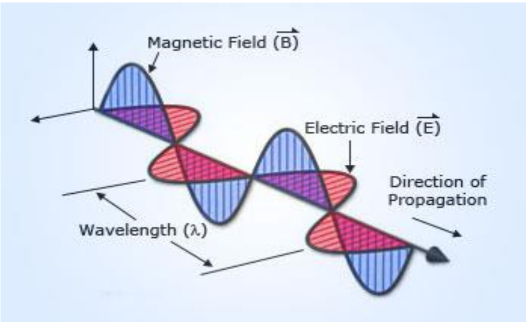
1. You are going to read a text about electromagnetic waves. Working in pairs, agree on at least three significant properties of electromagnetic waves that make them vital for various applications.

Read the text, explain the type of derivation of the terms. Give the Russian equivalents to them.

What are electromagnetic waves?

A wave is a vibration that travels through space. Many natural phenomena exhibit wavelike behavior. Mechanical waves such as water waves, earthquake waves and sound waves require a medium or substance to propagate.

As the name "electromagnetic" suggests, an electromagnetic wave is formed when an electric field combines with a magnetic field. Electromagnetic waves are transverse waves created by changing electric and magnetic fields that oscillate perpendicular to each other and to the direction of the wave propagation.



All periodic waves, whether they are electromagnetic or mechanical, are characterized by such properties as wavelength, frequency and speed. The wavelength of electromagnetic waves measures the distance between the successive pulses of electric or magnetic fields. Frequency represents how many wave pulses pass a given point each second and is measured in cycles or waves per second. One wave per second is called one Hertz. For example, the wavelength of radio waves can be as low as a few millimeters and as high as hundreds of kilometers. The frequencies vary between a few kilohertz to a few terahertz.

Electromagnetic waves travel at the speed of light, which is approximately $3x10^8$ m/sec. These waves do not require a medium for transmission and can travel through vacuum. Nevertheless, they move more slowly when they pass through various media such as air, glass and water.

The relationship between frequency, wavelength and speed is essential for electromagnetic waves. The product of frequency and wavelength equals the speed of light. Thus, wavelength and frequency are inversely related. The longer the wavelength, the lower the frequency is, and vice versa.

Electromagnetic waves possess a range of important properties. These waves have no mass. As the wavelength in the spectrum decreases, the amount of energy carried by the waves increases. This phenomenon can be illustrated by the formula $\varepsilon = hc/\lambda$ (where ε is the energy, h is Plank's constant, c is the speed of light in vacuum, λ is the wavelength). These waves follow the laws of reflection, refraction and polarization. Electromagnetic waves either travel through space directly, or have their path altered by reflection, refraction or diffraction.

Electromagnetic waves play a vital role in transmitting radio, television and telephone signals. They also transfer energy in the form of X-rays, ultraviolet rays and infrared radiation.

Comprehension

1. Decide whether in context each of the words in the left-hand column is a noun, verb, adjective or adverb. Match the words with the definitions on the right.

1 propagate	a) To find the exact size, amount, speed etc of something
2 behaviour	b) An explanation of a natural or scientific process
3 approximately	c) To show a particular quality, ability
4 phenomena	d) Lying or placed across something
5 measure	e) To spread
6 successive	f) Events or situations that can be seen to happen or exist
7 exhibit	g) The way in which two or more things are connected with or involve each other
8 law	h) The way that a substance, metal etc usually acts
9 inversely	i) Coming or happening one after another in a series
10 transverse	j) To show that an amount, number etc is nearly correct but not exact
11 medium	k) To be different in different situations
12 possess	l) Completely opposite
13 relationship	m) A substance that something exists in or moves through
14 vary	n) To have a quality or ability

2. According to the text, are the following statements true or false? If they are false, explain why.

1. Mechanical waves such as water waves or sound waves do not require any medium for transmission.

2. An electromagnetic wave is the product of alternating electric and magnetic fields oscillating perpendicular to each other.

3. Such features as wavelength, frequency and speed typical only of electromagnetic waves.

4. The speed of an electromagnetic wave does not depend upon the nature of the medium it travels. It passes through any medium at the same speed as through vacuum.

5. A relationship between frequency, wavelength and speed shows that wavelength and frequency are inversely related.

6. Planck's constant is a physical constant equal to the energy of any quantum of radiation divided by its frequency (named after Max Planck, a German physicist, the founder of quantum theory).

7. Technologies of radio, television and mobile communication would be impossible without electromagnetic waves.

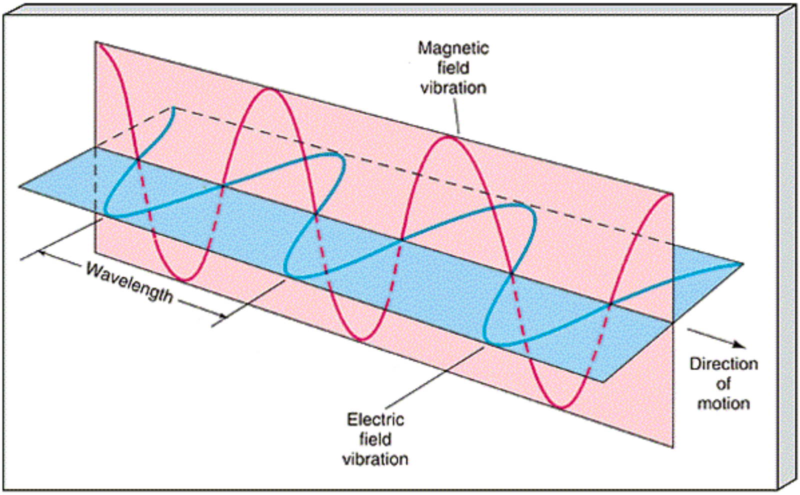
Focus on Vocabulary and Language

1. Read the text and decide which answer A, B, C, or D best fits each space. There is an example at the beginning (0).

Propagation of an Electromagnetic Wave

Electromagnetic waves are waves which can travel through the *0) B* of outer space. Mechanical waves unlike electromagnetic waves require the presence of a material 1) … in order to transport their 2) … from one location to another. Sound waves are examples of mechanical waves while light waves belong to electromagnetic waves.

Electromagnetic waves are created by the vibration of an electric 3) … This vibration generates a wave which has both an electric and a magnetic component. An electromagnetic wave 4) … its energy through the vacuum at a speed of light. The propagation of a wave through a medium occurs at a speed, which is less than 3.00×10^8 m/s.



The process of energy transmission through a medium involves the 5) … and reemission of the wave energy by the 6) … of the material. When an electromagnetic wave 7) … upon the atoms of the material, the energy of the wave is absorbed.

The energy absorption causes the electrons within the atoms to 8) … vibrations. In a short period of vibrational motion, the vibrating electrons generate a new electromagnetic wave with the same 9) … as the first wave. These vibrations 10) … the motion of the wave through the medium. The reemitted electromagnetic wave travels through a small space between atoms. Once it reaches the next atom, the electromagnetic wave is absorbed, transformed into electron vibrations and then reemitted again in the form of electromagnetic wave.

The actual speed of an electromagnetic wave through a material medium is dependent upon the optical 11) … of the medium.

Different materials cause a different time of delay due to the absorption and reemission process. Some materials have their atoms more closely packed and thus, the distance between atoms is less. As a result, the speed of an electromagnetic wave 12) … on the nature of the material, through which it travels.

0	A air	*B vacuum*	C atmosphere	D ionosphere
1	A medium	B channel	C way	D method
2	A force	B substance	C energy	D information
3	A material	B charge	C conductor	D wire
4	A pushes	B sends	C scatters	D transports
5	A arrangement	B absorption	C admission	D adjustment
6	A atoms	B molecules	C particles	D parts
7	A implants	B involves	C impairs	D impinges
8	A suffer	B feel	C undergo	D influence
9	A frequency	B value	C peak	D response
10	A stop	B cancel	C delay	D interrupt
11	A propagation	B density	C transfer	D transparency
12	A determines	B differentiates	C dedicates	D depends

2. Six sentences have been removed from the extract. Choose from the sentences (A-G) the one, which fits each gap. There is one extra sentence you need not use.

Reflection, Refraction and Diffraction of Electromagnetic Waves

As electromagnetic waves travel, they interact with objects and media in which they travel. 1________________________________.

These interactions cause the radio signals to change direction and to reach areas, which would not be possible to cover if the radio signals travelled in a direct line.

Reflection

Reflection of light is an everyday occurrence. Mirrors are a good illustration for this phenomenon. 2___________________________. Some loss of the signal is inevitable in the process of reflection through either absorption or passing a portion of the signal into the medium.

Various surfaces can reflect radio signals. For long-distance communication, the sea provides one of the best reflective surfaces. Desert areas are poor reflectors and other types of land fall in between these two extremes. 3______________________________.

Refraction

The concept of light wave refraction can be demonstrated by placing a part of stick or pole in water and leaving the remaining section in air. It is possible to see the apparent change or bend as the stick enters the water. Another well-known example of refraction is mirages. Radio waves are affected in the same way. 4_________________________.

Diffraction

Radio signals may also undergo diffraction. 5__________________.

To understand how this happens it is necessary to refer to Huygen's principle. It states that each point on a spherical wave front can be considered as a source of a secondary wave front. Even if there is a shadow zone immediately behind the obstacle, the signal will diffract around the obstacle and start to fill the void. 6_______________________________. For a radio signal, a mountain ridge may become a sufficiently sharp edge. It should be also stressed that low frequency signals diffract more markedly than higher frequency ones.

A. When reflection occurs, the angle of incidence is equal to the angle of reflection for a conducting surface.

B. It is known that when signals encounter an obstacle, they tend to travel around it.

C. As a result, waves can be reflected, refracted or diffracted.

D. A great deal of modern technology depends upon electromagnetic waves.

E. It is found that the direction of an electromagnetic wave changes as it moves from an area of one refractive index to another.

F. As a rule, diffraction is more pronounced when an obstacle has a sharp form similar to a knife- edge one.

G. For relatively short-range communication, many buildings, especially those with metallic surfaces, work as excellent reflectors of radio energy.

3. The text below is about the nature of electromagnetic waves. Before you read it, work with a partner and discuss the following questions.

1. What is the nature of electromagnetic waves? Do they behave like waves or particles?

2. In what areas are electromagnetic waves vitally important?

4. Read the text quickly without paying attention to the gaps to check your ideas.

What properties of these waves does the author analyze? What applications rely on electromagnetic waves?

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

The relationship *0) between* light and electromagnetism was established 1) . . . the prominent physicist James Clerk Maxwell in the 19^{th} century. This led 2) . . . electrodynamics 3) . . . regards electromagnetic waves, such as light, as disturbances or 'ripples' in an electromagnetic field created by the movement 4) … electrically charged particles.

At the beginning of the 20th century, experiments showed 5) . . . electromagnetic waves also had particle-like properties. The particles that make up electromagnetic radiation 6) . . . called photons. Although it seems contradictory, electromagnetic waves can behave 7) . . . as waves or as particles depending 8) . . . the type of experiment that is carried out. This is known as the wave-particle duality.

The wave-particle duality is one of the basic concepts of quantum theory. In quantum theory electromagnetic radiation is generated 9) . . . subatomic particles release energy. For example, an electron in an atom that absorbs energy, eventually drop to a lower energy level and release 10) . . . energy as electromagnetic radiation. This radiation can 11) . . . viewed as a particle or an electromagnetic wave.

The range of electromagnetic wave applications is extremely wide. Radio, television, mobile phones, the Internet relay on the transmission of radio frequency waves 12) . . . . air, space or fiber optic cables. Lasers apply light waves to record and play DVDs and audio CDs. X-ray machines are 13) . . . essential tool in medicine and airport security. In science, our knowledge about the universe comes largely 14) . . . analysis of light, radio waves and X-rays radiated by distant stars and galaxies.

Reading 2

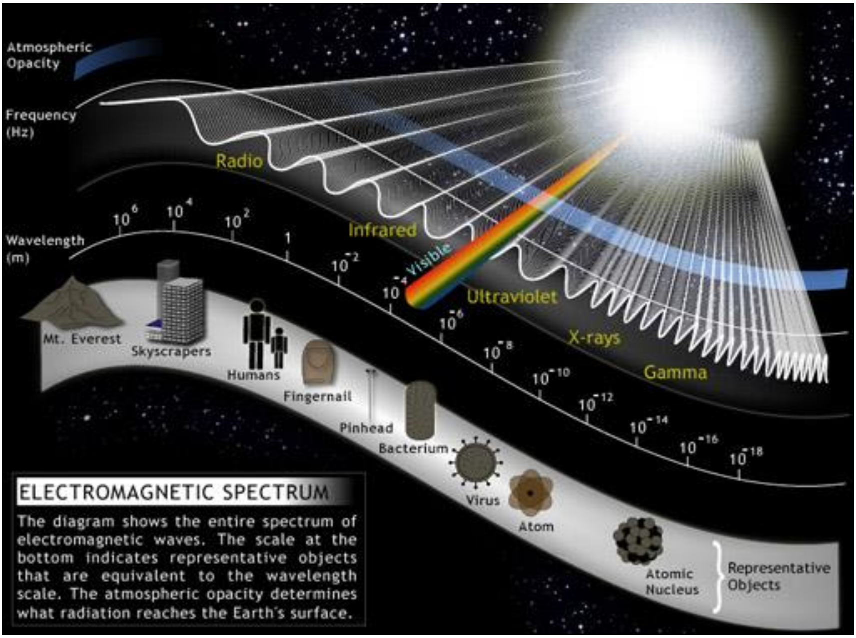
1. Electromagnetic waves have a wide range of frequencies. The full range is known as the electromagnetic spectrum. It is useful to divide the electromagnetic spectrum into regions exhibiting common properties important to science and technology.

Skim the text about the electromagnetic spectrum to find out according to what property different forms of electromagnetic waves are distinguished by.

2. Read the text more carefully and answer the questions.

1. What advantages does the band of low radio frequencies provide?
2. What factors limit transmission in the range of high frequencies?
3. What applications is the segment of very high and ultra- high frequencies suitable for?
4. In what areas is the microwave band application the most useful and perspective?

The Electromagnetic Spectrum



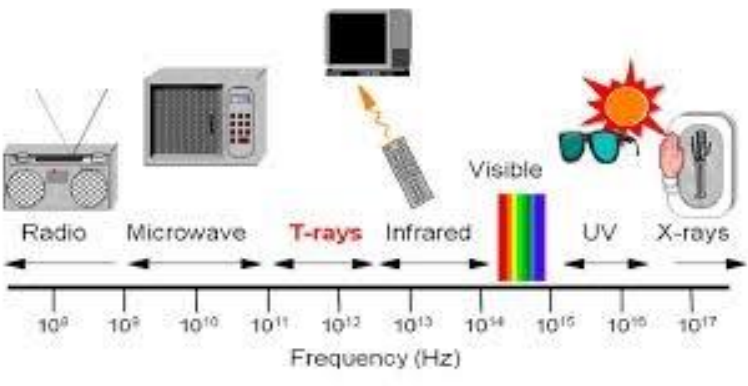
The electromagnetic spectrum includes different types of waves such as infrared waves, visible light rays, ultraviolet rays, X-rays, gamma rays, microwaves, radio waves. These waves differ according to their wavelength. The use of the electromagnetic spectrum depends primarily upon the frequency (or wavelength) of the radiation and the propagation properties of the medium in which the waves travel. Because the electromagnetic spectrum covers a range of more than 22 decades, it is split into regions with waves having similar properties.

Low Radio Frequencies (10^3 to 2×10^5 Hz)

This band is particularly useful for long-distance communication where reliability of transmission is important and sufficient radiation power is available. This band is generally used for radiotelegraphy. As frequency decreases in this band, reliability and signal strength improve. There are fewer interruptions because of diurnal, seasonal, and solar causes, but static and other radio noises tend to increase.

High Frequencies (2×10^6 to 3×10^7 Hz)

Useful but somewhat erratic long-range propagation is possible with low power in this frequency range. When the transmission path is entirely in darkness and the ionosphere is undisturbed, frequencies below a maximum usable frequency are propagated over long distances. Transmission is dependent upon peculiarities of the ionosphere. Fading and multiple-path effects often limit speed of communication. The large interference range limits the number of emissions that can be simultaneously radiated at a given frequency. This band is used for fixed services, mobile services, amateur transmissions, broadcasting, maritime mobile service and telemetering.



Very High and Ultra High Frequencies (3×10^7 to 3×10^9 Hz)

Lumped circuits, useful at lower frequencies, give way to transmission lines and other distributed circuits in this band. The band is suitable for relatively short-distance communication for services transmitting a large amount of detail, including radar and television. Directive antenna systems of small size are economical and effective. If powerful transmitters and high-gain antennas are used, reliable long-distance propagation is possible using waves scattered by turbulence in the troposphere. The band is useful for fixed services, mobile services, space research, radio astronomy, telemetering and tracking, amateur transmissions, satellite communication, meteorological aids, radiolocation, radar and television.

Microwaves (3×10^9 to 3×10^{11} Hz)

Transition from circuit to optical techniques characterizes microwave bands. Electromagnetic waves in this band are short enough to be transmitted by highly directive antennas and waveguides. Long-distance communication can be carried out by a series of automatic relay stations mounted at high elevations within line of sight of each other. This portion of the spectrum is vital for high-definition radar, television, and similar services requiring extensive bandwidths to convey a considerable amount of information. Microwave spectroscopy dealing with electron-spin resonance and molecular rotation is implemented in this band.

The infrared, visible, and ultraviolet portions of the spectrum have long been used for identifying molecules by their spectral emissions and as a means of qualitative analysis for determining the geometry of simple molecules, and quantitative analysis where spectral-line intensity is related to the concentration of substance.

Comprehension

1. Match up the terms in the box with the definitions given below. Explain the type of derivation of these terms. Give the Russian equivalents to them.

decade	band	bandwidth	transmission path
fading	interference	lumped circuit	directive antenna
turbulence			
electron-spin resonance	definition	waveguide	
reliability			

1. The width of a frequency range measured in hertz or the rate at which data may be transmitted through the system.

2. A section of a transmission line designed so that electric or magnetic energy is concentrated in it at specified frequencies, and inductance or capacitance is regarded as concentrated in it, rather than distributed over the length of the line.

3. The capability of a system to provide clear sounds or images.

4. A route along which something moves; the direction that a wave is moving in.

5. A group or period of ten.

6. The structure that transmits or receives electromagnetic waves in a certain direction with greater power and increased performance.

7. A hollow metal pipe used to carry radio waves.

8. A small section of the spectrum of radio communication frequencies in which channels are usually used or set aside for the same purpose.

9. Fluctuation in the strength of radio signals because of variations in the transmission medium.

10. The ability of a device to perform a required function under stated conditions for a stated period.

11. A fluid regime characterized by chaotic, stochastic property changes, e.g. a rapid variation of pressure and velocity in space and time; a sudden violent movement of air or water.

12. The addition of unwanted signals to a useful signal; anything, which alters, modifies or disrupts a signal as it travels along a channel between a source and a receiver.

13. A spectroscopic technique for studying chemical species that have one or more unpaired electrons, such as organic and inorganic free radicals or inorganic complexes possessing a transition metal ion.

2. Find words in the text that are the opposite of the words below.

1 to join

2 harmful

3 scarce

4 inaccessible

5 weakness

6 to deteriorate

7 nocturnal

8 stable, steady

9 partly

10 professional

11 inappropriate

12 wasteful

13 cavity, pit

14 narrow

15 insignificant, negligible

Speaking

1. Work in small groups. Do research to find out about apparatus, systems, installations that use wave energy for operations (e.g., a wave energy converter, a wave power station). Prepare a presentation about your system outlining its functions and purpose, structure, components, dimensions, principles of operation, spheres of application and benefits. Think of visual aids (photos, diagrams, tables) to make you presentation more informative and interesting.

2. Work in two groups.

Group A. You are designers. Imagine that you would like to start manufacturing your device, but you need a financial support. Make a presentation of your device to a group of business experts to persuade them to invest money in your idea. Be prepared to answer your audience's questions.

Group B. You are business experts. Brainstorm questions you would like to ask about features of a device to take a decision whether the project is worth investing.

Role-play your sessions.

Writing

1. You have seen the announcement in a popular scientific periodical inviting those who take interest in science to make their contributions to the magazine. The editors of the magazine try to attract young people's attention to science and technology by describing and explaining basic scientific concepts in a simple, clear, informal way. You specialize in waves and electromagnetism. Write your article on the subject.

2. Before you begin, consider the following questions.

1. What is the purpose of the article?
2. Who is going to read your article?

3. How many sections should the article contain?

4. What style (formal or informal) would be suitable for the article?

5. What tense form should you use: present, past, or future simple? Why?

6. What information should the article contain?

7. How can you make the article interesting for your readers (e.g. interesting title and beginning, questions, strong opinions)?

3. Write a plan for your article. Write an article following your plan. Write 120-180 words.

Unit 3 RADIO

Tuning-in

1. Radio is the technology of wireless data transmission over distances. As a rule we think of radio in the context of FM or AM stations that broadcast news or music programmes, but in fact radio waves are also used for sending and receiving data in such systems as Wi-Fi networks, communication satellites and Bluetooth devices.

Work in groups and discuss the purpose of radio, the devices it involves, the principles its operation is based on. Try to give a definition of radio.

2. Work with another group. Compare your ideas and decide whose definition is the most complete and accurate.

Vocabulary

1. The following sentences define some important words related to radio. Which word is defined in each case? Explain the type of derivation of the terms. Give the Russian equivalents to them.

1. The magnitude of change in oscillating variable with each oscillation within an oscillating system.

A pulse B peak C amplitude

2. A substance that allows heat or electricity to pass through it.

A insulator B conductor C capacitor

3. An electromagnetic wave that radio signals can be sent on.

A microwave B radio wave C infrared radiation

4. An electrical device, which converts electric power into radio waves, and vice versa.

A antenna (aerial) B transformer C amplifier

5. A periodic current whose average value over a period is zero.

A direct current B oscillating current C alternating current

6. A piece of electronic equipment used for generating and amplifying a radio-frequency carrier, modulating the carrier with information and feeding it to an aerial for transmission.

A transmitter B transducer C generator

7. The process of varying one or more properties of a high-frequency periodic waveform, called the carrier signal, with respect to a modulating signal.

A variation B modulation C demodulation

8. An electronic device that receives radio waves and converts the information carried by them to a usable form.

A receiver B resistor C regulator

9. The process of extracting the original information-bearing signal from a modulated carrier wave.

A reception B recovery C demodulation

10. A device comprising both a transmitter and a receiver, which are combined and share common circuitry or a single housing.

A modem B transceiver C converter

2. When we look into the origin of the word "radio', we discover that in earlier times radio or radiotelegraphy was called as "wireless telegraphy".

Read the extract about the etymology of radio and use the words in the box to complete the text. Explain the type of derivation of these terms. Give the Russian equivalents to them.

to radiate	networking	transceiver
transmission	broadcasts	mobile
communication		

Referring to radio etymology, the prefix "radio" in the sense of wireless 1) . . . was first used in the term "radio-conductor". This word was coined by Edouard Branly, the French physicist, in 1897. It is based on the verb 2) . . . (in Latin "radius" means "spoke of a wheel, beam of light, ray").

The United States Navy adopted the word "radio" in 1912 to distinguish it from several other wireless 3) . . . technologies in use at that time. The term had become common by the time of the first commercial 4) . . . in the United States in the 1920s. (The noun "broadcasting" itself comes from the area of agriculture where it means "scattering seeds widely".) Later, the term was introduced to other languages in Europe and Asia.

In recent years, the term "wireless" has gained renewed popularity due to the rapid growth of short-range computer 5) . . . , e.g. Wireless Local Area Network (WLAN), Wi-Fi and Bluetooth, as well as 6) . . . telephony such as GSM and UMTS. Today, the term "radio" often refers to the actual 7) . . . device or chip, whereas "wireless" matches the system and/or method used for radio communication.

Reading

1. You are going to read a text about the radio system and its components. Before you read it, try to predict what issues will be discussed in the text choosing the statements from those given below.

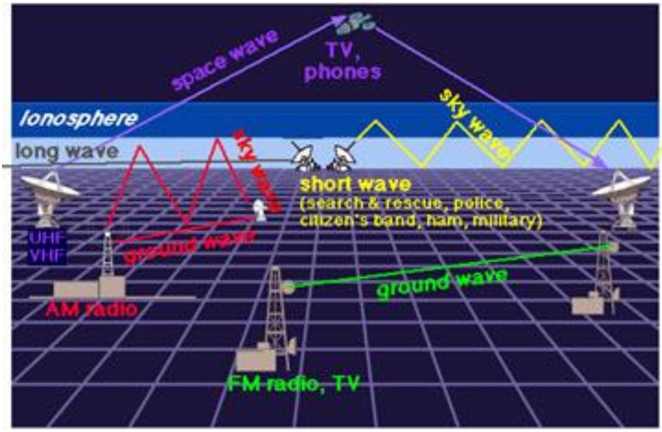
1. Radio system components.
2. Types of modulation.
3. Radio and its purpose.
4. Radio applications.
5. An antenna and its importance.
6. A transmitter and the principles of its operation.
7. Wireless communications systems.
8. The function of a receiver.
9. Drawbacks of the technology.

Read the text to check if your predictions were right. While reading match each statement with the paragraph in which it is discussed. Some statements do not fit. Explain the type of derivation of the terms. Give the Russian equivalents to them.

Radio

A. Radio is the transmission of signals through free space by electromagnetic radiation of a frequency significantly below that of visible light, in the radio frequency range from 30 kHz to 300 GHz. These waves are known as radio waves. Electromagnetic radiation travels by means of oscillating electromagnetic fields that pass through the air and the vacuum of space. Information is carried by systematically changing (modulating) a particular property of the radiated waves, such as their amplitude, frequency, phase or pulse width. When radio waves strike an electrical conductor, the oscillating fields induce an alternating current in the conductor. The information in the waves can be extracted and converted back into its original form.

B. Radio systems used for communication include the following elements: a transmitter, an antenna, a receiver. A wide range of techniques can be applied for implementing each process, their use depending on the communications purpose.



C. A transmitter is one of the key components of the system. The transmitter contains a source of electrical energy producing alternating current of a required frequency and a system for modulating some property of the produced energy to impress a signal on it. This modulation might be as simple as turning the energy on and off, or altering more subtle properties such as amplitude, frequency, phase or combinations of these properties. The transmitter sends the modulated electrical energy to a tuned resonant antenna, which transforms the rapidly changing alternating current into an electromagnetic wave that moves through space.

D. Radio uses two basic modulation techniques: amplitude modulation and frequency modulation. Amplitude modulation of a carrier wave works by varying the strength of the transmitted signal in proportion to the information being sent. For example, changes in the signal strength can be used to specify the sounds reproduced by a speaker or the light intensity of television pixels. Frequency modulation, as its name suggests, varies the frequency of the carrier. The instantaneous carrier frequency is directly proportional to the instantaneous value of the input signal. Digital data can be sent by shifting the carrier's frequency among a set of discrete values. This technique is known as frequency-shift keying.

E. An antenna (or aerial) is an electric device, which converts electric current into radio waves, and vice versa. It is usually used with both a transmitter and receiver. In transmission, a radio transmitter applies an oscillating radio frequency current to the antenna terminals, and the antenna radiates this energy as electromagnetic waves. In reception, an antenna intercepts some of the electromagnetic wave power to generate a tiny voltage at its terminals that is applied to a receiver for amplifying. A tuned receiving antenna captures some of the electromagnetic wave energy and returns it to the form of oscillating electrical currents. At the receiver, these currents are demodulated, i.e. converted to a usable signal form by a detector. The receiver is "tuned" to respond preferentially to the desired signals and reject undesired ones.

F. A radio receiver picks up its input from an antenna, uses electronic filters to separate a required radio signal from all other signals captured by this antenna. Then, it amplifies the signal to a level suitable for further processing. Finally, the receiver converts the signal through demodulation and decoding into a form usable for the consumer, namely sound, pictures, digital data, measurement values, navigational position, etc.

G. Early radio systems relied entirely on the energy collected by an antenna to produce signals. Radio became more effective after the invention of the vacuum tube and later the transistor that allowed amplifying weak signals. The first uses of radio were maritime intended for sending telegraphic messages using Morse code between ships and land. Nowadays radio takes various forms, including wireless networks and mobile communications, as well as radio broadcasting. Radio plays a significant role in the modern world due to a great number of its applications ranging from walkie-talkie children's toys to controlling space vehicles.

Comprehension

1. Match up the words below into

a) pairs that mean the same

oscillate	usable	respond
significant	implement	
property	instantaneous	

important	swing	react
immediate	suitable	
feature	carry out	

b) pairs of opposites

conductor	subtle	
reception	rapidly	
reject	strength	tiny

transmission	large	
noticeable	insulator	
slowly	accept	weakness

2. Find all the words in the text that mean the following.

1) To make something different- to change, …..
2) To have something as a part
3) To send
4) To take
5) To catch

3. Are the following statements true or false according to the text? If they are false, explain why.

1. The transmission of signals by radio is feasible only through wires.
2. To carry information one of the features of radio waves is systematically changed or modulated.
3. The number of components the radio system contains is different depending on the communication purpose.
4. The transmitter sends signals without any processing.
5. Radio broadcasting is performed by two methods known as amplitude modulation and frequency modulation.
6. An aerial is an electronic device that is used for transmitting signals.
7. The major function of a receiver is to select a wanted radio signal and demodulate it into a usable form.
8. At present radio does not play any significant role since the technology is outdated.

4. Ask questions to the following answers.

1. The transmission of signals through free space.
2. Through oscillating electromagnetic fields.
3. To generate alternating current of the required frequency.
4. To a tuned resonant antenna.
5. In case it is necessary to vary the strength of the transmitted signal or the carrier frequency.
6. To transform electric currents into radio waves.
7. Into a form suitable for the user.

8. When the vacuum tube and transistor were invented.
9. Wireless networks, mobile communications, radio broadcasting are.

Reading 2

1. Who invented radio? This is a very debatable topic since many prominent researchers have contributed to this breakthrough in the wireless technology.

The question does not have a specific answer. There have been numerous theories and patents filed for credits. The theory behind each discovery led to the practical experiments in most cases made by another researcher. A single inventor could be hardly credited for inventing radio because investigations carried out by many researchers made this achievement possible. Therefore, radio is the greatest, yet the most controversial discovery in the history of science and technology.

You are going to read a text about the history of radio. Before you read it, work in groups and discuss which of the researchers and inventors made the most significant contribution to the development of radio.

2. Work with another group. Compare your ideas and decide whose contributions to the area were crucial.

3. Read the text to check your ideas and see if you find scientists and inventors whose achievements and discoveries you talked about.

Who Invented Radio?

The roots of radio trace back to the 1800s when in 1819, Hans Ørsted, the Danish physicist, discovered relativity between magnetic energy and direct current. This theory later led to other important investigations by the physicist André-Marie Ampère who invented solenoid. This invention, in its turn, urged other scientists and researchers to explore this theory further for practical use. In 1831, Michael Faraday developed the theory of electromagnetic inductance, which stated that changes in the magnetic field in an electric circuit could generate current or electromotive force in another wire or circuit.

The early 1860s witnessed another scientific breakthrough made by James Clerk Maxwell, the Scottish physicist, who extended Michael Faraday's theory. He contributed greatly to the research on electromagnetism by predicting the existence of electromagnetic waves and developing the mathematical theory of electromagnetic wave propagation.

In 1888, the German physicist Heinrich Hertz made the sensational discovery of electromagnetic waves confirming Maxwell's ideas experimentally. He devised an apparatus that transmitted radio waves and managed to detect them in his laboratory. Thus, Hertz was the first researcher to prove the existence of electromagnetic waves by demonstrating that these waves could be sent out into space and remotely detected.

The next successful leap in the development of radio was connected with the genius of Nikola Tesla, the Serbian and American inventor, who began his research into radio in 1891. In 1893, in St. Louis, Missouri, Tesla gave a public demonstration of "wireless" radio communication. Addressing the Franklin Institute in Philadelphia and the National Electric Light Association, he described in detail the principles of radio communication. The apparatus that Tesla used contained all the elements that radio systems incorporated before the development of the early vacuum tube. Tesla was the first to apply the mechanism of electrical conduction to wireless practices. He initially experimented with magnetic receivers, unlike the coherers (detecting devices consisting of tubes filled with iron filings) used by other early experimenters.

The first radio could not transmit sound or speech and was called the "wireless telegraph". The first public demonstration of wireless telegraphy took place in the lecture theater of the Oxford University Museum of Natural History on August 14, 1894, made by Professor Oliver Lodge and Alexander Muirhead. During the demonstration, a radio signal was sent from the neighboring laboratory building and received by apparatus in the lecture theater.


MARCONI "SPARK GAP" TRANSMITTER

The Russian physicist Alexander Popov was the first to demonstrate the practical application of radio waves. In 1895, he built the first radio receiver containing a coherer. Further refined as a lightning detector, the device was presented to the Russian Physical and Chemical Society, on May 7, 1895. This day has since been celebrated in the Russian Federation as 'Radio Day'. In March 1896, Popov demonstrated in public transmission of radio waves between campus buildings in St. Petersburg. Later A. Popov experimented with ship-to-shore communication, but he never applied for a patent.

In 1895, Guglielmo Marconi, an electrical engineer, was also working on wireless communication. He managed to receive signals over a distance of 100 meters. By the end of 1895, he had extended the distance to over a mile. In 1896, he patented the discovery and carried out further research on practical and commercial use of the radio. In 1897, Marconi established the world's first radio station on the Isle of Wight, England. The effective operating distance of his transmitter increased as the equipment was improved, and in 1901, Marconi succeeded in transmitting a signal across the Atlantic Ocean. The letter 'S' was telegraphed from England to Newfoundland using Morse code.

Reginald Fessenden was a Canadian inventor recognized for his achievements in the early radio. The first audio transmission by radio in 1900, the first two-way transatlantic radio transmission in 1906, and the first radio broadcast in 1906, were his three significant milestones. Fessenden concluded that he could devise a better system than the spark-gap transmitter and coherer-receiver combination that had been developed by Lodge and Marconi. In 1906, he designed a high-frequency alternator and transmitted human voice over the radio.

From that moment, the development of radio for more practical use began. In 1904, John A. Fleming developed the first vacuum electron tube, which could detect radio waves electronically. Two years later, Lee de Forest invented the audion, a type of triode, which not only detected radio waves but also amplified them. Therefore, it became possible to transmit human voice instead of codes.

Soon the era of radio began and the technology gained recognition throughout the globe.

Comprehension

1. The text contains a number of important collocations (fixed expressions). Match words in A with words in B to make collocations and use them to complete the sentences given below.

A	B
electromagnetic	communication
radio	wave
human	breakthrough
electromagnetic	telegraphy

ship-to-shore	inductance
wireless	alternator
scientific	communication
high-frequency	voice

1. A.S. Popov performed many experiments to establish . . .

2. Heinrich Hertz was the first scientist to generate and detect . . .

3. Reginald Fessenden, a Canadian inventor, designed a . . . and transmitted . . . over the radio.

4. In 1831, Michael Faraday began a series of experiments in which he discovered…

5. The first public demonstration of . . . was implemented by Professor Oliver Lodge at Oxford University.

6. The 1860s began with another . . . made by James Clerk Maxwell who developed M. Faraday's ideas.

7. Nikola Tesla described in detail and demonstrated the principles of . . .

2. Complete the sentences below to summarize the text.

1. The discovery of relativity between magnetic energy and direct current made by the Danish physicist Hans Orsted was of great significance to the development of radio because . . .

2. Developing Michael Faraday's theory James Clerk Maxwell could . . .

3. The German physicist Heinrich Hertz validated Maxwell's ideas experimentally by . . .

4. The research carried out by Nikola Tesla could be considered a vitally important contribution to the area because . . .

5. A.S. Popov is usually credited for . . .

6. G. Marconi's achievements in wireless communication involved . . .

7. Reginald Fessenden, a Canadian inventor, was recognized for . . .

8. Human voice transmission became possible owing to . . .

Focus on Vocabulary and Language

1. Read the extract about the major components radio contains and choose the correct form in each case.

Radios consist of many *0) specialized/specializing* electronic circuits *1) designing/designed* to perform specific tasks—radio frequency amplifier, mixer, variable frequency oscillator, intermediate frequency amplifier, detector, and audio amplifier.

The radio frequency amplifier *2) designed/is designed* to amplify the signal from a radio broadcast transmitter. The mixer *3) is taken/takes* the radio signal and *4) combines/is combined* it with another signal *5) being produced/produced* by the radio's variable frequency oscillator to generate an intermediate frequency. The intermediate frequency *6) is amplified/amplifies* by the intermediate frequency amplifier. This intermediate signal *7) is being sent/is sent* to the detector, which *8) converts/is converting* the radio signal to an audio signal. The audio amplifier strengthens the audio signal and *9) send/sends* it to the speaker or earphones.

The simplest AM/FM radio *10) comprises/is comprising* all of these circuits mounted on a single circuit board. A single integrated circuit can *11) include/including* most of these circuits. The volume control (a variable resistor), tuning knob (a variable capacitor), speaker, antenna, and batteries can *12) be mounted/to be mounted* either on the printed circuit board or in the radio case.

2. It is essential for a modern radio communications system to meet a set of requirements, the provision of sufficient bandwidth to support multiple users being one of the most important issues. For this purpose, modern systems apply special techniques.

Decide which terms the following sentences define. Explain the type of derivation of these terms. Give the Russian equivalents to them.

1. The range of frequencies occupied by a modulated carrier wave.

A spectrum B width C bandwidth

2. A method of transmitting and receiving independent signals over a common signal path by means of synchronized switches at each end of the transmission line so that each signal appears on the line only a fraction of time.

A transfer function B time-division multiplexing C data rate

3. A technique by which the total bandwidth available in a communication medium is divided into a series of non-overlapping frequency sub-bands and each one is used to carry a separate signal.

A multiplexing B division C frequency-division multiplexing

4. A channel access method that employs spread-spectrum technology and a special coding scheme (each transmitter is assigned a code) and allows several transmitters to send information simultaneously over a single communication channel.

A code-division multiplexing B coding C decoding

3. Read the passage and complete it using the words in the box. Explain the type of derivation of these terms. Give the Russian equivalents to them.

frequency-division multiplexing	distance	duplex
time-division multiplexing	loudspeaker	output
bandwidth	terminal equipment	simplex
code-division multiplexing		

The radio equipment involved in communications systems includes a transmitter and a receiver, each having an antenna and appropriate 1) . . . such as a microphone at the transmitter and a 2) . . . at the receiver in the case of a voice-communication system.

The power consumed by a transmitting station varies depending on the 3) . . . of communication and the transmission conditions. The power received by a receiving station is usually only a tiny fraction of the transmitter 4) . . . , since communication depends on the information reception, not on the transmitted energy.

Conventional radio communications systems use 5) . . . as a strategy to split up and share the available radio-frequency 6) . . . by different parties communicating concurrently. Modern radio communications systems include those that divide a radio-frequency band by 7) . . . and 8) . . . as alternatives to the classical FDM technique. These systems allow supporting multiple users beyond the FDM strategy that was ideal radio broadcasting but inefficient for applications such as mobile telephony.

A radio communications system may send information only one way. For example, in broadcasting a single transmitter sends signals to many receivers. Two stations may take turns sending and receiving using a single radio frequency. This system is called 9) . . . By using two radio frequencies two stations may continuously and simultaneously send and receive signals. Such operation is known as 10) . . .

4. You are going to read a text about a two-way radio. While reading complete the text by filling in an appropriate word in each space. You should use "grammar" words. There is an example at the beginning (0).

Two-way Radio

A two-way radio is a system that can *0) both* transmit *and* receive, unlike a broadcast receiver 1) ____ only receives signals. A two-way radio (transceiver) enables the operator to have a conversation 2) ____ other similar radios operating on the same radio frequency. Two-way radios 3) ____ available in mobile, stationary base and hand-held portable configurations.

Two-way radio systems usually operate in a half-duplex mode, that is the operator can either talk or listen, but not 4) ____ the same time. A push-to-talk or press-to-transmit button activates the transmitter, when it 5) ____ released the receiver is active. A mobile phone is an example of a two-way radio. It uses two different radio frequencies to carry the two directions of the talk simultaneously.

6) ____ most common two-way radio systems operate in the very- high and ultra- high frequency parts of the radio spectrum. UHF has a shorter wavelength which makes it easier for the signal to find 7) ____ way through rugged terrain or inside a building. The longer wavelength of VHF means it can transmit further 8) ____ ideal conditions. 9) ____ most applications, lower radio frequencies are better for a longer range. A broadcasting TV station illustrates this. A typical VHF TV station operates at about 100,000 watts and has a coverage radius of about 60 miles. A UHF TV station with a 60-mile coverage radius requires transmitting at 3,000,000 watts.

10) ____ a system works mostly outdoors, a VHF radio is probably the best choice, especially if an external antenna 11) ____ added. 12) ____ higher the antenna is placed, 12) ___ further the radio can transmit and receive. One exception to using a VHF radio outdoors is if it is used in a heavily wooded or rugged area. In this case, a UHF radio may transmit better through the terrain. If the radios are used mainly inside buildings, UHF is likely the best solution 13) ____ its shorter wavelength travels through the building better. There are also repeaters that can 14) ___ installed to increase the communication distance.

5. The extract below is about the prominent Russian scientist A.S. Popov. Before you read it, take a guess and choose the correct option to complete the sentences.

Then compare your answers with those of your partner and decide whose guesses are more accurate.

1. A.S. Popov was the first researcher to demonstrate the practical application of ...

a) nuclear power b) electromagnetic waves c) digital transmission

2. He studied …. at the St. Petersburg university.

a) physics b) chemistry c) history

3. A. Popov's experiments were based on the ideas of ….

a) G. Marconi   b) T. Edison   c) H. Hertz

4. A.S. Popov demonstrated the operation of the world's first radio receiver on ….

a) March 22, 1894   b) January 1, 1895   c) May 7, 1895

5. The wireless station established under A. Popov's guidance provided ….

a) satellite communication   b) ship-to-shore communication

c) ground-to-air communication

6. Read the text to find out more about A.S. Popov's achievements and check whether your guesses were right. When reading use the words in brackets to form a word that fits in the gap in the sentence.

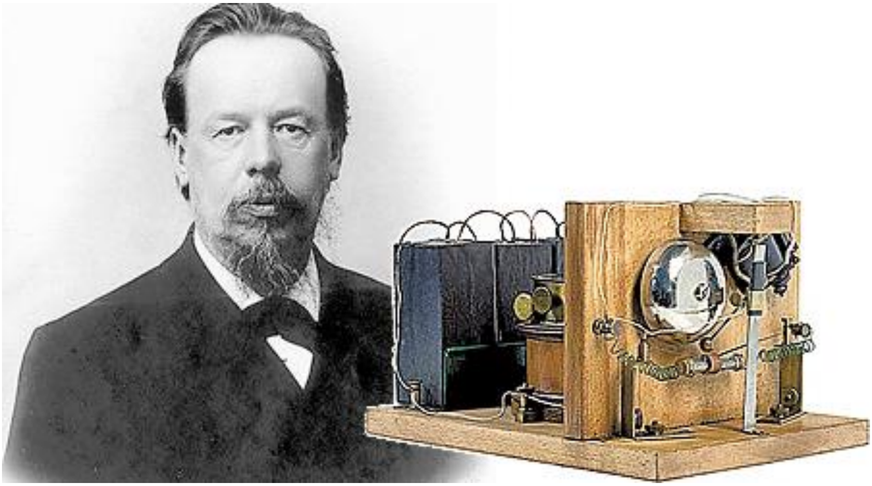
Alexander Stepanovich Popov

A.S. Popov (March 4/16 1859- January 13/December 31 1905/6), a Russian physicist, was the first to demonstrate the practical *0) application (apply)* of electromagnetic waves but he did not apply for a patent for this *1) (invent)*.

Born in the village Turinskiye Rudniki (now Krasnoturinsk, Sverdlovsk Oblast) in the Ural mountains as the son of a priest, he became interested in *2) (nature)* sciences early in his youth. A. Popov got a good education at the seminary in Perm and in 1877 enrolled the St. Petersburg University where he studied physics. After *3) (graduate)* with honors in 1882 he work as a laboratory *4) (assist)* at the university. However, the salary at the university was inadequate to support his family, and in 1883, he took a post as a teacher and head of laboratory at the Russian Navy's Torpedo School in Kronstadt on Kotlin Island.

In the early 1890s, Popov conducted experiments along the lines of H. Hertz's research. In 1894, he built the first radio receiver containing a coherer, which he used as a lightning detector. The scientist presented the device to the Russian Physical and Chemical Society on May 7, 1895. The paper on his findings was published the same year

(December 15, 1895). On March 24, 1896, Popov demonstrated *5) (transmit)* of radio waves between *6) (differ)* campus buildings in St. Petersburg.



In 1990, the radio station established under A. Popov's *7) (guide)* on Hogland Island provided a two-way communication by wireless telegraphy between Russian Navy base and ships.

In 1901, Alexander Popov was appointed professor and in 1905 elected as the director of the Electro Technical Institute, which was named after him.

In 1905, he fell seriously ill after being very uneasy about the suppression of a student movement. He died on December 31, 1905, which corresponds to January 13, 1906 in the Gregorian calendar.

7. Read the extract about the major advances in radio technology in the 20th century. The sentences in the extract have been jumbled. Rearrange the sentences to make up a complete text.

1. These two properties made possible the development of low-cost radio transceivers for a variety of applications.

2. In the early 1990s, cellular communications and wireless networking motivated a very rapid development of inexpensive, low-power radios, which caused the enormous growth of wireless communications.

3. This system was used to receive and demodulate radio signals by converting them into a lower intermediate frequency (IF).

4. By the end of the 1970s the system had been tested in the field and at the beginning of the 1980s, the first commercial cellular systems appeared.

5. The invention of the super-heterodyne receiver by Edwin H. Armstrong in 1917 became a critical point for the development of radio communications and related applications.

6. The super-heterodyne receiver was improved to demodulate satisfactorily very weak signals buried in noise (high sensitivity) and, at the same time, to distinguish the useful signals from others residing in neighbouring frequencies (good selectivity).

7. To fulfill the need for applications demanding high-quality bandwidth like data transmission, Internet, web browsing and video transmission 2.5G and 3G systems appeared 10 years later.

8. In a few decades, packet radios and networks targeting military communications gained increasing interest.

9. The demodulator that followed the IF amplification and filtering stages was used to extract the transmitted voice signal from a weak signal impaired by additive noise.

10. Satellite and deep-space communications gave the opportunity to develop very sophisticated radio equipment during the 1960s and 1970s.

11. The increasing demand for higher capacity, low cost, performance and efficiency led to the second generation of cellular communications systems in the 1990s.

12. In the 1960s, the AT&T Bell Laboratories carried out considerable research to develop a cellular communications system.

Speaking

1. Work in two groups.

Group A. Imagine that you are radio engineers. The popular radio station you work for needs to upgrade equipment. You are responsible for this project. Your task is to place an order for the new advanced equipment. **Prepare the design brief that you will be discussing with manufacturers.**

Group B. You are designers working for a manufacturing company. You are going to meet customers and discuss their requirements for the broadcasting equipment they need. Brainstorm questions to ask them about performance, features and functions of the system, what budget they are planning to spend on the project.

Role-play your conversation.

Writing

1. Imagine that you have been asked to prepare a report for a well-known company manufacturing wireless systems. They are planning to increase their activities in your region and need information on the existing market of wireless devices, consumers' demand for such devices and criteria they take into account when choosing gadgets.

When writing a report you should consider the following things:

- The report has a title.
- Divide it into sections and give each section a heading.

- The first section is usually Introduction where you state the purpose of the report.
- Finish with your conclusions, and, if appropriate, make suggestions and recommendations.

2. Write your report. Write 120-180 words.

Unit 4 INTEGRATED CIRCUIT

Tuning-in

1. In the 20-th century vacuum tubes were replaced by semiconductors. What do you know about the development of this branch of electronics? Share your ideas with the class.

Vocabulary and Reading

1. Tick the words, which come to your mind when you think of integrated circuits. Add some more words related to this area. Explain the type of derivation of these terms. Give the Russian equivalents to them.

vacuum tube	amplification
substrate	resistor
light	advanced
semiconductor	discrete
chip	appliance
valve	reliable

Make up sentences on the subject using the words from your lists.

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

discrete	previously	containing	circuit
power	chip devices	components	
silicon	reliability	surface	single

An integrated (1) . . . is a microscopic array of electronic circuits and (2) . . . that has been diffused or implanted onto the (3) . . . of a single crystal, or (4) . . ., of semiconducting material such as (5). . . . It is called an integrated circuit because the components, circuits and base material are all made together, or integrated, out of a (6) . . . piece of silicon, as opposed to a (7) . . . circuit in which the components are made separately from different materials and assembled later. ICs range in complexity from simple logic modules and amplifiers to complete microcomputers (8) . . . millions of elements.

The impact of integrated circuits on our lives has been enormous. ICs have become the principal components of almost all electronic (9) . . . . These miniature circuits have demonstrated low cost, high (10) . . . , low (11) . . . requirements, and high processing speeds compared to the vacuum tubes and transistors, which preceded them. Integrated circuit microcomputers are now used as controllers in equipment such as machine tools, vehicle operating systems and other applications where hydraulic, pneumatic, or mechanical controls were (12) . . . used.

Reading 1

1. Look through the following text and decide which paragraphs are about these subjects:

- advantages of integrated circuits
- the first integrated circuits
- the principle of producing ICs
- areas of IC application
- inventions that lead to making ICs
- improvements in integrated circuits

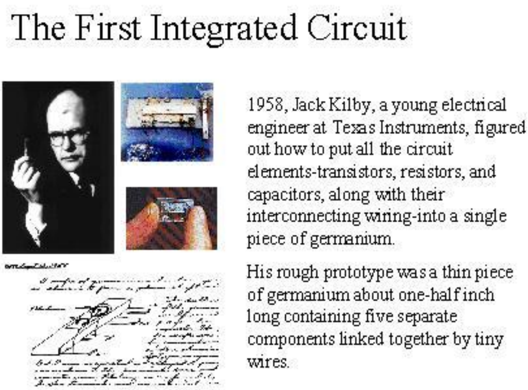
2. Divide the text into logical parts and think of a title for each part.

Integrated Circuit

In electronics, an integrated circuit (also known as IC, microcircuit, microchip, silicon chip, or chip) is a miniaturized electronic circuit (consisting mainly of semiconductor devices, as well as passive components) that has been manufactured in the surface of a thin substrate of semiconductor material. Integrated circuits are used in almost all electronic equipment in use today and have revolutionized the world of electronics. A hybrid integrated circuit is a miniaturized electronic circuit constructed of individual semiconductor devices, as well as passive components, bonded to a substrate or circuit board.

Integrated circuits were made possible by experimental discoveries, which showed that semiconductor devices could perform the functions of vacuum tubes. The integration of large numbers of tiny transistors into a small chip was an enormous improvement over the manual assembly of circuits using discrete electronic components. There are two main advantages of ICs over discrete circuits: cost and performance. Cost is low because the chips, with all their components, are printed as a unit. Performance is high since the components switch quickly and consume little power (compared to their discrete counterparts), because the components are small and close together.

The integrated circuit was conceived by a radar scientist, Geoffrey W.A. Dummer (1909-2002). Dummer unsuccessfully attempted to build such a circuit in 1956. The integrated circuit was independently co-invented by Jack Kilby around the same time. Kilby recorded his initial ideas concerning the integrated circuit in July 1958 and successfully demonstrated the first working integrated circuit on September 12, 1958. Kiby won the 2000 Nobel Prize in Physics for his part of the invention of the integrated circuit. Robert Noyce also came up with his own idea of integrated circuit, half a year later than Kilby. Noyce's chip had solved many practical problems that the microchip developed by Kilby had not. Noyce's chip was made of silicon, whereas Kilby's chip was made of germanium. Early developments of the integrated circuit go back to 1949, when the German engineer Werner Jacobi filed a patent for an integrated-circuit-like semiconductor amplifying device. The idea to the IC was to create small ceramic squares (wafers), each one containing a single miniaturized component. Components could then be integrated and wired into a bi-dimensional or tridimensional compact grid. This idea, which looked very promising in 1957, was proposed to the US Army by Jack Kilby, and led to the very short-lived Micromodule Program.

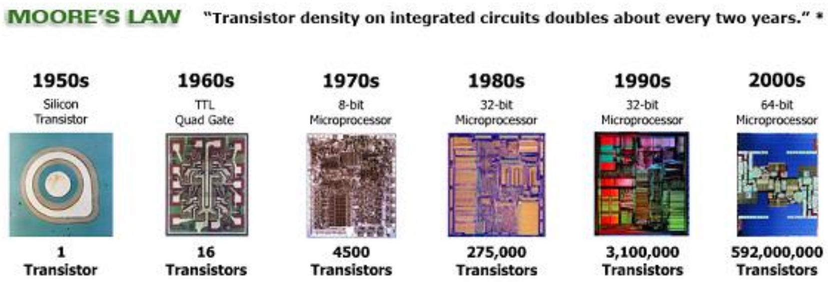


The first integrated circuits contained only a few transistors. Called "Small-Scale Integration" (SSI), they used circuits containing transistors numbering in tens. SSI circuits were crucial to early aerospace projects. Both the Minuteman missile and Apollo program needed lightweight digital computers for their inertial guidance systems. These programs purchased almost all of the available integrated circuits from 1960 through 1963. The next step in the development of integrated circuits, taken in the late 1960s, introduced devices, which contained hundreds of transistors on each chip, called "Medium-Scale Integration" (MSI). They were attractive economically because while they cost little more to produce than SSI devices, they allowed more complex systems to be produced using smaller circuit boards, less assembly work (because of fewer separate components), and a number of other advantages. Further development, driven by the same factors, led to "Large-Scale Integration" (LSI) in the mid -1970s, with tens of thousands of transistors per chip. Integrated circuits, calculator chips, and the first microprocessors, that began to be manufactured in moderate quantities in the early 1970s had under 4000 transistors. True LSI circuits, approaching 10000 transistors began to be produced around 1974, for second-generation microprocessors.

The final step in the development process, starting in the 1980s and continuing through the present, was "Very Large-Scale Integration" VLSI). This could be said to start with hundreds thousands of transistors in the early 1980s, and continues beyond several billion transistors as of 2007. There was no single breakthrough that allowed this increase in complexity, though many factors helped.

In 1986, the first one- megabit RAM chips were introduced, which contained more than one million transistors. Microprocessor chips passed the million transistor mark in 1989 and the billion transistor mark in 2005. The trend continues largely unabated, with chips introduced in 2007 containing tens of billions of memory.

Only a half century after their development was initiated, integrated circuits have become ubiquitous. Computers, cellular phones, and other digital appliances are now inextricable parts of the structure of modern societies. That is, modern computing, communications, manufacturing and transport systems, including the Internet, all depend on the existence of integrated circuits. Indeed, many scholars believe that the digital revolution, brought about by the microchip revolution, was one of the most significant occurrences in the history of humankind.



Comprehension

1. According to the text, are the following statement true or false? Give some arguments for or against them.

1. An integrated circuit is also referred to as IC, chip, or microchip.
2. Integrated circuits first appeared in early 2000s.
3. The cost of ICs is low because they are made of a very cheap material.
4. Integrated circuits were invented in the USA.
5. ICs offer high performance because the components switch quickly, consume little power due to the small size and close proximity of the components.
6. A hybrid integrated circuit is a single monolithic construction.
7. An integrated circuit can contain about a thousand transistors.
8. Integrated circuits have revolutionized the world of electronics.
9. Several scientists invented integrated circuits at about the same time.
10. In the early days of integrated circuits, only a few transistors could be placed on a chip.

2. Match the parts in A with the parts in B to complete a sentence.

A	B
1. An integrated circuit is manufactured by 2. A hybrid integrated circuit is constructed of 3. The first working integrated circuit 4. The idea of the integrated circuit 5. The integration of large numbers of tiny transistors into a small chip 6. The first integrated circuits called small scale integration 7. In the late 1960s devices called medium-scale integration 8. MSI devices allowed more complex system to be produced.	a. was successfully demonstrated in 1958. b. contained only a few transistors. c. pattern diffusion of trace elements into the surface of a thin substrate of semiconductor material. d. were introduced that contained hundreds of transistors on each chip. e. individual semiconductor devices and passive components bonded to a substrate or circuit board. f. using smaller circuit boards and less assembly work. g. was a great improvement over the manual assembly of circuits. h. was conceived by a radar scientist working for the British Ministry of Defense.

Focus on Vocabulary and Language

1. Four sentences have been removed from the text. Choose from the sentences (A-E) the one that fits each gap. There is one extra sentence you do not need to use.

A. However, ICs with nanometer-scale devices are not without their problems, principal among which is leakage current.

B. Digital memory chips and ASICs are examples of other families of integrated circuits that are important to the modern information society.

C. Starting with copper oxide, proceeding to germanium, then silicon, the materials were systematically studied in 1940s and 1950s.

D. Particular sealing strategies have to be taken in such biogenic environments to avoid corrosion or biodegradation of semiconductor materials.

E. This increased capacity per unit area can be used to decrease cost and increase functionality.

Advances in integrated circuits

Among the most advanced integrated circuits are the microprocessors or "cores", which control everything from computers and cellular phones to digital microwave ovens.(1) While the cost of designing and developing a complex integrated circuit is quite high, when spread across typically millions of production units the individual IC cost is minimized. The performance of ICs is high because the small size allows short traces which in turn allows low power logic (such as CMOS) to be used at fast switching speeds.

ICs have consistently migrated to smaller feature sizes over the year, allowing more circuitry to be packed on each chip. (2) In general, as the feature size shrinks, almost everything improves – the cost per unit and the switching power consumption go down, and the speed goes up. (3) Since these speed and power consumption gains are apparent to the end user, there is fierce competition among the manufacturers to use finer geometries. This process, and the expected progress over the next few years, is well described by the International Technology Roadmap for Semiconductors (ITRS).

In current research projects, integrated circuits are also developed for sensoric applications in medical implants or other bioelectronic devices. (4) As one of the few materials well established in CMOS technology, titanium nitride (TiN) turned out as exceptionally stable and well suited for electrode applications in medical implants.

2. The sentences in the following paragraph have been jumbled. Rewrite them in the correct order to make up a meaningful text.

1. The small size of these circuits allows high speed, low power dissipation, and reduced manufacturing cost compared with board-level integration.

2. Digital integrated circuits can contain anything from one to millions of logic gates, flip-flops, multiplexes, and other circuits in a few square millimeters.

3. These digital ICs work wing binary mathematics to process “one” and “zero” signals.

4. Integrated circuits can be classified into analog, digital and mixed signal (both analog and digital on the same chip).

5. They perform functions like amplification, active filtering, demodulation and mixing.

   Analog ICs, such as sensors, power management circuits, and operational amplifiers, work by processing continuous signals.

6. Such circuits offer small size and lower cost, but must carefully account for signal interference.

7. ICs can also combine analog and digital circuits on a single chip to create functions such as A/D converters and D/A converters.

Reading 2

1. Read the passage about manufacturing integrated circuits. Explain the type of derivation of the terms. Give the Russian equivalents to them.

Fabrication

The semiconductors of the periodic table of the chemical elements were identified as the most likely materials for a solid-state vacuum tube. Starting with copper oxide, proceeding to germanium, then silicon, the materials were systematically studied in the 1940s and 1950s. Today, silicon monocrystals are the main substrate used for ICs although some III-V compounds of the periodic table such as gallium arsenide are used for specialized applications like LEDs, lasers, solar cells and the highest-speed integrated circuits. It took decades to perfect methods of creating crystals without defects in the crystalline structure of the semiconducting material.

Semiconductor ICs are fabricated in a layer process, which includes these key process steps:

- Imaging
- Deposition
- Etching

The main process steps are supplemented by doping and cleaning.

Mono-crystals silicon wafers (or for special applications, silicon on sapphire or gallium arsenide wafers) are used as the substrate. Photolithography is used to mark different areas of the substrate to be doped or to have polysilicon, insulators or metal (typically aluminum) tracks deposited on them.

- Integrated circuits are composed of many overlapping layers, each defined by photolithography, and normally shown in different colors. Some layers mark where various dopants are diffused into the substrate (called diffusion layers), some define where additional ions are implanted (implant layers), some define the conductors (polysilicon or metal layers), and some define the connections between the conducting layers (via or contact layers). All components are constructed from a specific combination of these layers.

- In a self-aligned CMOS process, a transistor is formed wherever the gate layer (polysilicon or metal) crosses a diffusion layer.

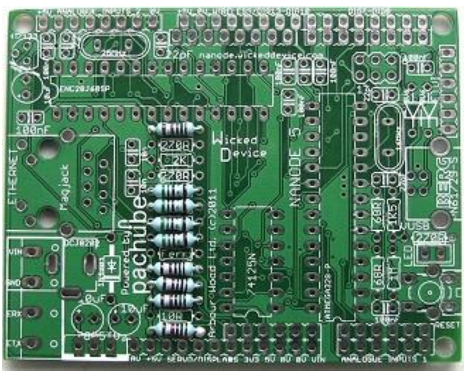
- Capacitive structures in form very much like the parallel conducting plates of a traditional electrical capacitor, are formed according to the area of the "plates", with insulating material between the plates. Capacitors of a wide range of sizes are common on ICs.

- Meandering stripes of varying length are sometimes used to form on-chip resistors, though most logic circuits do not need any resistors. The ratio of the length of the resistive structure to its width, combined with its sheet resistivity, determines the resistance.

- More rarely, inductive structures can be built as tiny on-chip coils, or simulated by gyrators.

Since a CMOS device only draws current on the transition between logic states CMOS devices consume much less current than bipolar devices.

A random access memory is the most regular type of integrated circuits; the highest density devices are thus memories; but even a microprocessor will have memory on the chip. Although the structures are intricate - with winds which have been shrinking for decades – the layers remain much thinner than the device widths. The layers of material are fabricated much like a photographic process although light waves in the visible spectrum cannot be used to "expose" a layer of material, as they would be too large for the features. Thus, photons of higher frequencies (typically ultraviolet) are used



to create the patterns for each layer. Because each feature is so small, electron microscopes are essential tools for a process engineer who might be debugging a fabrication process.

Comprehension

1. Complete the sentences to summarize the text.

1. Semiconductors include such substances as …
2. Substances like gallium arsenide are used in …
3. The process of fabricating semiconductor ICs includes …
4. Integrated circuits are composed of …
5. Capacitive structures are formed …
6. Bipolar devices consume …
7. Light waves in the visible spectrum cannot be used to expose a layer of material because …
8. Electron microscopes are used by …

Speaking

1. Imagine you are to give a lecture on integrated circuits. How would you start? Say a few sentences to make the listeners interested.

Writing

1. Write a short composition about the construction and use of integrated circuits.

Unit 5 LASERS

Tuning- in

1. Today lasers are widely used in various spheres of our life. Work in pairs and discuss what these spheres are, what you know about the history of their development and what principles they are based on.

Vocabulary and Reading

1. Tick the words, which come to your mind when you think of lasers. Add some more words related to this sphere.

incandescent	wavelength	coherent	
medicine	tube	X-rays	
amplification			
beam	screen	network	emit

Make up sentences on the subject using the words from your list.

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

term	beam	source	device
length	light	wave	distance

A laser is a 1)_______ that emits light through a process of optical amplification based on the stimulated emission of photons. The 2)_______ "laser" originated as an acronym for Light Amplification by Stimulated Emission of Radiation. The emitted laser 3)__________ is notable for its high degree of spatial and temporal coherence, unattainable using other technologies. Spatial coherence typically is expressed through a narrow 4)______which is diffraction-limited, often a so-called "pencil beam".

Laser beams can be focused to very tiny spots, achieving a very high irradiance. Or they can be launched into a beam of very low divergence in order to concentrate their power at a large 5)________ . Temporal coherence implies a polarized 6)________ at a single frequency whose phase is correlated over a very large distance along the beam. A beam produced by a thermal or other incoherent light 7)__________ has an instantaneous amplitude and phase, which vary randomly with respect to time and position, and thus a very short coherence 8)_________ .

Reading

1. Skim through the text and decide which paragraphs deal with the topics.

- Applications of lasers
- History of their creation
- Principle of laser operation
- Definition of lasers
- Characteristics of laser light

Laser

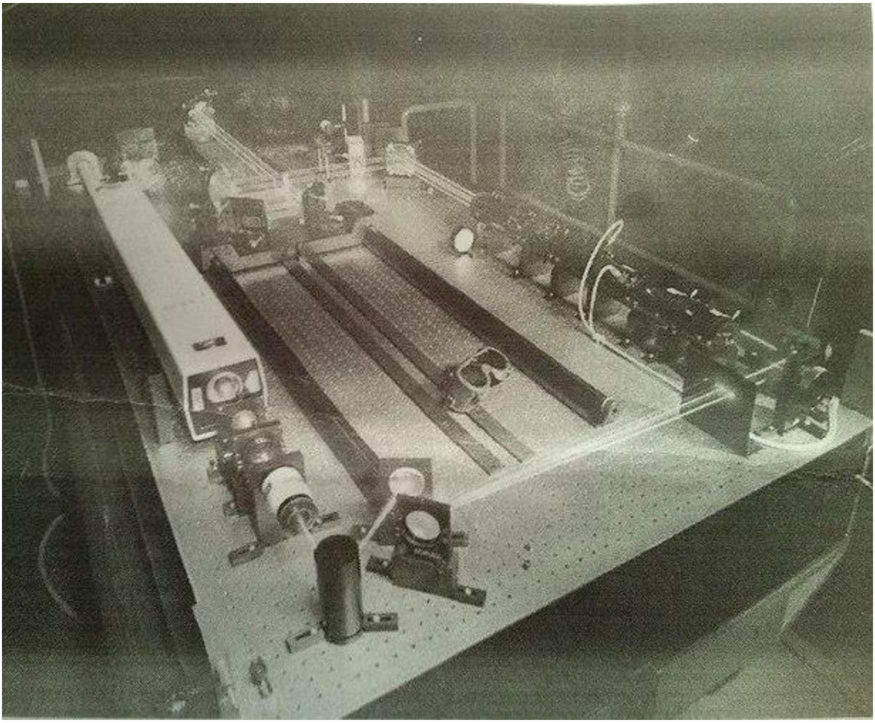
1. A laser (from the acronym Light Amplification by Stimulated Emission of Radiation) is an optical source that emits photons in a coherent beam. The verb to lase means "to produce coherent light".

2. Laser light is typically near-monochromatic, i.e. consisting of a single wavelength or color, and emitted in a narrow beam. This is in contrast to common light sources, such as the incandescent light bulb, which emit incoherent photons in almost all directions, usually over a wide spectrum of wavelengths.

3. Laser action is explained by the theories of quantum mechanics and thermodynamics. Many materials have been found to have the required characteristics to form the laser gain medium needed to power a laser, and

these have led to the invention of many types of lasers with different characteristics suitable for different applications.

4. The laser was proposed as a variation of the maser principle in the late 1950's, and the first laser was demonstrated in 1960. Since that time, laser manufacturing has become a multi-billion dollar industry, and the laser has found applications in fields including science, industry, medicine, and consumer electronics.



5. The gain medium transfers external energy into the laser beam. It is a material of controlled purity, size and shape, which amplifies the beam by the quantum mechanical process of stimulated emission, discovered by Albert Einstein while researching the photoelectric effect. The gain medium is energized, or pumped, by an external energy source. Examples of pump sources include electricity and light, for example from a flash lamp or from another laser. The pump energy is absorbed by the medium, producing excited states. When the number of particles in one excited state exceeds

the number of particles in some lower state, population inversion is achieved. In this condition, an optical beam passing through the medium produces more stimulated emission than the stimulated absorption so the beam is amplified. An excited laser medium can also function as an optical amplifier.

6. The light generated by stimulated emission is very similar to the input signal in terms of wavelength, phase, and polarization. This gives laser light its characteristic coherence, and allows it to maintain the uniform polarization and monochromaticity established by the optical cavity design.

7. Some types of lasers, such as dye lasers and solid-state lasers can produce light over a broad range of wavelengths; this property makes them suitable for the generation of extremely short pulses of light, on the order of a femtosecond (10^{-15} s).

8. Though the laser phenomenon was discovered with the help of quantum physics, it is not essentially more quantum mechanical than are other sources of light. In tact the operation of a free electron laser can be explained without reference to quantum mechanics.

9. In science, lasers are employed in a wide variety of interferometric techniques, and for Raman spectroscopy and laser induced breakdown spectroscopy. Other uses include atmospheric remote sensing, and investigation of nonlinear optics phenomena. Holographic techniques employing lasers also contribute to a number of measurement techniques. Laser (LIDAR) technology has application in geology, seismology, remote sensing and atmospheric physics. Lasers have also been used aboard spacecraft such as in the Cassini-Huygens mission. In astronomy, lasers have been used to create artificial laser guide stars, used as reference objects for adaptive optics telescopes.

10. In medicine, the laser scalpel is used for laser vision correction and other surgical techniques. Lasers are also used for dermatological procedures including removal of tattoos, birthmarks, and hair. Lasers are also applied in photo-bio-modulation (laser therapy) and in acupuncture.

11. In industry, laser cutting is used to cut metals and other materials. Laser line levels are used in surveying and construction. Lasers are also used for guidance for aircraft. Lasers are used in certain types of thermonuclear fusion reactors. Lasers are also used extensively in

both consumer and industrial imaging equipment. The name laser printer speaks for itself but both gas and diode lasers play a key role in manufacturing high-resolution printing plates and in image scanning equipment.

12. Military uses of lasers include use as target designators for other weapons; their use as directed-energy weapons is currently under research. Thus, today laser has a wide application in all spheres of our life.

Comprehension

1. Complete the sentences below to summarize the text.

a. Laser light differs from common light sources in that it emits …

b. Albert Einstein discovered …

c. Excited states are produced in the gain medium when …

d. Population inversion takes place when …

e. The optical beam is amplified because …

f. Laser light is coherent because …

g. Some types of lasers can generate …

2. According to the text, are the following statements true or false? Give some arguments for or against them.

a. The first laser application took place in the last years of the 20^{th} century.

b. Lasers are used in aviation and space engineering.

c. The letter “r” in the word “laser” stands for “radar”.

d. The laser beam is amplified in the gain medium.

e. Laser operation is based on photon emission.

f. The gain medium absorbs pump energy, which produces excited states.

g. For population inversion to take place the number of particles in excited states must be equal.

h. Laser gain medium is a liquid material.

i. Lasers are used in metallurgy.

j. Lasers do not need any source of external energy for their operation.

3. Match words in A with words in B to form word combinations and use them in the sentences below.

A	**B**
gain	state
stimulated	inversion
excited	bulb
photoelectric	signal
incandescent	medium
population	range
input	emission
solid-state	laser
broad	energy
external	effect

Sources such as__________ emit incoherent photons in all directions.

1. ____________ is a material which amplifies the laser beam.
2. In a laser light is amplified by __________of radiation.
3. There are different kind of lasers, e.g.________.

4. Some lasers produce light over a ____________________ of wavelengths.

5. When the number of particles in one _________ is greater than that in some lower-energy state _____________is achieved.

6. The light generated by stimulated emission is similar to the __________.

7. A source of ____________ energizes the gain medium.

8. The investigation into the _____________ helped discover the quantum mechanical process of stimulated emission.

Focus on Vocabulary and language

1. There are 11 mistakes in the text. Find and correct them.

The gain medium of a laser has a material of controlled purity, size, concentration and shape, which amplifies the beam of the process of stimulated emission. The gain medium is absorbs pump energy, which raises some electrons into higher – energy states. Particles can interacted with light by either absorbing nor emitting photons. Emission can is spontaneous or stimulated. In the latter case, the photon emitted in the same direction than the light passing by. When the number of particle in one excited state exceeds the number from particles in some lower-energy state the amount of stimulated emission is largest than the amount of absorption. Hence, the light is amplified.

2. Read the passage and decide which answer A, B, C or D best fits each space.

The word laser is an acronym for light amplification by stimulated emission of radiation. The word light in this phrase refers to electromagnetic radiation of (0) . . . frequency, not just that in the visible spectrum. Hence, there are infrared lasers, ultraviolet lasers, X-ray lasers etc. Because the microwave equivalent of the laser, the maser was (1) . . . first, devices that emit microwave and radio frequencies are usually (2) . . . masers. In early literature, particularly from (3) . . . at Bell Telephone Laboratories, the laser was often called the optical maser. The verb to lase means “to (4) . . . laser light” or “to apply laser light to”.

A laser consists of a (5) . . . inside a highly reflective optical cavity, as well as a (6) . . . to supply energy to the gain medium. The gain medium is a material with (7) . . . that allow it to amplify light by stimulated emission. In its simplest form, a cavity (8) . . . of two mirrors arranged so that light travels back and forth, each time passing through the gain medium.

Light of a specific (9) . . . that passes through the gain medium is amplified (increases in power). Part of the light that is between the mirrors (that is, within the cavity) passes through the partially transparent mirror and escapes (10) . . . a beam of light.

	A	B	C	D
0	all	Any	every	Other
1	received	described	developed	Emitted
2	called	stimulated	produced	Described
3	students	devices	receivers	Researchers
4	increase	produce	transmit	Deliver
5	gain medium	laser beam	light amplification	constant amplitude
6	process	possibility	Means	Way
7	applications	properties	studies	Disadvantages
8	contains	composes	conveys	Consists
9	gain	colour	Size	Wavelength
	like	through	As	Without

3. Match each underlined word in column A with the word in column B having a similar meaning. There are some words in column B you do not have to use.

	A
1	A laser has a wide range of applications
2	It consists of a single wavelength…
3	The laser was proposed…
4	It produces coherent light.
5	This medium has the required properties.
6	Lasers are used in such areas as…
7	The scientists researched this phenomenon…
8	Lasers produce light over a wide range of frequencies.

	B
a	Suggested
b	Explained
c	needed, necessary
d	Broad
e	Amplified
F	Spectrum
g	Contains
h	demonstrates
I	Generates
J	Fields
K	investigated
L	Stimulates

Speaking

1. Work in pairs and discuss the possibilities of using lasers in our life.

Writing

1. The sentences in the following paragraph have been jumbled. Rewrite them in the correct order to make up a meaningful text.

1) But the first maser was incapable of continuous output.

2) These systems could release stimulated emission without falling to the ground state, thus maintaining a population inversion.

3) Soon after masers became a reality, people began to look at the possibility of stimulated emission in other regions of the electromagnetic spectrum.

4) The precursor to the laser was the maser.

5) The first maser was created by Charles Townes (1954), who along with James Jordon and Herbert Zeiger succeeded in producing maser.

6) In order to achieve continuous output new systems with more than two energy levels had to be designed.

7) Nikolai Basov and Alexander Prokhorov of the USSR first developed this idea.

8) Townes, along with Arthur Schawlow began investigating the possibility of optical masers (later named lasers).

9) Together, Basov, Prokhorov and Townes shared the 1964 Nobel Prize for developing the maser concept.

10) The maser amplified electromagnetic radiation of much shorter wavelengths in the microwave range.

2. Write a short article about the history of lasers.

SUPPLEMENTARY READING

Task 1. **Read the extract about manufacturing of semiconductor devices. Explain the type of derivation of the terms. Give their Russian equivalents.**

Once the various semiconductor devices have been created they must be interconnected to form the desired electrical circuits. This "Back End Of Line" (BEOL the latter portion of the front end of wafer fabrication, not to be confused with "back end" of chip fabrication which refers to the package and test stages) involves creating metal interconnecting wires that are isolated by insulating dielectrics. The insulating material was traditionally a form of SiO_2 or a silicate glass, but recently new low dielectric constant materials are being used. These dielectrics presently take the form of SiOC and have dielectric constants around 2.7 (compared to 3.9 for SiO_2), although materials with constants as low as 2.2 are being offered to chipmakers.

Historically, the metal wires consisted of aluminum. In this approach to wiring often called "subtractive aluminum", blanket films of aluminum are deposited first, patterned, and then etched, leaving isolated wires. Dielectric material is then deposited over the exposed wires. The various metal layers are interconnected by etching holes, called "vias," in the insulating material and depositing tungsten in them with a CVD (chemical vapor deposition) technique. This approach is still used in the fabrication of many memory chips such as dynamic random access memory (DRAM) as the number of interconnect levels is small, currently no more than four.

More recently, as the number of interconnect levels for logic has substantially increased due to the large number of transistors that are now interconnected in a modern microprocessor, the timing delay in the wiring has become significant prompting a change in wiring material from aluminum to copper and from the aforementioned silicon dioxides to newer low-K material. This performance enhancement also comes at a reduced cost via damascene processing that eliminates processing steps. In damascene processing, in contrast to subtractive aluminum technology, the dielectric material is deposited first as a blanket film and is patterned and etched leaving holes or trenches. In "single damascene" processing, copper is then deposited in the holes or trenches surrounded by a thin barrier film resulting in filled vias or wire "lines" respectively. In "dual damascene" technology, both the trench and via are fabricated before the deposition of copper resulting in formation of both the via and line simultaneously, further reducing the number of processing steps. The thin barrier film, called Copper Barrier Seed (CBS), is necessary to prevent copper diffusion into the dielectric. The ideal barrier film is effective, but is barely there. As the presence of excessive barrier film competes with the available copper wire cross section, formation of the thinnest yet continuous barrier represents one of the greatest ongoing challenges in copper processing today.

As the number of interconnect levels increases, planarization of the previous layers is required to ensure a flat surface prior to subsequent lithography. Without it, the levels would become increasingly crooked and extend outside the depth of focus of available lithography, interfering with the ability to pattern. CMP is the primary processing method to achieve such planarization although dry "etch back" is still sometimes employed if the number of interconnect levels is no more than three.

(http://www.agsemiconductor.com/semiconductor-device-fabrication)

1. Match the words to form phrases which are used in the text and translate them.

dielectric	technology
timing	delay
damascene	diffusion
interconnect	levels
copper	constant

2. Guess if the following statements are true or false. Some of them can be not mentioned in the text and should be marked as 'not mentioned' or 'NM'.

1) Interconnection of semiconductor devices for forming the desired electrical circuits is the final stage of semiconductor devices manufacturing.

2) Historically, the metal wires consisted of gold, silver, and platinum.

3) The various metal layers are interconnected by etching holes in the insulating material and depositing tungsten in them.

4) The timing delay in the wiring has not become significant.

5) Planarization of the previous layers is necessary to ensure a flat surface prior to subsequent lithography.

6) Field-effect transistors are used in the central processing units.

7) Formation of the thinnest yet continuous barrier is one of the greatest ongoing challenges in copper processing today.

3. Find and add the remaining words to make a whole sentence. All sentences can be found in the text.

1) This performance enhancement also comes at a reduced cost … that .. processing steps.

2) Once the various … have been created they must be interconnected to form the desired electrical circuits.

3) The thin barrier film, called …, is necessary to prevent … into the dielectric.

4) As the number of … increases, planarization of the previous layers is required to ensure … prior to subsequent lithography.

5) In this approach to wiring often called "subtractive aluminum", blanket … are deposited first, patterned, and then etched, leaving … wires.

4. Try to find a title for each paragraph from options given below.

1) An important process

2) Metal Layers

3) Interconnect

4) New technologies

Task 2. **Read and translate new words.**

Clock receivers

Many manufacturers and retailers sell radio clocks under the name "atomic clocks", but the clocks themselves are not atomic. Instead they receive coded time signals from a radio station which in turn derives the time from a true atomic clock. [200]

One of the first radio clocks was offered by Heathkit in late 1983. Their model GC-1000 "Most Accurate Clock" received shortwave time signals from radio station WWV in Colorado whenever propagation conditions permitted, automatically switching between the 5, 10, and 15 MHz frequencies to find the strongest signal as conditions changed through the day and year. It kept time during periods of poor reception with a quartz-crystal oscillator. This oscillator was disciplined, meaning that the microprocessor-based clock used the highly accurate frequency standard signal received from WWV to trim the crystal oscillator. The timekeeping between updates was thus considerably more accurate than the crystal alone could have achieved. Time down to the tenth of a second was shown on an LED display. The GC-1000 originally sold for $250 in kit form, $400 pre-assembled, and was considered impressive at the time. Heath Company was granted a patent for their design.

In the 2000s, radio-based "atomic clocks" became common in retail stores. Simple units can be purchased in the United States at most electronics or discount stores for $20 to $50 and often feature wireless outdoor and indoor thermometers. These use the longwave signal from WWVB. They require placement in a location with a relatively unobstructed atmospheric path to the transmitter, perform synchronization only once a day during the nighttime, and need fair to good atmospheric conditions to successfully update the time. The device that keeps track of the time between updates, or in their absence, is usually a fairly inaccurate non-disciplined quartz-crystal clock, since it is thought that an expensive precise time keeper is not necessary with automatic atomic clock updates. The clock may include an indicator to alert users to possible inaccuracy when synchronization has not been successful within the last 24 to 48 hours. In other cases, the indicator will indicate that synchronization has been achieved within the last few hours, and will go blank in the mid-morning.

Modern radio clocks can be referenced to atomic clocks, and provide a means of accessing high-quality atomic-derived time over a wide area using inexpensive equipment. However, radio clocks are not appropriate for high-precision scientific work.

News radio

One method to access standard time is to listen to the news on radio. National radio news programs set their clocks to the transmissions from the standards departments of their respective countries. In the era when national broadcasting networks operated over point-to-point terrestrial microwave links, the time announcements were very precise. Today, however, satellite and digital networks often have latencies on the order of a second. In places where a car radio can receive more than one station broadcasting the same national news program, when switching between them one often either misses part of a word or hears part of the same word twice due to such variations. Some stations, such as WTIC (noted below) and WCBS (AM, 880 kHz), still do provide highly accurate time beeps. But HD Radio broadcasts and analog simulcasts of HD Radio broadcasts have a delay of up to 15 seconds, and stations carrying network news broadcasts may run them, along with locally originated programs, through a delay system. Recently, WINS (AM, 1010 kHz) in New York City moved to HD broadcasting, so its time signal is now only approximate.

Mobile telephones

Some mobile telephone technologies, such as Qualcomm's CDMA, are designed to distribute high-quality standard time signals (referenced to GPS in the case of CDMA). CDMA clocks are increasingly popular for providing reference time to computer networks. Their precision is nearly as good as that of GPS clocks, but since the signal comes from a nearby cell phone base station rather than a distant satellite, CDMA clocks generally work better inside buildings. So in many cases, when a GPS reference clock would require installing an outdoor antenna, a CDMA clock can overcome this requirement.

Other indirect sources

While not strictly radio sources, these sources of time signals are indirectly synchronized to primary radio sources:

Network Time Protocol (NTP)

The Network Time Protocol (NTP) is a protocol for synchronizing the clocks of computer systems over data networks such as the Internet, and has been in use since before 1985. It is designed particularly to resist the effects of variable latency, such as on the Internet. In practice, NTP is usually precise to within a few tens of milliseconds when used over the Internet. Many computer operating systems set their clocks automatically using NTP. For operating systems lacking this functionality, third-party NTP client software is usually available.

Web sites

Some time references are available through Web sites. Time referenced to the U.S. NIST/USNO and French BIPM atomic clocks are available to the public on their Web sites (see below) with a time-of day display precise to within about 300 ms, depending on the round-trip travel time of IP packets between the client system and the server. Both NIST and BIPM use applets to provide this service: the applet running in your web browser exchanges packets with their server; both also display precision estimates based on network latency. On the dates when civil time changes, time- related sites on the Internet are often very slow to respond due to heavy usage; it is therefore wise to check one's clocks a day or two before the seasonal time change will occur.

(https://www.sciencedirect.com/)

1. Explain the type of derivation of the terms. Give their Russian equivalents.

Oscillator	Placement
Frequencies	Wireless
Timekeeping	Indicator
Update	High-quality
Led	Link
Kit	Broadcast
Patent	

2. Match the words to form phrases and translate them:

Atomic	Clock
Crystal	Oscillator
Mobile	Telephone
Computer	Network
Operating	System
Web	Site
Heavy	Usage
Retail	Stores
Indoor	Thermometer

3. Answer the questions:

1. What company released the first radio clock?
2. What year was the first radio clock created?
3. What ilias had the first radio clock?
4. Where was located the radio station of the first radio clock?
5. When Network Time Protocol(NTP) was coming the usage?
6. What was the price of "atomic clock" in 2000s?

4. Guess if the following statements are true or false.

1. The GS-1000 sold for 25$ in kit form.

2 "Most Accurate clock" received shortwave time signals from radio station in California.

3. The Network Time Protocol has been in use since 1985.

4. “Web clock” is located in French and Canada.
5. The first radio clock’s offered in late 1983.
6. In kept time during periods of poor reception with a zinc-crystal oscillator.

5. Write an essay «The importance of time accuracy in the modern world».

Task 3. **Read and translate new words.**

Timbre

The perception of a continuous sound, such as a note from a musical instrument, is often divided into three parts: loudness is a measure of sound wave intensity. Pitch is the frequency of the fundamental component in the sound that is the frequency with which the waveform repeats itself. While there are subtle effects in both these perceptions, they are a straightforward match with easily characterized physical quantities.

Timbre is more complicated, being determined by the harmonic content of the signal.

The ear’s insensitivity to phase can be understood by examining how sound propagates through the environment. Suppose you are listening to a person across a small room. Much of the sound reaching your ears is reflected from the walls, ceiling and a floor. Since sound propagation depends on frequency (such as: attenuation, reflection and resonance), different frequencies will reach your ear through different paths. This means that the relative phase of each frequency will change as you move about the room. Since the ear disregards these phase variations, you perceive the voice as unchanging as you move position. From a physics standpoint, the phase of an audio signal becomes randomized as it propagates through a complex environment. Put another way, the ear is insensitive to phase because it contains little useful information.

However, it cannot be said that the ear is completely deaf to the phase. This is because a phase change can rearrange the time sequence of an audio signal. An example is the chirp system that changes an impulse into a much longer duration signal. Although they differ only in their phase, the ear can distinguish between the two sounds because of their difference in duration. For the most part, this is just a curiosity, not something that happens in the normal listening environment.

Suppose that we ask a violinist to play a note, say, the A below C. When waveform is displayed on oscilloscope, it appears much as the sawtooth. This is a result of the sticky rosin applied to the fibers of the violinist's bow. As the bow is drawn across the string, the waveform is formed as the string sticks to the bow, is pulled back, and eventually breaks free. This cycle repeats itself over and over resulting in the sawtooth waveform.

It is often said that timbre is determined by the shape of the waveform. This is true, but slightly misleading. The perception of timbre results from the ear detecting harmonies. While harmonie content is determined by the shape of the waveform, the insensitivity of the ear to phase makes the relationship very one-sided. That is, a particular waveform will have only one timbre, while a particular timbre has an infinite number of possible waveforms.

The ear is very accustomed to hearing a fundamental plus harmonics. Of a listener is presented with the combination of a 1 kHz and 3 kHz sine wave, they will report that it sound natural and pleasant. If sine waves of 1 kHz and 3.1 kHz are used, it will sound objectionable.

(https://link.springer.com/)

1. Explain the type of derivation of some complex terms. Give the Russian equivalents to the words.

1. deaf	a)другими словами
2. reflection	b)пренебрегать

3. put another way	c) отражение
4. sine	d) затухание
5. loudness	e) громкость
6. attenuation	f) мера
7. sequence	g) глухой
8. disregards	h) продолжительность
9. measure	i) последовательность
10. duration	j) синус

2. Form nouns from the verbs using some suffixes given at p. 5:

a) to percept

b) to complicate

c) to attenuate

d) to oscillate

e) to propagate

f) to differ

g) to variate

h) to examine

3. Match up the words below into pairs that means the same:

1) complex	a) form
2) examining	b) fully
3) loudness	c) ignore
4) shape	d) exploring

5) completely	e) wave
6) disregards	f) difficult
7) signal	g) volume

4. Guess if the following statements are true or false. Some of them can be not mentioned in the text and should be marked as 'not mentioned' or 'NM'.

1. Loudness is a measure of sound wave intensity.

2. The human's ears can't listen any sounds.

3. Particular waveform will have a lot of timbres.

4. The ear is insensitive to phase, because it contains little useful information.

5. A sticky rosin is applied on the fiber of the bow.

6. The loudness of sounds depends of the violin.

5. Match up the terms with the definitions given below:

a) Loudness

b) Timbre

c) Sound

d) Sensitivity

e) Signal

f) Frequency

g) Phase

1. Subjective perception of intensity of sound.

2. Carrier of information, used to transmit messages.

3. A physical phenomenon perceived by hearing caused by oscillating movements of air or other particles.

4. Physical quantity, a characteristic of a periodic process, equal to the number of complete cycles of a process per unit of time.

5. The characteristic color of the sound.

6. The ability of an object to respond in a certain way to a certain small impact.

7. Argument of a periodic function describing on oscillatory or wave process.

Task 4. **1. The following article is about nanotechnology. Read the article and highlight the arguments in favour of nanotechnology.**

2. How many definitions of nanotechnology are given in the article? Explain each of them.

3. Explain the type of derivation of the terms. Give their Russian equivalents.

What is Nanotechnology?

Eggenstein-Leopoldshafen, Germany | Posted on July 31st, 2019 (http://www.nanotech-now.com/news.)

The term "nanotechnology" has evolved over the years via terminology drift to mean "anything smaller than microtechnology," such as nano powders, and other things that are nanoscale in size, but not referring to *mechanisms* that have been purposefully built from nanoscale components. This evolved version of the term is more properly labeled "nanoscale bulk technology," while the original meaning is now more properly labeled "molecular nanotechnology" (MNT), or "nanoscale engineering," or "molecular mechanics," or "molecular machine systems," or "molecular manufacturing." Recently, the Foresight Institute has suggested an alternate term to represent the original meaning of nanotechnology: *zettatechnology*.

At the most basic *technical* level, MNT is building, with intent and design, and molecule by molecule, these two things: 1) incredibly advanced and extremely capable nano-scale and micro-scale machines and computers, and 2) ordinary size objects, using other incredibly small machines called assemblers or fabricators (found inside nanofactories). In a nutshell, by taking advantage of quantum-level properties, MNT allows for unprecedented control of the material world, at the nanoscale, providing the means by which systems and materials can be built with exacting specifications and characteristics. Or, as Dr. K. Eric Drexler puts it "large-scale mechanosynthesis based on positional control of chemically reactive molecules."

MNT represents the state of the art in advances in biology, chemistry, physics, engineering, computer science and mathematics. The *major research objectives* in MNT are the design, modeling, and fabrication of molecular machines and molecular devices. The emergence of MNT - both infant and mature - has numerous social, legal, cultural, ethical, religious, philosophical and political implications. At the most basic social level, MNT is going to be responsible for massive changes in the way we live, the way we interact with one another and our environment, and the things we are capable of doing.

Much as the invention of electricity and transistors were enabling technologies, so too is Nanotechnology (more precisely, nanoscale technologies) enabling - it will enable us to do radical new things in virtually every technological and scientific arena. It will also change things in unpredictable and unanticipated ways. Having learned lessons from their experiences with other revolutionary technologies, scientists (technologists and social scientists) are collaborating in examinating the implications of the developments that are beginning to take place, in an effort to both smooth the transitions, and to head off potential negative consequences (such as Gray Goo or government intervention in research and development).

Task 5. **Use the words from the box to complete the text below. Explain the type of derivation of the terms. Give their Russian equivalents.**

virtually	suffering	nanostructured	neuron	device
nanocomputer	biological	long-term	motivation	lifetimes

What would be the biggest benefit to be gained for human society from nanomedicine?

Nanomedicine will eliminate 1) ______ all common diseases of the 20th century, virtually all medical pain and 2) ______, and allow the extension of human capabilities–most especially our mental abilities.

Consider that a 3) ______ data storage device measuring ~8,000 micron^3, a cubic volume about the size of a single human liver cell and smaller than a typical 4) ______, could store an amount of information equivalent to the entire Library of Congress. If implanted somewhere in the human brain, together with the appropriate interface mechanisms, such a 5) _____could allow extremely rapid access to this information.

A single 6) ______ CPU, also having the volume of just one tiny human cell, could compute at the rate of 10 teraflops (10^{13} floating-point operations per second), approximately equalling (by many estimates) the computational output of the entire human brain. Such a nanocomputer might produce only about 0.001 watt of waste heat, as compared to the ~25 watts of waste heat for the 7) ______ brain in which the nanocomputer might be embedded.

But perhaps the most important 8) ______ benefit to human society as a whole could be the dawning of a new era of peace. We could hope that people who are independently well-fed, well-clothed, well-housed, smart, well-educated, healthy and happy will have little 9) _______ to make war. Human beings who have a reasonable prospect of living many "normal" 10) _______ will learn patience from experience, and will be extremely unlikely to risk those "many lifetimes" for any but the most compelling of reasons.

Task 6. **1. Read the extract about optical engineering. Explain the type of derivation of the terms. Give their Russian equivalents.**

2. Divide the text into logical parts. Think of the subtitle to each part. Highlight the key words of each part.

OPTICAL ENGINEERING

Durham, NC | Posted on June 7th, 2019 (http://www.nanotech-now.com/news.)

Optical engineering is the field of study that focuses on applications of optics. Optical engineers design components of optical instruments such as lenses, microscopes, telescopes, and other equipment that utilize the properties of light. Other devices include optical sensors and measurement systems, lasers, fiber optic communication systems, optical disc systems (e.g. CD, DVD), etc. Because optical engineers want to design and build devices that make light do something useful, they must understand and apply the science of optics in substantial detail, in order to know what is physically possible to achieve (physics and chemistry). However, they also must know what is practical in terms of available technology, materials, costs, design methods, etc. As with other fields of engineering, computers are important to many (perhaps most) optical engineers. They are used with instruments, for simulation, in design, and for many other applications.

Engineers often use general computer tools such as spreadsheets and programming languages, and they make frequent use of specialized optical software designed specifically for their field. Optical engineering metrology uses optical methods to measure micro-vibrations with instruments like the laser speckle interferometer.

4,000 years ago there were some signs and indications that early optical engineers used optical applications. People who designed and built the Stonehenge and Pyramid of Cheops used basic optical engineering principles. These structures had a connection with the earth and sun. These early engineers knew light travels in straight lines and understood the cycle of the seasons, which made these structures relative to the calendar and the compass. In 350 BC, Platon and Aristotle argued about the accurate nature of light. Plato thought vision was achieved by the discharge of optical beams from the eyes. Aristotle believed vision is accomplished when particles from the object releases into the pupil of the eye. In 300 BC, Euclid, who wrote and studied optics and geometry, wrote the book Optics, which heavily contributed to the study of the science of optics.

Optical engineering is the engineering discipline that focuses on the design of equipment and devices that function by using light. It is based on the science of optics, a field of physics that studies the properties and behaviors of visible light and its two nearest neighbors on the electromagnetic spectrum, infrared and ultraviolet. The practice of optical engineering is ancient, and the use of mirrors, shaped and polished crystals, or containers of clear water for purposes such as magnification or focusing sunlight to start fires is more than 2,000 years old. In modern times, this field is important to a very wide array of technologies, including optical instruments such as microscopes and binoculars, lasers, and many commonly used electronic and communication devices.

Some practical applications of optics can be done using a model of electromagnetic radiation based on classical physics. This is because the predictions of modern quantum mechanics diverge noticeably from classical mechanics only at the atomic or subatomic scale or under extremely unusual conditions such as near- absolute zero temperatures. Many modern optical technologies are based on how individual photons interact with atoms and particles, where the predictions of classical mechanics cease to be a useful approximation of reality, and so the science of quantum optics is necessary to understand and master these phenomena. Materials science is also important knowledge for optical engineering.

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