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Учебник английского языка

для технических вузов

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*Допущено
Министерством
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Учебник английского языка для технических вузов предназначен для студентов второго этапа обучения, специализирующихся в электронной технике, электроприборостроении, автоматике, вычислительной и измерительной технике, телемеханике, электротехнике, радиотехнике, системах управления и программировании.

Текстовой материал основного курса и система разработанных к нему заданий предназначены для развития всех видов речевой деятельности, для выработки навыков просмотрового, ознакомительного, изучающего и поискового чтения, а также аннотирования и реферирования текста.

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ПРЕДИСЛОВИЕ

Учебник английского языка для технических вузов составлен в соответствии с требованиями действующей программы по английскому языку для неязыковых специальностей высших учебных заведений и предназначен для второго этапа обучения студентов, специализирующихся в области электронной техники, электроприборостроения, автоматики, вычислительной и измерительной техники, телемеханики, электротехники, систем управления и программирования.

Учебник представляет собой комплекс учебных материалов, организованный в соответствии с конкретными задачами и условиями обучения, имеющий своей целью формирование у учащихся навыков и умений в различных видах речевой деятельности.

Основной целью учебника является обучение чтению и пониманию специального неадаптированного текста на английском языке без словаря (или с ограниченным его использованием) для получения необходимой информации и ведению беседы по специальности.

Тексты учебника взяты из современной технической оригинальной литературы на английском языке по основным профилирующим дисциплинам технического вуза.

Учебник состоит из введения, основного курса и краткого грамматического справочника.

Основной курс состоит из шести глав: Глава I — Электричество и магнетизм; Глава II — Электронные приборы и электронная техника; Глава III — Вычислительная техника; Глава IV — Радиотехнические цепи и измерительная техника; Глава V — Электроавтоматика и телемеханика; Глава VI — Системы управления и программирование.

Каждый урок содержит учебный материал для самостоятельной работы, для классной работы под руководством преподавателя, грамматические упражнения.

Тексты урока тематически взаимосвязаны, что позволяет изучить до 30 новых лексических единиц по каждой теме. Большое внимание в учебнике уделяется выработке навыков и умений в различных видах чтения, которая обеспечивается разработанной системой методических приемов, реализуемых в упражнениях. Это способствует развитию у учащихся умений быстро ориентироваться в текстовом материале и извлекать основную информацию по специальности. Тексты, предназначенные для обучения чтению, используются также и как основа для обучения устной речи при обсуждении, интерпретации содержащейся в тексте информации, схем, применяя денотатные планы высказывания и созданные кафедрой диафильмы.

Раздел Independent Work включает предтекстовые упражнения, тексты для просмотрового и ознакомительного чтения, задания. При просмотровом чтении (Skimming Reading) дается установка на понимание главной идеи текста, на сопоставление отдельных элементов текста с целью научить студентов определять основную информацию и кратко излагать ее. Ознакомительное чтение (Average Reading) предполагает выявление элементов текста, несущих главную и дополнительную информацию. Для обобщения информации и передачи основного содержания текста выполняются соответствующие задания.

Студентам рекомендуется проводить самостоятельную работу в лингафонном кабинете: прослушивание магнитофонных записей предтекстовых упражнений и текстов для просмотрового и ознакомительного чтения с последующим чтением их и выполнением послетекстовых заданий.

Раздел Classwork состоит из предтекстовых упражнений, текстов для изучающего и поискового чтения, заданий. Изучающее чтение (Close Reading) требует от студента тщательного анализа структурных и семантических связей в каждом предложении, выявления отношения автора к изложенному материалу и определения своего отношения к нему. Результатом такого вида чтения должно быть максимально точное понимание содержащейся в тексте информации, составление реферата и аннотации текста. Задания к тексту носят творческий характер.

Поисковое чтение (Searching Reading) предполагает поиск нужной информации: по теме в тексте и дополнительной информации в журналах по специальности. Тексты для поискового чтения рекомендуется использовать для внеаудиторного чтения.

Тексты учебника содержат информацию, в которой освещаются современные достижения в области науки и техники, что возбуждает у студентов профессиональный интерес к изучению текстового материала.

Таким образом по теме урока вводятся тексты для разного вида чтения, начиная с более легких для самостоятельной работы студентов к более сложным для их детального анализа. Такая последовательность ввода учебных текстов рекомендуется современной методикой обучения иностранным языкам (см. работы С. К. Фоломкиной, М. В. Ляховицкого, И. А. Зимней) и практикой обучения иностранному языку в техническом вузе. Учебный материал как для самостоятельной, так и для классной работы рекомендуется проверять преподавателю во время занятий.

Весь методический аппарат учебника (предтекстовые упражнения, задания после текстов) ставит своей целью обучение чтению, говорению, аудированию, письму. Задания активизируют учебную деятельность студентов, развивают умение формировать условно-неподготовленные высказывания на английском языке, создают предметность речевого высказывания, способствуют процессу общения между студентами, максимально приближая его к речевому общению. Задания на реализацию проблемных ситуаций, описание схем и беседы развивают мыслительную деятельность студентов, создают надежную основу для ведения дискуссий по специальности. Приобретенные умения и навыки преподаватель может использовать во время учебной игры по специальности.

Для контроля понимания текста можно использовать денотатные планы (схемы) текстов, в которых в логической последовательности развертывается содержание текста. Они помогают студентам в определении содержания текста, в формировании структуры монологического и диалогического высказывания по теме текста. Преподаватели кафедр иностранных языков технических вузов могут составить денотатные планы к каждому тексту, выделяя необходимые слова и словосочетания по плану высказывания.

Грамматические упражнения предназначены для выработки навыка распознавания и перевода грамматических явлений, встречающихся в текстах учебника. Они могут быть выполнены студентами самостоятельно и под контролем преподавателя. Для консультации при выполнении этих упражнений можно использовать краткий грамматический справочник в конце учебника или любой учебник по грамматике английского языка.

Все тексты уроков и упражнения, предназначенные для обучения устной речи, рекомендуется начитать на магнитофонную ленту квалифицированным диктором.

INTRODUCTION

ENGINEERING RISES TO A NEW STAGE

The 27th Congress of the CPSU points out that acceleration in the growth rate of Soviet engineering is the main direction in the long term development and that it serves as a backbone for progress in science and technology in all branches of the national economy.

Everyone knows about the contribution which Soviet scientists have made to mathematics, mechanical engineering, physics, chemistry, and the theory of automatic control — areas of knowledge which will make up the engineering of the future. This country has made undoubted progress in the peaceful exploration of space and in the branches of engineering producing machines for power engineering, metallurgy, transport, and other industries. Over the past few years new technologies and equipment have been designed for most branches of engineering.

Nevertheless we intend to make further sharp increase in the rate of progress in science and technology, to deepen fundamental research and to speed up the introduction of scientific development in engineering practice.

There are many lines along which the scientific and technological progress will continue in engineering. They all can be grouped together into two main headlines. Firstly, it is automation, including the creation of "unmanned" industries. Secondly, it is raising of the reliability and extending the service life of machines.

In the near future the traditional equipment is to go through substantial changes. It should be modified so that it could operate in tandem with automatic systems and industrial robots. Controlled machines based on microprocessors and microcomputers should be introduced on a large scale. Machines are being designed so as to take into account the changing operating conditions.

The main task now is to "teach" machines to operate without man's presence. They should be able to position the workpieces whose types and sizes can change from hour to hour. They should also be able to select the mode of machining and themselves to control the quality of their own operations.

Intense work is being carried out on new robots. What we need is not merely manipulators which can take up a workpiece and pass it on, but robots which can identify objects, their position in space, etc. We also need machines that would trace the entire process of production. Some of them have been designed and manufactured. They can automate the process of positioning of the workpiece in the machine, give commands at various stages of production and check the precision of manufacture.

The use of a computer is known to provide a vast opportunity for finding answers to many of most complex social problems as well. During the next 20 years computers are expected to make an explosion in the social sciences comparable to that which we saw in the past half of the 20th century in the physical sciences.

To understand these possibilities of the future, we should first consider the tendency of today's computer technology and the nature of the system to be used. These systems will be considerably smaller then today's and they will perform far more complex functions. Their operating speeds will be measured in nanoseconds. A nanosecond is to a second as a second — to 30 years. These computers of tomorrow will respond to handwriting, to images, and to spoken commands. They will communicate with one another over any distance. They will recognize a voice, a face or a symbol among tens of thousands.

A link-up of computers will be accomplished through communication satellites; high-capacity transistorized cables, microwave insulated tubes, as well as standard telephone and telegraph links. In these systems data will move thousands of times faster than in today's. In the future, laser beams will be used to transmit vast quantities of information in the form of light through special cables.

At present scientists are working upon another very interesting problem connected with electronic computers — a chemical memory system which would be better than the electronic memory system. The chemical system will make it possible to store a million bits of information (such as codes, symbols, and formulas) on three square centimetres of paper.

Soviet society is to reach new heights on the basis of accelerating its social and economic development. This means: raising the national economy to a basically new scientific-technological and organisational-economic level, gearing it towards intensive development; achieving the world's highest level in productivity of social labour, quality of output, and efficiency of production; ensuring an optimum structure and balance for the integral national economic complex of the country.

Chapter I. ELECTRICITY AND MAGNETISM

Lesson 1. BASIC CONCEPTS OF ELECTRICITY AND MAGNETISM

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Listen and repeat after the speaker. b) Practise the pronunciation of the following.

[ɔ:] law, draw; [ju:] new, few; [au] down, town; [ou] snow, show; [ɔ] was, want; [ɔ:] war, warn; [ə:] work, word.

What, wash, low, drew, drawn, grew, grow, grown, world, ward, blew, window, brown, blow, glow.

II. a) Make sure that you know these words. Say what Russian words help you to guess their meanings. b) Repeat these words after the speaker.

Ma'terial; phe'nomenon [f], (*pl*) phenomena; manife'station [ʃn]; 'magnetism [æ]; in'duction [ʌ]; practical [æ]; period ['pɪərɪəd]; telegraph [f]; telephone [f]; Coulomb ['ku:lɔm]; ma'chine [i:]; as'sociate [ʃ]; chemical [k]; 'concentrate [s]; oxide ['ɔksaid]; sulphate ['sʌlfeit]; pro'portion; arc [a:k]; 'energy [dʒ], nature [tʃə], 'transport [æ].

III. a) Listen, repeat and memorize the following words and word-combinations. b) Check if you know their meanings.

I. Certain [sə:tn] определенный; amber [æ] янтарь; glass [ɑ:] стекло; fur мех; capacity [æ] способность; cork пробка; ability способность; lodestone магнитный железняк; etc. [it 'setrə] и т. д.; quantitative laws [ɔ] [ɔ:] количественные законы; induction индукция; prior to ['praiə] до; increase [s] v. увеличивать; current revolution современная революция; notably ['nəutəblı] особенно; rub v. тереть; silk шелк;

II. Acquire [ə'kwaiə] приобретать; a bit of paper кусочек бумаги similarly подобным образом; iron ores [ɔ:z] железная руда; ancient [ʃ] times древние времена; get weaker [i:] слабеть; investigate v. исследовать; the only единственный; the lightning rod молниеотвод; expend v. увеличиваться (в объеме); ever-increasing control все возрастающее управление.

IV. a) Give English equivalents to the Russian words and word-combinations in brackets and translate the sentences into Russian. b) Check yourself listening to the complete sentences after the speaker.

1. When we rub (определенные) substances, notably (янтарь) and (стекло) with (шелк) or (мех), they (приобретать) the (способность) to attract small (кусочки бумаги) and (пробка). 2. This (явление) is the manifestation of electricity. 3. (Подобным образом), the ability of certain (железная руда) such as (магнитный железняк) to attract small bits of iron is a manifestation of magnetism. 4. All these things were known from (древние времена). 5. Most of the basic (количественные законы) of electricity and magnetism were discovered between 1784 and 1831. 6. Michael Faraday discovered magnetic (индукция). 7. (До этого) the only practical electrical (изобретение) was the (молниеотвод). 8. The practical utilization of electricity (увеличивать) rapidly with the development of the telegraph, the telephone, incandescent lighting and electric motors. 9. Uses of electricity (расширять) to this day with the (современная революция) in microelectronics. 10. Microelectronics gives us (все возрастающее управление) over the machines.

Text A

CHARGING A BODY

I. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

The only way to charge a body negatively is to add electrons to it, and the only way to charge it positively is to take electrons away from it, leaving an excess of positive electricity.

When the rubber rod was charged negatively by rubbing with cat's fur, some electrons passed from the cat's fur to the rubber rod, leaving the cat's fur charged positively and the rubber charged negatively. On the other hand, when the glass rod was charged positively by rubbing with silk, some electrons passed from the glass to the silk, leaving the glass rod charged positively and the silk charged negatively.

2. Average Reading

Text B

ELECTRICITY AND MAGNETISM

I. a) Listen to the text. b) Read it (time limit is 3 min.). c) Find the part of it dealing with the descriptions of electricity and magnetism.

When certain substances, notably amber and glass are rubbed with a material such as silk or fur they acquire the capacity to attract small bits of paper and cork. This phenomenon is a manifestation of electricity, one of the fundamental forces of nature. Similarly, the ability of certain iron ore, such as lodestone, to attract small bits of iron is a manifestation of magnetism, another fundamental force.

Although these simple electric and magnetic phenomena have been known since ancient times, most of the basic quantitative laws of electricity and magnetism were discovered between 1784, when Charles Coulomb investigated the forces between charged objects, and 1831, when Michael Faraday discovered magnetic induction. Prior to this 50 year period of discovery, the only practical electric invention was the lightning rod of Benjamin Franklin (1752). After this period, the practical utilization of electricity increased rapidly with the development of the telegraph (1844), the telephone (1877), incandescent lighting (1880) and electric motors (1887). Uses of electricity have continued to expand to this day, with the current revolution in microelectronics giving us ever increasing control over the machines.

ASSIGNMENTS

I. a) Find out the key sentences in the Text A. b) Say what physical phenomenon the text is concerned with.

II. a) Skim through the Text B and find the part of it dealing with the fundamental forces of nature. b) Discuss the information with your fellow-students.

III. a) Find the paragraph in the Text B containing information about the discovering of the basic quantitative laws of electricity and magnetism. b) Discuss it.

IV. Answer the following questions embracing the contents of the Text A and the Text B.

1. What is the way to charge a body negatively or positively? 2. What capacity did amber and glass aquire when rubbed with silk or fur? 3. What is magnetism? 4. When were the basic quantitative laws of electricity and magnetism discovered? 5. When did C. Coulomb

investigate the forces between charged objects? 6. When did M. Faraday discover magnetic induction? 7. What was invented by B. Franklin?

V. Be ready to discuss the information obtained from the Text B.

VI. Make a short summary of the Text B.

VII. Speak on the Text A and the Text B according to the following plan:

1. The manifestation of electricity.
2. The most important development in electricity.

VIII. Make up a short dialogue on the following situations:

1. A few students make an experiment with different materials to receive electricity.
2. Professor asks the students about history of electricity and magnetism.

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these words.

Associate v. связывать; mention упоминать; application приспособление, применение; act along действовать самостоятельно; own собственный; thin тонкий; solid твердый; event событие; numerous многочисленный; however однако; presence присутствие; yet все же, еще; retain v. удерживать, сохранять; permanent постоянный; liberate v. освобождать; e. g. (for example) например; obvious очевидный; exert v. оказывать действие; heat v. нагревать; surface поверхность.

II. Memorize these words and word-combinations used in their specialized meanings.

Device прибор; sound звук; loud speaker громкоговоритель; lead свинец; purity v. очищать; resistive резистивный, имеющий сопротивление; deposit осаждать; silver серебро; electric fire электрическая печь; electric current электрический ток; copper медь; wire провод; plate v. покрывать; solution раствор.

III. Find these word-combinations and terms in the Text C and translate the sentences containing them.

Lead-acid battery кислотно-свинцовая батарея; fork lightning молния; sufficient to melt достаточно, чтобы расплавить; arc welding дуговая сварка; to glow red hot раскаливать докрасна; candlestick подсвечник; gimlet буравчик.

IV. Give English equivalents to the Russian words in brackets. Translate these sentences.

1. An electric (печь) is the most (очевидный) example of the heating effect of a current. 2. This wire (раскален докрасна) as the current passes through it. 3. If the wire is very (тонкий) it is heated (добела). 4. A great proportion of light to heat is released as in the tungsten (вольфрамовая лампа накаливания). 5. Electrolysis is used (очищать) metals such as (медь). 6. The element of the fire is just highly (ре-

зистивный) wire. 7. During (дуговая сварка) and (молния) large (количество) of electrical energy are concentrated and give temperature (достаточно, чтобы расплавить) metals.

Text C

BASIC ELECTRIC CONCEPTS

I. a) Read the text. b) Find the part of it describing three basic effects of an electric current and examples of electromagnetism and chemical effect of current.

We associate all kinds of events and devices with electric current: electric light, electric transport, electric sound, etc. They are too numerous to mention. However, there are only three basic effects of an electric current and all the other applications follow from them: (a) magnetic effect, (b) chemical effect, (c) heating effect.

The magnetic effect of current is the basis for most electromechanical devices. Near a current there is a magnetic field and this exerts a force on other currents or magnetic materials.

The presence of magnetic materials such as iron can make the forces thousands of times greater than the currents acting alone, and yet it is the current which control the magnet.

Loudspeakers and electric motors are other applications of electromagnetism.

The materials themselves may retain the magnetism and become permanent magnets which exerts their own influence. Permanent magnets are the basis for some of the simpler devices. The compass needle responds to the magnetic field of the Earth which is itself a permanent magnet.

When a lead acid battery is charged the acid becomes more concentrated and hydrogen and oxygen are liberated. As the battery discharges the acid gets weaker and lead oxide on the positive plate is charged to lead sulphate. These processes are examples of the chemical effect of a current, i. e. electrolysis. Electrolysis is used to purify metals such as copper and alluminium and to deposit metals onto surface, e. g., silver plating.

An electric fire is the most obvious example of the heating effect of a current. The element of the fire is just highly resistive wire which glows red hot as the current passes through it.

If the wire is very thin it is heated white hot and a greater proportion of light to heat is released as in the tungsten filament lamp. Hotter still and more dramatic are the effects of arc welding and fork lightning when large amounts of electrical energy are concentrated to give temperature sufficient to melt metals.

ASSIGNMENTS

I. Read the Text C attentively and answer the following questions.

1. What do we associate electric current with? 2. How many effects of an electric current are there? 3. What is the magnetic effect of cur-

rent? 4. What can make the forces thousands of times greater then the currents acting along? 5. What applications of electromagnetism do you know? 6. What may become permanent magnets? 7. When does the acid become more concentrated? 8. What is the result of the battery discharge? 9. What is electrolysis? 10. What is the most obvious result of the heating effect of a current?

II. Read the text again and ask additional questions embracing its contents.

III. Analyse the sentences containing the main idea of the text.

IV. Comment on the author's attitude to basic electric concepts.

V. Read the text and find the part of it describing three basic effects of electric current and examples of electromagnetism and chemical effect of current.

VI. Pick out and translate the sentences with the Infinitive and Gerund.

VII. Make up a plan of the text using the active vocabulary of the lesson.

VIII. Retell the text according to your plan.

IX. Express your opinion of the text from the point of your knowledge of this topic.

X. Translate the Text C to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

to be familiar with	прямой угол
temporary magnet	буравчик
permanent magnet	средний палец
observe	правая рука
thumb	менять направление
forefinger	указательный палец
right hand	наблюдатель
reverse	большой палец
gimlet	быть знакомым с
middle finger	постоянный магнит
right angle	магнит с временным магнетизмом (электромагнит)

Text D

1. MAGNETISM

I. a) Read the Text D and say what it is about. b) Review the text.

Anyone working in the field of electricity must be familiar with the principles of magnetism because generators, transformers and motor depend on magnets and magnetism for their operation.

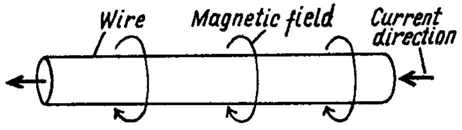


Fig. 1.1. The relation between electricity and magnetism.

A magnet is either permanent or temporary. If a piece of iron or steel is magnetized and retains its magnetism, it is a permanent magnet. A compass is one form of permanent magnet. Others with which you are probably familiar are horseshoe-shaped magnets and bar magnets. Each one of these magnets has a north magnetic pole and south magnetic pole; in fact, all magnets have a north and a south poles.

When current flows through a coil, a magnetic field with a north and a south pole is set up just like that of a permanent magnet. However, when the current stops, the magnetic field also disappears. This type of temporary magnetism is called electromagnetism. Permanent magnets are used for the magnetic field necessary in the operation of small, inexpensive electrical motors.

When electricity flows through a wire or conductor, magnetic lines of force (magnetic flux) are created around that wire (Fig. 1.1). When a piece of wire is passed through a magnetic field (magnetic lines of force), electricity is created in that wire. We then can readily see the relation between electricity and magnetism. In fact, the very existence of the electrical industry is dependent upon magnetism and magnetic circuits.

2. RULES FOR DIRECTION OF CURRENT AND MOTION

II. Read the text and find the part of it describing the methods of determining direction of the lines of force.

To determine the polarity of an electromagnetic solenoid: In looking at the end of a solenoid, if an electric current flows in it clockwise, the end to the observer is a south pole and the other end is a north pole; if the current flows counter-clockwise, the position of the pole is reversed.

To determine the direction of the lines of force set up around a conductor: If the current in a conductor is flowing away from the observer, then the direction of the lines of force will be clockwise around the conductor (the rule of gimlet).

To determine the direction of an induced current in a conductor that is moving in a magnetic field: Place thumb, forefinger, and middle finger of the right hand each at right angles to the other two; if the forefinger shows the direction of the lines of force and the thumb shows the direction of the motion of the conductor, then the middle finger will show the direction of the induced current.

ASSIGNMENTS

I. Answer the following questions embracing the contents of the Text D.

1. Why must anyone working in the field of electricity be familiar with the principles of magnetism? 2. What kind of magnets do you

know? 3. What do all magnets have? 4. What is set up in a coil when current flows through it? 5. Where are permanent magnets used? 6. Where is electromagnetism used? 7. How can we determine the polarity of an electromagnetic solenoid? 8. How can we determine the direction of the lines of force set up around a conductor? 9. How can we determine the direction of an induced current in a conductor that is moving in a magnetic field?

II. a) Examine Fig. 1.1 and describe it. b) Answer the questions.

1. What does Fig. 1.1 show? 2. What does electricity flow through? 3. When are magnetic lines of force created around the wire? 4. When is electricity created in the wire?

III. Speak on:

1. The Principles of Magnetism;
2. Rules for Direction of Current and Motion.

IV. Ask some questions on the text.

V. Prepare a dialogue on your own situation.

VI. Express your opinion of the text. Does the text prove that generators, transformers and motors depend on magnets and magnetism for their operation?

VII. Look through the latest magazines and find information on basic electric concepts describing all kinds of devices with electric current.

III. GRAMMAR EXERCISES

I. Analyse the structure of the following words and give their initial forms.

Magnetic, magnetism, to magnetize; movement, movable, remove; direction, directional, director.

II. Give the degrees of comparison of the following words.

High, large, long, wide, big, little, good, small, great, many, much, few, well, bad, far, easy, difficult, different.

III. Change the sentences adding some words and using comparative and superlative degrees of adjectives and adverbs.

Model. This is an **interesting** book.— This book is **more interesting** than that one. (This is **the most interesting** book I have ever read.)
I like to swim **much**. He likes to swim **more** than I. (He likes to swim **most** of all.)

1. The Kiev Metro is beautiful. 2. I like to read much. 3. He knows English badly. 4. Professor explains the material well. 5. The students were answering loudly. 6. A big house was erected nearby. 7. This problem is simple.

IV. a) Translate the following sentences. b) Pay attention to the words and word-combinations in bold type.

1. The education system in the USSR differs greatly **from that** in capitalist countries. 2. The aeronautics is one of the many branches of mechanical engineering, **the one that is the most interesting** to me. 3. **The more** I read about this event **the less** I understand it. 4.This problem is not so difficult as **the one that** we solved last time. 5. He studied this subject **as much as possible.**

V. Find Infinitives and Gerunds in the following sentences. State their functions and translate them into Russian.

a) 1. To develop a new device we had to study structures of many other similar devices. 2. To obtain the desired properties of the device the scientist had to continue this experiment. 3. To determine the direction of the lines of force set up around a conductor we must know the rule of gimlet. 4. The above mentioned method is used to determine the polarity of an electromagnetic solenoid. 5. To make an electric current flow continuously along a wire, a continuous supply of electrons must be available at one end and a continuous supply of positive charges at the other. 6. To avoid possible breakdown of the insulation, the practice is to put extra insulation on the end turns.

b) 1. Before switching on current for a test the circuit should be thouroughly checked. 2. On joining the upper ends of the metals with a metal wire we caused the current to flow through the wire. 3. In this case the reading will fall slowly after reaching full load. 4. In making permanent steel magnets we must prepare steel of high quality.

Lesson 2. ELECTRICAL UNITS AND CIRCUITS

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Listen and repeat after the speaker. b) Practise the pronunciation of the following.

[eɪ] main, way; [ɛə] chair, hair; [ɔ:] cause, saw, law; [i:] mean, treat; [e] head, read; [ɪə] hear, ear; [ə:] heard, early.

Exception: [ʌ] aunt; [e] pleasure, treasure, measure, pleasant, but: [i:] to please; [e] threat, dealt, meant, wealth, health, heaven, heavy, weapon; [eı] great, break; [ieı] create; [i:] to read, to lead, leader; [iə] real.

II. a) Repeat after the speaker. b) Find words in the Text A with similar pronunciation.

air, pair, fair, because, automation, applaud, applause, to read, read, to hear, heard, to lead, ready, to mean, meant, to deal, dealt, lead, fear, clear, tear, earn, earth, heart, day, pain, pay, laid, sea, stream, to measure, law, saw.

III. a) Make sure that you know these words. Say what Russian words help you to guess their meanings. b) Repeat these words after the speaker.

Ampere ['æmpɛə], ammeter ['æmıtə], battery [æ], potential [ʃ], experimental [eks͵peri'mentl], maximum ['mæksiməm], volt [voult], voltmeter ['volt͵mi:tə], voltage ['voultıdʒ], gene'rator [dʒ], pro'portional, graph [græf], re'sult [ʌ], con'ductor [ʌ], value ['vælju:]-re'sistor [z], watt [wɔt], effect [ı'fekt].

IV. a) Listen, repeat and memorize the following words and word-combinations. b) Check if you know their meanings.

I. Stream поток; particle частица; arrangement *зд.* соединение; burn (burnt) v. гореть; calculate v. рассчитывать; circuit цепь; conductor проводник; connection соединение; current ток; deduce v. устанавливать; determine v. определять; define v. определять; mains электрическая сеть; measure v. измерять; match v. сопоставлять, согласовывать; obey v. подчиняться (выполняться); particular отдельный; produce v. производить; quantity количество, величина; ratio отношение; raise v. поднимать; rearrange преобразовывать; resistance сопротивление; equation уравнение; experimental опытный; flow (flew, flown) v. течь; law закон; low value малая величина; to go dim (bright) затухать (разгораться); just below чуть ниже; electromotive force (e. m. f.) электродвижущая сила; light bulb электролампа; stream n. поток; suggest v. предлагать; verification проверка; potential difference (p. d.) разность потенциалов; in series (соединять) последовательно; to be true быть действительным; become significant становиться значительным.

II. set up v. устанавливать; drop v. падать; just as также, как; pressure давление; mean (meant) v. значить; really действительно; force v. заставлять; energy per unit charge энергия на единицу заряда; supply снабжать; liquid жидкость; pipe труба; the same thing то же самое; available в наличии; from one point to another от одной точки к другой; source источник; connect in line соединять последовательно.

V. a) Give English equivalents to the Russian words and word-combinations in brackets and translate the sentences into Russian. b) Check yourself listening to the complete sentences after the speaker.

1. An electric (ток) is a (поток) of charged particles, which flow in (проводник). 2. We have just (определить) the unit of current. 3. A voltage (приложенное) to a conductor in a circuit (создавать)

a current. 4. The (отношение) of U to I for a (отдельный) conductor is called the (сопротивление) of the conductor R. 5. Ohm's (закон) can be (выражен) in the experimental results. 6. In the graph we have seen the (проверка) of Ohm's law. 7. (Преобразуя уравнение) we have $U = IR$. 8. A high resistance (ограничивать) the current to a (малая величина). 9. Values of current (измеряться). 10. A resistor carries a current of 0.2 A when a (разница потенциалов) of 4.0 V is applied across it. 11. Electrons move under the influence of (электродвижущая сила — ЭДС). 12. This equation (справедливо) for resistors (включенные последовательно). 13. These (величины) are (сопоставлять) with the current units. 14. In a parallel (устройство) of resistors the following equation is true.

Text A

CURRENT AND RESISTANCE

I. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

An electric current (I) is a stream of charged particles. In a conductor the particles that move are electrons which are so small that they can flow past the atoms without resistance. Current I is measured in terms of the quantity of charge Q flowing per unit time — $I = \frac{Q}{t}$.

The charge on a single electron is very small as a unit of charge. Quantity of charge is measured in coulombs (symbol — C) where 1 coulomb $= 6.24 \times 10^8$ electron charges. We can now determine the unit of current the ampere (symbol A).

A voltage applied to a conductor in a circuit produces a current. One have found that for some conductors the current I directly proportional to the voltage U, i. e., $I \propto U$.

This is Ohm's law and it can be expressed in the experimental results shown in the graph of Fig. 1.2 *a*.

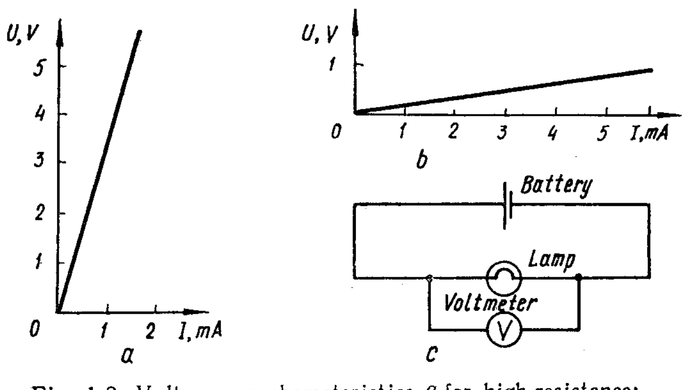


Fig. 1.2. Volt-ampere characteristics *a* for high-resistance; *b* low-resistance; *c* using the voltmeter to measure p. d. across the contacts of a lamp.

The ratio of U to I for a particular conductor is called the resistance of the conductor R: $R = \frac{U}{I}$. The unit of the resistance is the ohm, symbol Ω. The resistance determines how much current flows for a given voltage. Rearranging the equation we must have $U = IR$ or $I = \frac{U}{R}$.

A high resistance restricts the current to a low value. When the resistance is small the current is large (Fig. 1.2*b*).

2. Average Reading

Text B

VOLTAGE

I. a) Listen to the text. b) Read it (time limit is 3 min.) c) Find the part of it dealing with the source of energy.

The voltage is the force that drives the current around the circuit. The source of energy, e. g., a battery exerts the force of the charges by setting up a positive or high potential at one contact, and a negative or low potential, at the other. The current flows from the positive to the negative contact or expressed another way, from higher to lower potential.

The potential drops around the circuit from positive to negative just as the liquid pressure drops around the pipes from the higher pressure.

The difference in potential between two points is measured in volts. In fact we use the term "voltage" or "voltage drop" or "potential difference" (p. d.) to mean the same thing.

Voltage is really a measure of how much energy is available to force each coulomb of charge move from one point to another. Voltage = energy per unit charge, i. e. volts $= \frac{\text{joules}}{\text{coulombs}}$.

When we are considering the maximum energy per coulomb that a force of voltage can supply, we refer to it as the electromotive force or e. m. f. for short. The e. m. f. of a source is measured in volts. E. m. f. is only used to describe a source potential such as a battery or generator whereas the terms voltage or potential difference (p. d.) may refer to any part of a circuit.

Voltmeters are used to measure potential differences. They are not connected in line with the circuit but parallel to it between the points that are being considered (Fig. 1.2*c*).

ASSIGNMENTS

I. a) Skim through the Text A and find the part of it dealing with the measuring of current and the resistance of the conductor R. b) Discuss the information with your fellow-student.

II. a) Find the part of the Text B containing information about the potential drop. b) Discuss it.

III. Answer the following questions embracing the contents of the Text A and Text B.

1. What is an electric current? 2. What is the size of particles in a conductor? 3. In what terms is current measured? 4. What produces current in a circuit? 5. What is the relation between current and voltage? 6. What is resistance? 7. What is the unit of the resistance? 8. What is voltage? 9. What does the battery exert? 10. How does the current flow? 11. How does the potential drop around the circuit? 12. What units is p. d. between two points measured in? 13. What other terms can we use instead of voltage? 14. What is e. m. f.? 15. What is used to measure the p. d.?

IV. Pick out the key sentences from the Text B. Translate the sentences.

V. Entitle each of the paragraphs of the Text B using the key sentences.

VI. Be ready to discuss the information obtained from the Text B.

VII. Make a short summary of the Text B.

VIII. Speak on the Text A and the Text B according to the following plan:

1. Current and the quantity of charge.
2. Resistance. The unit of resistance.
3. The relation between resistance and current.

IX. Prepare a short dialogue on the following situations:

1. One of the students is Professor who gives to the other students some problems to solve on the blackboard. Professor asks whether their solutions are right or wrong.

2. Professor gives the assignments for multiple choice. (The assignments are given below.).

Problems

1. During 8 seconds 36 coulombs of charge pass a point in a circuit. Calculate the current. (Solution: $I = \frac{Q}{t} = 4{,}5$ A. The current flowing is 4,5 amperes.)

2. A potential of 6 V is applied to a resistor of 2,5 Ω. Calculate the current. (Solution: $I = \frac{U}{R} = 2.4$ A. Current in the resistor is 2.4 amperes.)

3. What voltage applied to a resistance of 40 Ω will produce 2.8 A? (112 V).

4. A resistor carries a current of 0.2 A when a potential difference of 4.0 V is applied across it. What p. d. will produce 0.5 A if Ohm's law is obeyed? (10 V).

Multiple Choice

1. The coulomb is a unit of what quantity?
(a) a current, (b) charge, (c) resistance, (d) voltage.

2. Which of the following equations does not correctly describe Ohm's law?

(a) $U = IR$, (b) $I = \frac{U}{R}$, (c) $R = UI$, (d) $R = \frac{U}{I}$.

3. Which of the following quantities does an ammeter measure directly?

(a) voltage, (b) current, (c) resistance, (d) charge.

4. Which of the following quantities are measured in volts?

(a) voltage, (b) p. d., (c) energy, (d) e. m. f.

5. Which of the following quantities is true for resistors in series?

(a) $U = U_1 + U_2$, b) $I = I_1 + I_2$, (c) $R = R_1 + R_2$, (d) $R = \frac{1}{R_1} + \frac{1}{R_2}$.

6. Which of the following quantities are matched with the correct units?

(a) voltage: joule, (b) current: ampere, (c) resistance: ohm, (d) power: watt.

7. In a parallel arrangement of resistors R_1 and R_2, which of the following are true?

(a) $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$, (b) $I = I_1 + I_2$, (c) $U = U_1 + U_2$, (d) $R = R_1 + R_2$.

8. Which of the following are units of electrical energy?

(a) watt, (b) kilowatt hour, (c) joule, (d) ampere.

9. In a parallel connection of light bulbs to the mains when one bulb burns out, what is the effect on the other bulbs?

(a) other bulbs go out, (b) little or no effect, (c) other bulbs go dim, (d) other bulbs go bright.

10. If in question 9 the lamps were in series: what would the effect be?

Multiple Choice Answers: 1 (b), 2 (c), 4 (abd), 5 (ac), (acd), 7 (ab), 8 (bc), 9 (b), 106 (a).

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these words:

Overcome v. преодолеть; cause v. заставлять; external внешний; flow n. поток; apply применять; represent представлять; reffer относиться; compare сравнивать; offer предлагать; decrease уменьшать; increase увеличивать; in order to для того, чтобы; cause вызывать; define определять; encounter встречать(ся).

II. Memorize these words and word-combinations used in their specialized meanings.

Pressure давление, напряжение; measure мера, измерять; direct current постоянный ток; alternating current переменный ток; circuit цепь; resistance сопротивление; external force внешняя сила.

III. Find these word-combinations and terms in the Text C and translate the sentences containing them.

Electric pressure электрическое напряжение; the unit strength of an ampere единица силы тока в один ампер; electromotive force электродвижущая сила; power factor коэффициент мощности; resistive circuit резистивная цепь; electrical construction works электрические устройства.

IV. Form nouns using the following suffixes.

-ence: to depend, to exist, to differ; **-ance:** to resist; **-ment:** to develop, to move, to measure; **-(t)ion:** to calculate, to oppose, to conduct.

V. Find nouns with suffixes -ence, -ance, -ing, -ment, -tion in the Text C.

VI. Put questions to the words and word-combinations in bold type. Translate the sentences.

1. **The external force** applied to a circuit to overcome the opposition to the flow of current **is measured** in volts. 2. The voltage is equal to **the current** multiplied **by the resistance.** 3. The electrical current passing through a specified solution of nitrate of silver in water deposits **silver.** 4. **This formula** is read as the voltage squared divided by the resistance. 5. The current **equals** voltage divided by the resistance. 6. Having measured voltage and resistance we can find **the value of the current.** 7. Being learned Ohm's Law **gives the possibility** to measure the current in a circuit. 8. Having been set down the equation can be used **for defining** missing quantity. 9. **When studied well** the problem can be solved successfully. 10. While making experiments the **scientist** discovered **the law of measuring** three basic electrical units.

Text C

FUNDAMENTAL ELECTRICAL UNITS

I. a) Read the Text C. b) Comment on the three basic electrical units.

The three basic electrical units in any electrical circuit are the ampere, ohm, and volt. The ampere is an electrical unit to measure the flow of current in a circuit; the resistance or opposition to the flow of current is measured in ohms; while the external force applied to a circuit to overcome the opposition to the flow of current is measured in volts.

The ampere: The rate at which electricity flows through a conductor is represented by the unit called the ampere and may be compare to the rate of flow of water through a pipe in gallons per second. The unit strength of an ampere is represented when an electrical current passing through a specified solution of nitrate of silver in water deposits silver at the rate of.001118 gram per second.

The ohm: All substances offer resistance to the flow of electricity through them. This opposition, or resistance, is measured with a unit called the ohm. The resistance of all metals increases with the increase in temperature while the resistance of carbon, insulating materials, and electrolytic solution decreases with an increase in their temperatures.

The volt: In order to overcome the resistance of conductors and cause current to flow, an external force is necessary. This force is commonly called voltage since the unit of measurement is volt. This force is also reffered to as electromotive force or electric pressure. The electromotive force that will cause a current of 1 ampere to flow through a resistance of 1 ohm equals 1 volt. A kilovolt = 1,000 volt; a millivolt = .001 volt; and a microvolt = .000001 volt.

Another important unit of electrical measurement is the watt — the unit of power. Power is defined as the rate at which work is done or the rate at which energy is expanded.

ASSIGNMENTS

I. Read the Text C attentively and answer the following questions.

1. What are the three basic electrical units? 2. What is measured in amperes? 3. What is measured in ohms? 4. What is measured in volts? 5. What is represented by the unit called the ampere?

II. a) Read the Text C again and ask additional questions embracing its contents. b) Combine your answers into a short summary of the text.

III. a) Find the part of the text containing information about the ampere. b) Discuss it.

IV. Read the text closely and pick out the key sentences. Translate the sentences.

V. Look through the text and find the part of it dealing with the electromotive force.

VI. Read the text and pick out all technical terms. Translate them.

VII. Comment on the author's attitude to fundamental electrical units.

VIII. Make up a plan of the text using the active vocabulary.

IX. Review the text in written form.

X. Express your attitude to the fundamental electrical units.

XI. Translate the text to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

series circuit	цепь управления
parallel circuit	результирующее сопротивление
be connected in tandem (with the lines)	обычные магнитные устройства управления контактами
be connected across the lines	неизвестная величина
control circuit	отдельное сопротивление

conventional magnetic contactor controls	величина сопротивления
static controls	статические управляющие устройства
total resistance	решить уравнение
individual resistance	решить задачу
solve a problem	последовательная цепь
set down the equation	соединены параллельно
missing quantity	параллельная цепь
resistance value	друг за другом (последовательно)

II. Give the initial forms of the following words. Translate them.

Physicist, electrical, conductor, resistance, equation, directly, resistive, alternate, alternating, stating, calculation, voltage, combination.

Text D

OHM'S LAW AND ELECTRICAL CIRCUIT

I. Read the Text D and tell about the basic ways of stating Ohm's law. Review the text.

Georg S. Ohm, a German physicist, discovered that the current through an electrical conductor depends upon the amount of pressure (volts) and resistance of the circuit components. These laws or equations are summarized in Fig. 1.3. They are directly applicable to any resistive circuit, any resistive portion of a circuit, any d. c. (direct current) circuit, and any a. c. (alternating current) circuit or portion of an a. c. circuit with a power factor of 100 %.

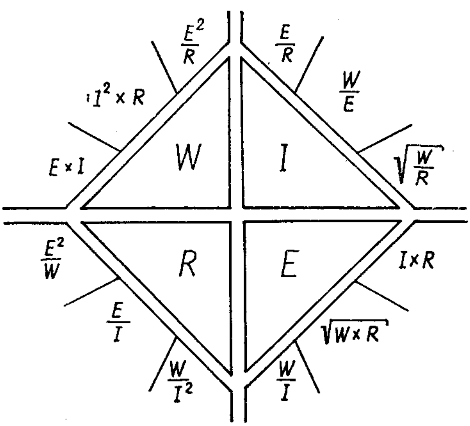


Fig. 1.3. The summary of Ohm's Law.

The basic ways of stating Ohm's Law when I = amperes, R = resistance in ohm, and E = volts are:

1. $E = IR$ or the voltage is equal to the current multiplied by the resistance.

2. $I = \frac{E}{R}$ or the current equals the voltage divided by the resistance.

3. $R = \frac{E}{I}$ or the resistance equals the voltage divided by the current.

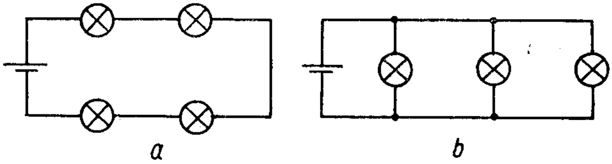


Fig. 1.4. The connections of electrical lamps:
a in series; *b* in parallel.

The electrical unit for power — the watt — may also be incorporated into Ohm's Law for further calculations. When W = watts, current may be found by the following equations:

1. $I = \frac{W}{E}$ or the wattage divided by the voltage.

2. $I = \sqrt{\frac{W}{R}}$ or the square root of the wattage divided by the resistance.

Voltage may be found by using the following equations:

1. $E = \frac{W}{I}$ or the wattage divided by the current.

2. $E = \sqrt{W \times R}$ or the square root of the wattage times the resistance.

Resistance may be found by the following equations:

1. $R = \frac{E^2}{W}$ or the voltage squared divided by the wattage.

2. $R = \frac{W}{I^2}$ or the wattage divided by the current squared.

The power, in watts, of a circuit may be found by the equations:

1. $W = \frac{E^2}{R}$; That is, the voltage squared divided by the resistance.

2. $W = I^2 \times R$ = the current squared times the resistance.

3. $W = E \times I$ = the voltage times the current.

In order for an electric circuit to be complete, it must provide a path for the electric current. All electrical circuits consist of two distinct types of circuits or a combination of these two circuits, that is, the series circuit and the parallel circuit.

The series circuit (Fig. 1.4*a*) is one in which all components are connected in tandem and is used very often in control circuits — for conventional magnetic conductor controls, static control, and electric controls. The following four rules state the conditions which exist in a series circuit:

1. The current is the same in all parts of series circuit.

2. The total resistance in series circuit is equal to the sum of the individual resistances.

3. The total voltage applied to a series circuit divides between the resistors in direct proportion to their resistance.

4. The sum of the voltage drops across all resistors in a series resistive circuit is equal to the applied (source) voltage.

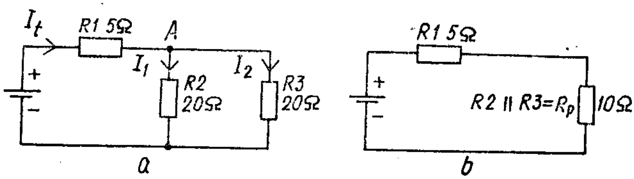


Fig. 1.5. The connections ot resistors:
a in series parallel circuit; *b* in series parallel circuit after resistors R_2 and R_3 in *a* have been totalled.

A simple parallel circuit is shown in Fig. 1.4b. Here the electrical components are connected across the lines rather than in tandem with the lines. Most of the circuits encountered on electrical construction work will consist of parallel circuits or a combination of series and parallel circuits.

There are several ways to calculate the total resistance of a parallel circuit, but remember that the total resistance of a parallel circuit is always smaller than the smallest resistor. The three most commonly used equations for resistors in parallel are: $R_t = \frac{R_1}{N}$; $R_t = \frac{R_1 \times R_2}{R_1 + R_2}$; $\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}$

In dealing with the current, voltage, and resistance in a parallel circuit, there are a few simple rules which must be learned.

1. The voltage is the same in all parts of a parallel circuit.
2. The total current in a parallel circuit is the sum of the currents through the separate parts.

To solve the problem for parallel circuits, first draw a circuit diagram of the problem, set down the equation to be used, fill in the equation with the given quantities, then solve for the missing quantity.

The circuit in Fig. 1.5*a* shows the resistors R_2 and R_3 connected in parallel, but resistor R_1 is the series with both the battery and the parallel combination of R_2 and R_3. That in the current flow (indicated by the arrows) leaves the positive terminal of the battery and travels through resistor R_1 and then divides at point *A* into I_1 and I_2.

The total resistance of this circuit is the sum of R_1 and the resistance of R_2 and R_3 in parallel. Therefore, to find R_t we first need to find the resistance R_2 and R_3 in parallel. Because these two resistors have identical values, we have a resultant parallel resistance R_p of $R_p = \frac{R}{n} = \frac{20 \text{ ohms}}{2 \text{ resis.}} = 10$ ohms.

The circuit now looks like Fig. 1.5*b*, in which R_2 and R_3 have been replaced with R_p. We now have a simple series circuit in which the total circuit resistance R_t is $R + R_p = 5 + 10 = 15$ ohms. The total circuit current I_t supplied by the battery is then $I_t = \frac{E}{R_t} = \frac{30 \text{ volts}}{15 \text{ ohms}} = 2$ amperes.

Because R_1 is in series with the battery, we know that the current through R_1 must be 2 amperes. Since R_2 is equal to R_3, equal currents of 1 ampere must flow through each of these two resistances.

ASSIGNMENTS

I. Answer the following questions embracing the contents of the text D.

1. What is necessary for an electrical circuit to be complete? 2. What does Fig. 1.4*a* show? 3. What does Fig. 1.4*b* show? 4. What does Fig. 1.5*a* show? 5. What does Fig. 1.5*b* show?

II. Examine Figs. 1.3, 1.4, 1.5 and describe them.

III. Discuss the problems of Ohm's law.

IV. Retell the Text D according to your own plan.

V. Express your opinion of the text. Does the text prove that Ohm discovered the dependence of the current on the amount of pressure and resistance of the circuit components.

VI. Pick out the most interesting problems for your discussion in the group.

VII. Look through the latest magazines, find some articles dealing with Ohm's law and make a summary of the topic.

III. GRAMMAR EXERCISES

I. a) Find in the Text A and the Text B the sentences, containing the following verbs. b) Define their tense-forms and translate the sentences into Russian.

To measure, to call, to determine, to apply, to find, to express, to restrict.

II. Give three forms of the following verbs:

To draw, to show, to use, to concentrate, to conduct, to represent, to flow, to use, to know, to think, to understand.

III. a) Define the forms of the following Participles. b) State the verbs they are formed of. c) Translate them.

Writing; sitting; reading; having read; written; having written; having been written; having asked; having been asked; being asked; asking; taking; having been taken; taken; being taken; given; giving; having been given; having given; done; used; doing; lying; tying; reffering; connecting; connected; preffered; worked.

IV. a) State the Infinitives of the following Participles II of irregular verbs. b) Translate them.

Overcome, found, taken, written, done, read, spoken, known, said, been, given, set out, brought, arisen.

V. Transform the following sentences into the Past and Future.

1. We can solve this problem with the help of Ohm's law. 2. You must calculate these data. 3. May I measure this quantity in volts? 4. They cannot describe Ohm's law correctly.

VI. a) Translate the following sentences. b) Pay attention to the subordinate clauses beginning with "whether" and "if".

1. We do not know whether they have asked this question correctly. 2. They ask if we could describe Ohm's law. 3. He does not know whether electromotive force is measured in volts or in some other units. 4. Professor asked if the resistors were connected in series.

5. My friend asks if I am able to make a parallel arrangement of resistors.

VII. Substitute the subordinate clauses for Participial Constructions.

1. The external force which is applied to a circuit to overcome the opposition to the flow of current is measured in volts. 2. The voltage is equal to the current which is miltiplied by the resistance. 3. The electrical current that is passing through a specified solution of nitrate of silver in water deposits silver. 4. The resistance is equal to the wattage that is divided by the current squared. 5. The current that is passing through the conductor equals 2 amperes.

VIII. Change Continuous Tenses into Perfect Tenses.

1. I am switching on the radio. 2. Tom is showing all figures to us. 3. The student is writing down a new rule. 4. We are considering the voltage as an energy per unit charge. 5. They are determining the resistance.

IX. a) Translate the following sentences. b) Pay attention to the words and word-combinations in bold type.

1. **In order to define the power** in watts we must know Ohm's law, that is the watt is the voltage times the current. 2. The solution of the formula is: the watt is equal to the current **squared times** the resistance. 3. **For defining** the power in watts according to the formula the voltage squared must be divided by the resistance. 4. **In order to overcome** the resistance of conductors and cause current to flow, **an external force** is necessary. This force is also reffered to as **electric pressure.** 5. This unit strength of an ampere is represented when an electrical current **passing through a special solution of nitrate of silver in water** deposits silver at the rate of .001118 gram per second.

X. Translate the sentences and explain the use of Perfect Tenses.

1. We have calculated the resistance in each case. 2. Yesterday we had calculated the resistance in each case before we began solving the problem. 3. We shall have calculated the resistance in each case before we begin to solve the problem.

XI. Memorize the reading of the following mathematical actions.

$=$ is equal to; $2 + 3 = 5$ (Two plus three is equal to five.)
is (equals); $3 + 6 = 9$ (Three plus six is (equals) nine.)
$+$ plus плюс
— minus минус
$\times$ multiplied by умноженное на
: divided by (into) деленное на
$\times$ times / multiplied by $3 \times 3 = 9$. (Three multiplied by 3 equals nine.)
: divided by $10 : 2 = 5$. (Ten divided by two equals five.)
$=$ equals (is equal to) is / makes
2^2 two squared / two to the second power
2^3 two to the third power
10^{-7} ten to the minus seventh power
0.3 ou point three (zero point three) point three
0.0004 — ou point three ouz four / point three ouz four
34.321 thirty four point three two one

$\frac{1}{2}$ a half (one second) a second

$\frac{2}{4}$ two fourth

Lesson 3. MAGNETISM

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Listen and repeat after the speaker. b) Practise the pronunciation of the following.

[s] so, sits; [z] rose, these; [ks] box, fox; [gz] example, examine. same, takes, course, us, thus, bus, plus; poison, tables, times, rings, shells, house, washes; exercise, explain, excess, except, exception, experience; exaggerate, exact exhibit.

II. a) Make sure that you know these words. Say what Russian words help you to guess their meanings. b) Repeat these words after the speaker.

compass ['kʌmpəs], pole [ou], horisontal ['hori'zontl], horizon [hə'raɪzn], ˌfunda'mental [ʌ], 'vertical [ə:], component [kəm'pounənt], region ['ri:dʒən], react [ri:'ækt], cylinder ['sɪlɪndə], 'permanent [ə:], magnet [æ], hysterisis [hɪ'sterɪsɪs], instrument, mass [æ], perpendicular [ˌpə:pən'dɪkjulə], 'distance [ɪ].

III. a) Listen, repeat and memorize the following words and word-combinations. b) Check if you know their meanings.

no matter неважно; exact точный, точно; approximately приблизительно; compass needle стрелка компаса; fine thread тонкая нить;

similar подобный; similarity подобие; experience испытывать; repulsion отталкивание; surround v. окружать; give rise вызывать, порождать; iron железо; exert v. создавать; carrying несущий; move v. двигаться; velocity скорость; motion движение; explain v. объяснять; base on v. основываться на; left-hand rule правило левой руки; south end южный конец; location расположение; locate v. располагать; point toward v. указывать на; force of attraction сила притяжения; modify v. изменять; strength сила, прочность; circular круглый; close замкнутый; conservation of energy principle принцип сохранения энергии.

IV. a) Give English equivalents to the Russian words and word-combinations in brackets and translate the sentences into Russian. b) Check yourself listening to the complete sentences after the speaker.

1. A compass (стрелка) suspended horizontally by (тонкая нить) will (реагировать) and (указывать) toward the north. 2. A current in a circular loop of the wire (порождать) to a magnetic (северный полюс) on one side of the loop and a south pole on the other side. 3. I shall (доказать) my viewpoint. 4. A magnet modifies the magnetic characteristics of the space (окружать) it. 5. All magnets, (неважно) how small, exhibit polarity. 6. The (точное расположение) of the two poles of a given magnet cannot be determined. 7. Each pole is located (приблизительно) near each end of the magnet.

Text A

MAGNETS

I. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

All magnets, no matter how small, exhibit a north and south end.

The exact location of the two poles of a given magnet cannot be determined. Each pole is located approximately near each end of the magnet.

One end of a compass needle will point toward the north when the needle is suspended horizontally by a fine thread. That end of the compass is called its north pole.

When the north pole of one magnet is placed near the south pole of another magnet, each magnet will experience a force of attraction; when two similar poles are placed near each other, each magnet will experience a force of repulsion.

A magnet modifies the magnetic characteristics of the space surrounding it.

Charges in motion (electric current) give rise to a magnetic field.

A current in a circular loop of wire gives rise to a magnetic north pole on one side of the loop and a south pole on the other side.

2. Average Reading

Text B

MAGNETIC FIELD AND CURRENT

I. a) Listen to the text. b) Read it (time limit is 2 min.). c) Find the part of it dealing with the description of charged particles. Translate it.

A magnetic field exerts a force on a current carrying wire. The left-hand rule is used to determine the direction of the force. A magnetic field exerts a force on a moving charge. Charged particles move in circular orbits when the velocity of the particle is perpendicular to the magnetic induction B.

Relative motion between a magnet and a wire causes an induced e. m. f. in the wire. If the wire is a closed loop, the induced e. m. f. causes an induced current.

Lenz's law explains the conservation of energy principle when applied to induced voltages and currents.

The operation of a voltmeter, ammeter, and motor is based on forces produced by a current in a wire that is located between the poles of a magnet. These forces produce torques.

ASSIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about.

II. Skim through the Text B and find the part of it dealing with the relative motion between a magnet and a wire. b) Discuss the information with your fellow-students.

III. Find the part in the Text B containing information about the Lenz's law. Discuss it using your knowledge of the topic.

IV. Answer the following questions embracing the contents of the Text A and the Text B.

1. What do all magnets exhibit? 2. Where is each pole located? 3. Where does one end of a compass needle point to? 4. When will each magnet experience a force of attraction? 5. When will each magnet experience a force of repulsion? 6. What gives rise to a magnetic field? 7. What does a magnetic field exert? 8. What is used to determine the direction of the force? 9. Does a magnetic field exert a force on a moving charge? 10. When do charged particles move in circular orbits? 11. What causes relative motion between a magnet and a wire? 12. What does Lenz's law explain?

V. Discuss the information obtained from the Text A and the Text B.

VI. Be ready to discuss the information on the topic obtained at your lectures on speciality.

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these words.

Essential существенный; neutralize [njutrə'laiz] v. нейтрализовать; corres'pond v. соответствовать; in most cases в большинстве случаев.

II. Memorize the words and word-combinations used in their specialized meanings.

Delta [deltə] дельта; winding ['waindiŋ] обмотка; primary coil ['praiməri] первичная обмотка; secondary coil вторичная обмотка; leakage ['li:kədʒ] утечка ; autotransformer ['o:tətræns'fo:mə] автотрансформатор; current flux данный (текущий) поток.

III. Find these word-combinations and terms in the Text C and translate the sentences containing them.

Laminated iron core пластинчатый железный сердечник; insulated coil изолированная катушка; magnetizing current намагничивающий ток; counter voltage противоЭДС; closed magnetic circuit замкнутая магнитная цепь; full-load current ток при полной нагрузке; magnetic leakage магнитная утечка; eddy-current losses потери от вихревых токов (Фуко); well-designed хорошо сконструированный; current effective in setting up ток, устанавливающий; the service is out of order работа (устройства) нарушилась.

Text C

TRANSFORMER

I. a) Read the text. b) Find the part of it describing the essential parts of a transformer. Translate it.

The transformer is a device that step-up and step-down alternating currents and voltages.

The essential parts of a transformer are shown in Fig. 1.6*a* and consist of a laminated iron core upon which are wound two separate insulated coils — the primary and the secondary. In most cases, the primary coil is connected to the supply or main side of the line where the alternating current sets up an alternating magnetic flux. This not only sets up a counter voltage equal and opposite in the primary coil, but also sets up a voltage in the secondary coil. The ratio of the voltage in the secondary coil as compared to that in the primary coil depends upon the amount of magnetic flux, the frequency of the alternating current, and mainly the number of turns in the coils.

The only current that flows in the primary coil or windings is the magnetizing current to set up the flux in a closed magnetic circuit and is usually a very small percentage of full load primary current of the transformer.

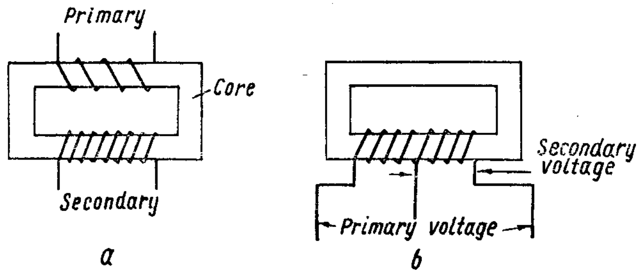


Fig. 1.6. The essential parts of:
a a transformer; *б* an autotransformer.

In a well-designed transformer, there is very little magnetic leakage. The effect of the leakage is to cause a decrease of secondary voltage when the transformer is loaded. When a current flows through the secondary in phase with the secondary voltage, a corresponding current flows through the primary in addition to the magnetizing current previously mentioned. The magnetizing effects of the two currents are equal and opposite.

In a perfect transformer — one having no eddy-current losses, no resistance in its winding, and no magnetic leakage — the magnetizing effects of the primary load current and the secondary neutralize each other, leaving only the constant primary magnetizing current effective in setting up the current flux. Such a transformer, if supplied with a constant primary pressure, would maintain constant secondary pressure at all loads.

In an autotransformer (Fig. 1.6*b*), there is only one coil, any portion of which may be used as primary and any portion as secondary. The ratio of transformation depends on the portions used; if the whole winding is used as primary and one-third of it a secondary, and the losses, which are small, are neglected, voltage of the primary equals 3 times the voltage of the secondary and the current of the secondary equals 3 times the current of the primary.

ASSIGNMENTS

I. Read the Text C attentively and answer the following questions embracing its contents.

1. What are the essential parts of a transformer? 2. What is the only current that flows in the primary coil or windings? 3. What is the effect of the leakage in a transformer? 4. When does the corresponding current flow through the primary in addition to the magnetizing current? 5. What are the characteristics of a perfect transformer?

II. Divide the Text C into logical parts. Choose the key sentences and translate them.

III. Read the text again and find the part of it describing the effect of the leakage.

2 7-528

IV. Read the final paragraph of the text and speak about the autotransformer.

V. Entitle each of the paragraphs of the text using the key sentences.

VI. Comment on the author's attitude to transformers.

VII. Make up a plan of the text using disjunctive questions.

VIII. Combine your answers into a short summary of the text.

IX. Speak on:

1. The essential parts of a transformer.
2. The characteristics of different kinds of transformers.

X. Prepare a dialogue on your own situation.

XI. Work in pairs. One student reads the Russian sentences for the other student to translate them and checks his translation with the key.

Sentences for translation	**Key**
1. Основные части трансформатора показаны на рис. 1.6*a*.	The essential parts of the transformer are shown in Fig. 1.6*a*.
2. Трансформатор состоит из пластинчатого железного сердечника, на который намотаны две отдельные изолированные обмотки — первичная и вторичная.	The transformer consists of a laminated iron core upon which are wound two separate insulated coils – the primary and the secondary.
3. Первичная обмотка соединена с питающей или основной стороной линии, где переменный ток создает переменный магнитный поток.	The primary coil is connected to the supply or main side of the line, where the alternating current sets up an alternating magnetic flux.

Now the first student will translate the sentences.

4. Единственный ток, протекающий по первичной обмотке — это намагничивающий ток.	The only current that flows in the primary coil is the magnetizing current.
5. В хорошо спроектированном трансформаторе магнитная утечка незначительна.	In a well-designed transformer, there is a very little magnetic leakage.
6. Намагничивающие эффекты двух токов равны и противоположны.	The magnetizing effects of the two currents are equal and opposite.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

primary leads	внешние зажимы (выводы)

primary main wire	основной первичный провод
be out of order	в каждый момент
outside terminals	выйти из строя, быть не в порядке
at every instant	выводы первичной обмотки

II. a) Give initial forms of the following words and check if you know the function of their suffixes. b) Translate these words into Russian.

Connecting, corresponding, voltage, secondary, transformer, generated, winding.

Text D

TRANSFORMER CONNECTIONS

I. a) Read the following text and say what it is about. b) Review the text.

When connecting two or more single-phase transformer in parallel, corresponding primary leads of each transformer must be connected to the same primary main wire, and the secondary leads must be so connected that the secondary voltage of the transformers shall at every instant oppose each other. If this is done, no current can flow through the secondary coils or windings until the secondary load is applied — even if the secondary coils are connected in series. On the other hand, if the leads are improperly connected, the secondaries will be short-circuited on each other.

When three single-phase transformers are connected to a three-phase Y system, two coils are in series across each phase, and the voltage on each coil is the voltage per phase divided by 1.73. When the primaries are connected in either Y or delta, the secondaries are usually connected in the same way.

It is possible to use only two single-phase transformers on a Y or delta three phase system, but if one of the transformers fails, the service is out of order.

Single phase primary systems may be transformed to three-phase by either the open delta or Scott systems. The Scott system uses two special transformers, as shown in Fig. 1.7, which have primaries connected to the single-phase circuit. The secondary of the transformer «A» contains sufficient turns in its windings to give, between its outside terminals, the voltage desired between lines on the three-phase circuit. The secondary of the transformer «B» contains sufficient turns to give.87

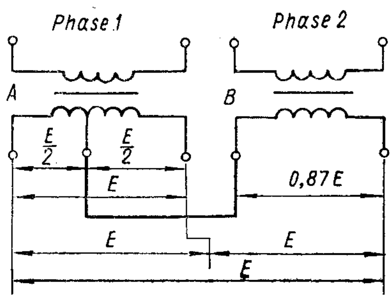


Fig. 1.7. The Scott or T-connected transformer.

times the voltage; one end feeds directly into one side of the three-phase circuit, and the other to the middle point of the secondary transformer «A». One of the three phases, then, has the voltage generated by the secondary of transformer „A", and each of the other two has a voltage equal to the square root of $(.5E)^2+(.87E)^2$.

ASSIGNMENTS

I. Answer the following questions embracing the contents of the Text D.

1. When connecting two or more single-phase transformers in parallel what must corresponding primary leads of each transformer be connected to? 2. How must the secondary leads be connected? 3. When will the secondaries be short-circuited on each other? 4. How are two coils connected when three single-phase transformers are connected to a three-phase Y system?

II. a) Look at Fig. 1.7. and describe it. b) Discuss it with your fellow-student.

III. Speak on:

1. Connecting two or more single-phase transformers.
2. The Scott system of transformers.

IV. Make up a plan of the text.

V. Prepare a dialogue on your own situation.

VI. Give some additional informations about transformers.

VII. Discuss the problem of fabrication and utilization of transformers nowadays.

VIII. Look through the latest magazines, find some articles on transormers and discuss the topic with your fellow-students.

III. GRAMMAR EXERCISES

I. a) Pay attention to the following prefixes and their meanings. b) Check if you know them well.

mis- (something wrong): mislead вводить в заблуждение; **ill-** (something wrong or bad): ill-use плохо обращаться; **post-** (after): post-war послевоенный; **pre-** (before): pre-war довоенный; **out-** (пере-, пре-): outgo превосходить; **over-** (пере-, пре-): overcome преодолеть.

II. a) Analyse the following sentences. b) Find the verbs in the Subjunctive Mood. c) Translate the sentences.

1. It is important that they should achieve satisfactory results. 2. We insist that the results of these researches be published. 3. You must write this rule lest you should forget it. 4. I wish you would be more attentive. 5. I wish I had been present at that discussion yesterday. 6. She spoke as if she were an expert in this field of production. 7. Even though it were raining I should come to see you.

III. Change the following sentences according to the model adding the phrases "I wish" with Past Indefinite (мне бы хотелось), "I wish" with Past Perfect (как жаль, что не):

Model. I was present at the meeting.
I wish I were present at the meeting.
Мне бы хотелось присутствовать на собрании.
I wish I had been present at the meeting.
Как жаль, что я не присутствовал на собрании.

1. He received good results during his experiments. 2. The report is successful. 3. They were present at the discussion. 4. You helped me in my research work. 5. You understand me better.

IV. Change the following sentences using the phrase "should + S + + V". Translate them.

Model. If I got permission to work in this laboratory we should begin at once.
Should we **get** permission to work in this laboratory we should begin at once.

1. If we came, they would tell him about this accident. 2. If comrade Ivanov returned from his mission, we should repeat our experiment. 3. If they read this book, they would know much about South Africa. 4. If she calculated these data correctly, she would solve these problems. 5. If it were possible, we should begin our work immediately.

V. Translate the following sentences into Russian paying attention to the function of the Infinitive in the sentence.

Model 1. The student **to be sent abroad** is very capable.
Студент, *которого отправят за границу*, очень способный.

1. The work to be done is very useful. 2. The example to be given must illustrate the rule. 3. The research to be carried on is very important for our industry.

Model 2. I know **him to be a good student.**
Я знаю, *что он хороший студент.*

1. We know him to carry out research in cybernetics. 2. I suppose his article to be published. 3. They considered him to be a very experienced researcher. 4. I heard him speak at the meeting. 5. We often see him talk with the students.

VI. a) Define the tense-forms of the verb in the following sentences. b) Translate these sentences into Russian.

1. The primary coil is connected to the supply or main side of the line. 2. A corresponding current flows through the primary in addition to the magnetizing current previously mentioned. 3. If such a transformer were supplied with a constant primary pressure, it would maintain constant secondary pressure at all loads.

VII. Give three forms of the following verbs:

Exert, use, move, be, cause, explain, apply, produce, exhibit, locate, point, call, experience, place, give, show, wind, connect, flow, load, mention.

VIII. a) Define the forms and functions of the Participles. b) State the verbs they are formed of. c) Translate them into Russian.

I. Given, determined, located, suspended, called, placed, surrounding, used, moving, charged, induced, applied, based, shown, wound, insulated, connected, alternating, compared, magnetizing.

II. Given magnet; magnet cannot be determined; each pole is located near each end; the needle is suspended; one end of the compass is called the north pole; one magnet is placed near the south pole; a magnet modifies the magnetic characteristics of the space surrounding it; it is used to determine; a force on a moving charge; charged particles move in circular orbit; the induced e. m. f. causes an induced current; Lenz's law explains the conservation of energy principle when applied to induced voltages and currents; motor is based on forces; a transformer is shown in Fig. 1.6*a*; it consists of an iron core upon which are wound two insulated coils; the primary coil is connected to the supply or main side of the line.

Lesson 4. ELECTRIC LIGHTING

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Listen and repeat after the speaker. b) Practise the pronunciation of the following.

Con'ceivable [i:] возможный; envelope колба; quartz-iodine ['kwɔ:ts'aɪədi:n] иодисто-кварцевый; luminance ['lju:mɪnəns] освещение; interference [ˌɪntə'fɪərəns] помеха; vapor ['veipə] пар; merchandise ['mə:tʃəndaɪz] товары; seal [si:l] паять; delux [dɪ'lju:ks] дневной свет; ambient ['æmbiənt] окружающий; ultra-violet ['ʌltrə'vaïəlɪt] ультрафиолетовый; diameter [daɪ'æmɪtə] диаметр.

II. a) Listen and repeat after the speaker. b) Notice the word-building elements and define the function of the suffix -ing.

to light освещать	light**ing** освещение
to design проектировать	design**ing** проектирование
to interfere мешать	interfer**ing** помехи
to cool охлаждать	cool**ing** охлаждение

III. a) Listen, repeat and memorize the following word-combinations and terms from the text. b) Check if you know their meanings.

Lighting layout план (проект) освещения; highest visual comfort and performance наилучший визуальный комфорт и качество; conceivable lighting application возможное применение освещения; incandescent filament lamp лампа накаливания; basic incandescent lamp типовая лампа накаливания; white light (incandescence) белый свет (накаливание); quartz-iodine tungsten-filament lamp йодистокварцевая лампа с вольфрамовой нитью накала; surface luminance поверхностное освещение; critical light control регулировка критического света; iodine vapor йодистые пары; cool white lamp холодная лампа дневного света; delux warm white lamp теплая лампа дневного света; flattering colour приятный свет.

Text A

ELECTRIC LAMPS

I. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

Electric lamps are made in thousands of different types and colours, from a fraction of a watt to over 10 кW each, and for practically any conceivable lighting application.

Incandescent filament lamps, for example, consist of a sealed glass envelope containing a filament that produces light when heated to incandescence (white light) by its resistance to a flow of electric current. This type of light source is relatively inexpensive to install, is not greatly effected by ambient temperatures, is easily controlled as to direction and brightness, and gives a high colour quality.

The quartz-iodine tungsten-filament lamp is similar to the basic incandescent lamp except that the glass envelope contains an iodine vapor, which prevents the evaporation of the tungsten filament. This increases the normal life to about twice that of a normal incandescent lamp.

2. Average Reading

Text B

FLUORESCENT LIGHTING

I. a) Listen to the text. b) Read it (time limit is 3 min.). c) Find the part of it dealing with the types of lamps.

Fluorescent lighting has a high efficiency as compared to incandescent lighting. Fluorescent lighting further provides a linear source of light, long lamp life, and a means of relatively low surface luminance. However, the initial installation cost is normally higher due to the required auxiliary equipment (balast, etc.). Also, fluorescent lighting is temperature and humidity sensitive, produces radio interference, and does not lend itself to critical light control.

The most popular types are cool white and delux warm white. The cool-white lamp is often selected for offices, factories, and commercial areas where a psychologically cool working atmosphere is desirable. It is also one of the most efficient fluorescent lamps manufactured to-day.

Deluxe warm-white lamps produce a more flattering colour to the complexion; the colour is very close to incandescent in that they impart a ruddy or tanned due to the skin. They are generally recommended for applications in homes and for commercial use where flattering effects on people and merchandise are considered important.

ASSIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about.

II. a) Skim through the Text B. b) Discuss the main idea of it.

III. Find in the Text A and the Text B the English equivalents of the following word-combinations. Translate the sentences with them.

Лампа накаливания; теплая лампа дневного света; регулировка критического света; йодистые пары; холодная лампа дневного света; план освещения; применение освещения.

IV. Skim through the Text B and choose the key sentences. Translate them.

V. Answer the following questions ambracing the contents of the Text A and the Text B.

1. What does the incandescent lamp consist of? 2. What does the filament produce? 3. What is the difference between the filament lamp and the quartz-iodine tungsten-filament lamp?

VI. Read the text and answer the questions.

Fig. 1.8 shows the general contour of high intensity discharge lamps with a verbal description of the code used for the shapes.

We can see here different shapes of the bulbs. The complete description of a bulb also includes a number that represents the maximum diameter of the bulb in eighths of an inch. The E-37 bulb, therefore, is elliptical in shape and 37/8 inches at its widest point; the R-80 is a reflector bulb with 10-inch maximum diameter.

1. What does Fig. 1.8 show? 2. What code is used for the shapes in Fig. 1.8? 3. What is the E-37 bulb in shape? 4. What is its diameter at its widest point? 5. What is the maximum diameter of the R-80?

VII. Speak on:

1. Fluorescent lighting.

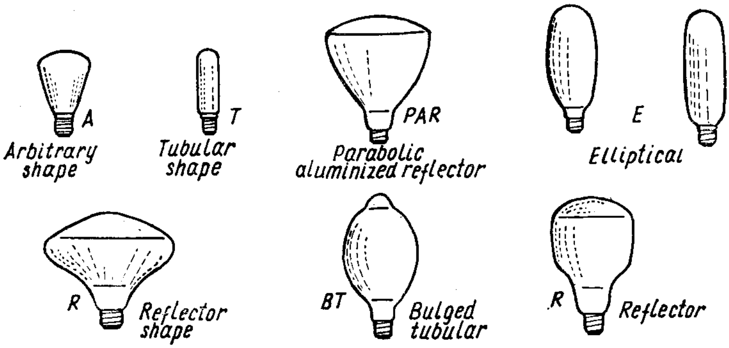


Fig. 1.8. The general contour of hign intensity discharge lamps.

2. Deluxe warm-white lamps.

VIII. Prepare a dialogue on your own situation.

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these words.

Describe описывать; variety разнообразие; common общий; consist (of) состоять (из); operate работать; density плотность; provide обеспечивать; include включать; distribution распределение; achieve достигать; description описание.

II. Memorize these words and word-combinations used in their specialized meanings.

Tube лампа, lighting свет, pressure давление, current ток, radiate излучать, absorb поглощать, intensity интенсивность, life срок службы, maintenance эксплуатация, содержание, label v. обозначать.

III. Find these word-combinations and terms in the Text C and translate the sentences containing them.

High intensity discharge lamp высокоинтенсивная газоразрядная лампа; gaseous discharge arc tube дуговая газоразрядная трубка (колба); fused quartz плавленый кварц; heat resisting теплоустойчивый; arc-tube performance параметры дуговой лампы; rounded shape закругленные формы; bulb walls стенки колбы; phosphor coatings фосфорное покрытие.

Text C

HIGH INTENSITY DISCHARGE LAMPS

I. a) Read the Text C. b) Describe common characteristics of wide variety of lighting sources.

The term "high intensity discharge lamps" describes a wide variety of lighting sources. Their common characteristics is that they consist of gaseous discharge arc tubes which, in the versions designed for lighting, operate at pressures and current densities sufficient to generate desired quantities of radiation within their arcs alone.

Mercury vapor lamps contain arc tubes which are formed of fused quartz. This has resulted in great improvements in lamp life and maintenance of output through life. These arcs radiate ultraviolet energy as well as light, but the glass used in outer bulbs is generally of a heat-resisting type that absorbs most of the ultraviolet.

The outer bulbs of high intensity discharge lamps are designed to provide, as nearly as possible, optimum internal environments for arc-tube performance. For example, the rounded shapes labelled E and BT in the sketches in Fig. 1.8 were designed to maintain uniform temperatures of the bulb walls for better performance of phosphor coatings.

In some cases, special consideration dictates the bulb shape. The R and PAR contours have been selected to achieve desired directional distribution of light.

Most of the general contours of high intensity discharge lamps are shown in Fig.1.8 with verbal descriptions of the code used for the shapes. The complete description of a bulb also includes a number that represents the maximum diameter of the bulb in eighths of an inch. The E-37 bulb, therefore, is elliptical in shape and 37/8 inches in diameter at its widest point; the R-80 is a reflector bulb with 10-inch maximum diameter.

ASSIGNMENTS

I. a) Divide the Text C into logical parts. b) Choose the key sentences and translate them.

II. Look through the Text C and find the part of it dealing with the outer bulbs of high intensity discharge lamps.

III. Read the Text C attentively and answer the following questions.

1. What does the term «high intensity discharge lamps» describe? 2. What is their common characteristic? 3.What do mercury vapor lamps contain? 4. What absorbs most of the ultraviolet?

IV. Make up a plan of the text.

V. Retell the text according to your own plan.

VI. Speak on:

1. Measuring vapor lamps.

2. The bulb shapes of an electric lamps.

VII. Prepare a dialogue on your own situation.

VIII. Review the text in written form.

IX. Translate the Text C to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

mercury	капли дождя
thermal shock	окисление
borosilicate glass	боро-кремниевое стекло
raindrops	ртутный
strike	пусковой газ
nitrogen	баласт (буфер) для цепи переменного тока
oxidation	удар
starting gas	тепловой удар
a. c. circuit	азот
ballast	

II. Give initial forms of the following words and translate them.

Resistant, striking, outer, electrical, insulation, oxidation, distribution, inductive, capacitive, burning, maitenance, operation, popularity, lighting.

Text D

MERCURY LAMPS

I. a) Read the following text and say what it is about. b) Review the text.

A typical mercury lamp consists of the several parts enclosed in an outer bulb made of borosilicate glass, which can withstand high temperatures, and which is resistant to thermal shocks such as those imposed by cold raindrops striking a hot bulb. The outer bulb contains a small quantity of nitrogen, an inert gas; this atmosphere maintains internal electrical stability, provides thermal insulation for the arc tube, and protects the metal parts from oxidation. The quartz arc tube contains a small quantity of high-purity mercury, and a starting gas, argon.

Most mercury lamps operate on a. c. circuit ballast usually consists of a transformer to convert the distribution voltage for the lamp, and inductive or capacitive reactance components to control lamp current and — in some ballasts — to improve power factor.

Most mercury lamps start and operate equal well in any burning position. However light output and maintenance of output through life are generally slightly higher with vertical than with horisontal operation.

The operating life of mercury lamps is very long, which accounts for much of their popularity in recent years. Most general lighting lamps of 100 to 1,000 watts have rated lives in excess of 24,000 hours, while the 50-, 75-, and 100-watt lamps with medium screw bases are rated at 10,000 hours.

ASSIGNMENTS

I. Skim through the Text C and divide it into logical parts. Choose the key sentences and translate them.

II. Find the part of the text describing the operating life of mercury lamps.

III. Ask your friend about mercury lamps.

IV. Make up a plan of the text.

V. Discuss the problem of mercury lamps.

VI. Make a short summary of the text.

VII. Look through the latest magazines and find additional information about mercury lamps.

III. GRAMMAR EXERCISES

I. Find the words in the Text C with suffixes -ment, -ing, -ic, -ate, -ance, -tion, -al, define their initial forms and translate them into Russian.

II. Give the main forms of these verbs.

Consist, enclose, impose, contain, maintain, operate, account.

III. Find the following words and word-combinations in the Text D and translate the sentences with them.

Withstand high temperature; resistant to thermal shocks; a small quantity of nitrogen; internal electrical stability; thermal insulation; a. c. circuit ballast; in any burning position.

IV. Translate the following sentences using the models.

Model 1. Задача, *которую нужно решить*, проста.
The problem **to be solved** is simple.

Model 2. *Использованная* формула известна.
The formula **used** is well known.

Model 3. *Когда меня спросили*, я не мог ответить.
When asked I could not answer.

1. Текст, который нужно изучить, посвящен электрическому освещению. 2. Рисунок, который нужно показать, демонстрирует различные виды ламп. 3. Пройденный урок был посвящен электрическому освещению. 4. Лампы, представленные на рисунке, являются флюоресцентными лампами. 5. Когда лампа включена, она ярко светит. 6. Если дан рисунок, текст легко запомнить. 7. Нить накала светится, если она нагрета до накала. 8. Если флюоресцирующий материал активизирован, он излучает видимую энергию.

V. Translate the sentences using the models. Pay attention to the forms and functions of Gerund.

Model 1. **Lighting** the streets is very important. *(A subject)*
Освещение улиц очень важно.

Model 2. Deciding is **acting.** *(A part of the predicate)*
Решить значит *действовать.*

Model 3. I like **reading.** *(An object)*
Я люблю *читать.*

Model 4. The problem **for solving** is difficult one. *(An attribute)*
Задача *для решения* очень трудная.
In reading the text we paid attention to the description of different types of motors.
Читая текст, мы обращали внимание на описание различных видов моторов. *(Adverbial Modifier)*

1. The scientist went on working at his reseach. 2. Demonstrating his experiments was not an easy task. 3. They knew of his having spent much time investigating this phenomenon. 4. The motion of a body is changed as a result of its being acted upon by a force. 5. We know of his having been provided with new equipment. 6. By repeating experiments one gets more data. 7. On being set on a proper orbit the Earth's sputnik keeps on moving.

VI. In the following sentences find the Infinitive, Gerund and Participle II, state their functions and translate the sentences.

1. Lighting layout for building construction should be designed to provide the highest visual comfort and performance that is consistent with the type of area to be lighted and the budget provided. 2. The lamp to be selected for office, factories and commercial areas is the cool white lamp. 3. Fluorescent material when activated by the ultraviolet rays emits visible energy.

VII. Ask questions about the word-combinations in bold type.

1. Electric lamps **are made** in thousands of different types and colour. 2. **Fluorescent lighting** has a high efficiency as compared to incandescent lighting. 3. The cool white lamps is often selected for **offices, factories, and commercial areas.** 4. The term «high intensity discharge lamps» describes **a wide variety of lighting sources.** 5. **Mercury vapor lamps** contain arc tubes which are formed of fused quartz.

Lesson 5. POWER SOURCES

I. INDEPENDENT WORK

Laboratory Work

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Listen and repeat after the speaker. b) Practise the pronunciation of the following words. Memorize their Russian equivalents.

Rectification ['rektıfıkeıʃn] выпрямление; advantage [əd'va:ntıdʒ] преимущество; ˌporta'bility портативность; 'absence отсутствие; exhaust [ıg'zɔ:st] v. истощать; acci'dentally случайно; avoid [ə'voıd] избегать; replacement [rı'pleısmənt] замена, замещение; hermetically герметически; facility возможность; nickel-cadmium cell никель-кадмиевый элемент; quote [kvout] v. цитировать; capacity емкость; мощность; производительность; pound фунт; worth [wə:θ] стоящий; reduce [rı'dju:s] v. сокращать; incorporate соединять, объединять.

II. a) Listen and repeat after the speaker. b) Notice the word-building elements and define their functions.

electron электрон	— electronic электронный
rectify выпрямлять	— rectification выпрямление
replace заменять	— replacement замещение
probable вероятный	— probability вероятность
portable портативный	— portability портативность
capable способный	— capability способность
accidental случайный	— accidentally случайно
hermetic герметичный	— hermetically герметически
usual обычный	— usually обычно
complete полный	— completely полностью
occasional случайный	— occasionally случайно

III. Read abbriviations and memorize them.

d. c. — direct current	постоянный ток
a. c. — alternating current	переменный ток
e. m. f. — electromotive force	электродвижущая сила (ЭДС)
V — volt	вольт
A — ampere	ампер
r. m. s. — root-mean-square	среднеквадратичный
AH — ampere-hour	ампер-час
mA — milliampere	миллиампер

IV. a) Listen, repeat and memorize the following words and word-combinations. b) Check if you know their meanings.

Draw v. получать, тянуть, рисовать; a. c. mains напряжение основной цепи переменного тока; endanger подвергать опасности; rechargeable перезаряжаемый; tiny «button» cells крошечные «кнопочные» элементы; electric traction городской электротранспорт; seal герметизировать, закрывать; topping up нагромождение; low (high) load current низкий (высокий) ток нагрузки; quote along with назначать в зависимости от; step down ступенчато (дискретно) понижать; half-wave rectifier circuit схема однополупериодного выпрямителя; half-wave (HW) однополупериодный; full-wave (FW) двухполупериодный; diamond-shaped diode configuration ромбовидная диодная конфигурация; bridge rectifier мостиковый выпрямитель; centre tap средний вывод; conveniently удобно; bi-phase двухфазный; cheaply дешево.

V. Translate the question-answer units into English. Work in pairs.

1. Какие преимущества имеют батареи? (Батареи имеют преимущества в портативности и полном отсутствии переменной составляющей на выходе.) 2. Когда появляется опасность утечки? (Опасность утечки появляется в том случае, если истощенные батареи случайно будут оставаться слишком долго в аппаратуре.) 3. Насколько падает ЭДС никель-кадмиевой батареи? (ЭДС никель-кадмиевой батареи падает от 1,3 В до 1,1 В за время полезного разряда.) 4. В чем выражается емкость батареи? (Емкость батареи обычно выражается в ампер-часах.)

Text A

BATTERIES

I. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

The necessary d. c. supplies for electronic circuits may be drawn from batteries or obtained by rectification of the a. c. mains. Batteries composed from separate cells have the advantage of portability and complete absence of a. c. components in their output. There is, however, a danger of leakage if exhausted batteries are accidentally allowed to stay too long in equipment; this may endanger many hundreds of pounds worth of circuitry through corrosion damage.

Rechargeable nickel-cadmium cells are available in an enormous variety of sizes, ranging from tiny «button» cells to the large batteries used for electric traction. The smaller sizes are usually hermetically sealed so that there is no risk of leakage and no need for topping up. They make an ideal power sources for portable electronics, since the need for battery replacement is avoided.

The e. m. f. of a nickel-cadmium cell falls from 1.3 to 1.1 V over the useful discharge range.

The capacity of a battery is usually expressed in ampere-hours (AH), which is the product of the discharge current and the time for which the battery will give that current. Because the capacity of most batteries is greater at low load currents than high load currents, the normal rate of discharge is usually quoted along with the capacity. The discharge rate is often stated in terms of time required to discharge the battery completely.

The capacity of the sort of dry cells used to power small electronic circuits is often in the region of 3 AH at the 100-hour rate, indicating that a current of 30 mA is available for 100 hours.

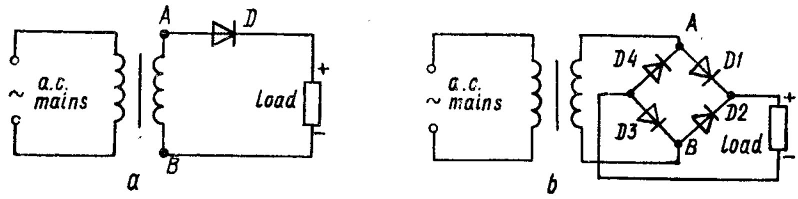


Fig. 1.9. The rectifier circuits:
a a simple half-wave (HW) rectifier circuit; *b* a full-wave (FW) rectifier circuit.

2. Average Reading

Text B

RECTIFICATION OF A. C.

I. a) Listen to the text. b) Read it (time limit is 3 min.). Find the part of it dealing with the resultant waveform. Translate it.

In the majority of power supply units, a transformer is used to step down the a. c. mains to the required voltage. A simple half-wave rectifier circuit is shown in Fig. 1.9*a*.

The diode only allows current to flow when terminal *A* is positive, cutting off when *A* is negative. The waveform of the resulting d. c. voltage across the load is shown in Fig. 1.10*b* where it may be compared with the original sinusoidal a. c. waveform in Fig. 1.10*a*. Since only the positive half-cycles are available, the d. c. consists of a series of indirectional pulses. This is known as half-wave (HW) rectification.

Fig. 1.9*b* shows an improved rectifier circuit which makes use of the whole a. c. waveform and is therefore known as a full-wave (FW) rectifier. Because of the similarity of the diamond-shaped diode configuration to the Wheatstone bridge, this particular circuit is called a bridge rectifier. We can easily sort out its operation by considering what happens on successive half-cycles of the transformer output. When *A* is positive, D_1 conducts to make the top end of the load positive, at the same time *B* is negative and D_3 conducts to the bottom end of the load. On the next half-cycle, *A* is negative and *B* is positive so that D_2 conducts from *B* to the top end of the load and D_4 conducts from *A* to the bottom end of the load. The resultant waveform is shown in Fig. 1.10*c* where it is clear that the FW d. c. waveform is of a more con-

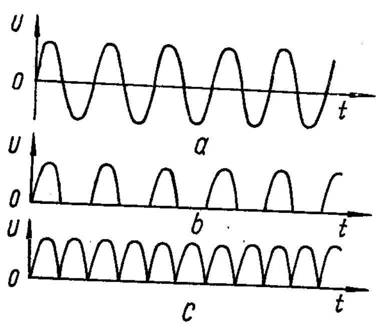


Fig. 1.10. The waveforms in rectifier circuits:
a the original sinusoidal a. c. waveform; *b* the waveform of the resulting d. c. voltage across the load in HW rectifiers.

tinuous nature than in the HW case. Notice that the frequency of the FW rectified waveform is double that of the original a. c., the negative half-cycle inverted and located between adjacent positive half-cycles.

ASSIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about.

II. Skim through the Text B and find the part of it dealing with half-wave rectification.

III. Find the part in the Text B containing information about an improved rectifier circuit which makes use of the whole a. c. waveform.

IV. Answer the following questions embracing the contents of the Text A and the Text B.

1. What advantages have batteries? 2. When is there a danger of leakage? 3. How does the e. m. f. of a nickel-cadmium cell fall? 4. How is the capacity of a battery expressed? 5. What is shown in Fig. 1.9*a*? 6. When does the diode allow current to flow? 7. What is shown in Fig. 1.9*b*?

V. Make up a plan of the text.

VI. Retell the text according to your plan.

VII. Speak on:

1. Waveforms in HW rectifier circuit.
2. FW bridge rectifier.

VIII. Prepare a dialogue on your own situation.

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Read the following words and memorize their Russian equivalents.

Fluctuation колебание; faithful верный, точный; overcome преодолевать; regulation регулирование; compare сравнивать; to take into account принимать во внимание; breakdown поломка, пробивание, пробой; sophisticated сложный, запутанный; Zener [zi:nə] diode диод Зенера.

II. Memorize the following terms.

Mains input voltage входное напряжение основной цепи переменного тока; step-down transformer понижающий трансформатор; p. d. (potential difference) разность потенциалов; IC circuit regulators регуляторы (стабилизаторы) на интегральных схемах, line regulation линейное регулирование.

Text C

VOLTAGE STABILIZERS

I. a) Read the text. b) Find the part of it dealing with typical characteristics of a Zener diode.

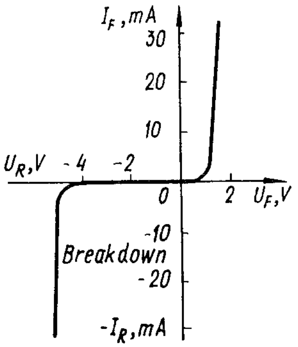


Fig. 1.11. Typical Zener diode characteristics.

The variable voltage circuits have one disadvantage in common. Any fluctuation in mains input voltage will be faithfully transmitted to the output so that, even if the load is constant, there will be variations in input voltage. These limitations are overcome in that class of circuits known as voltage stabilizers.

Zener or avalanche diodes make use of high doping levels to obtain artificially low reverse breakdown voltages. Typical characteristics of a Zener diode are shown in Fig. 1.11 where a 5 V breakdown is illustrated.

The p. d. across the diode in the breakdown condition is almost constant over a wide range of currents; this property is exploited in the simple voltage stabilizer circuit of Fig. 1.12*a*. Here the output voltage is equal to the diode p. d. and is therefore constant over a wide range of input voltages.

The degree of stabilization produced by a particular circuit can be specified as its stabilization ratio, which is obtained by measuring the percentage change in output voltage produced by a given percentage change in input voltage. Then stabilization ratio = $= \frac{\text{change in input voltage}}{\text{change in output voltage}}$. A basic Zener diode stabilizer like Fig. 1.12*a* usually gives stabilization ratios between 5 and 20, whilst some of the more sophisticated IC regulators give values over 1000.

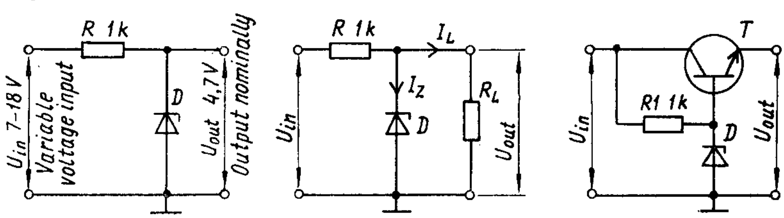
ASSIGNMENTS

I. a) Divide the Text C into logical parts. b) Choose the key sentences and translate them.

II. Find the part in the Text C describing the degree of stabilization produced by a particular circuit.

III. Read the Text C attentively and answer the questions.

1. What is known as voltage stabilizers? 2. What is the output voltage in Fig. 1.12*a*? 3. How can the degree of stabilization produced



a b c

Fig. 1.12. Voltage stabilizer circuits:
a basic Zener diode; *b* Zener stabilizer with load; *c* Zener stabilizer with emitter follower.

by a particular circuit be specified? 4. How is the stabilization ratio obtained?

IV. Speak on:

1. Voltage stabilizers.
2. Stabilization ratio.

V. Prepare a dialogue on your own situation.

VI. Translate the Text C to be sure you understand it well.

VII. Translate the question-answer units into English. Work in pairs.

1. Что собой представляют стабилизаторы напряжения? (Стабилизаторы напряжения — это такие схемы, которые обеспечивают почти постоянное выходное напряжение в широком диапазоне изменений входного напряжения.) 2. Какое выходное напряжение на рис. 1.12*а*? (Выходное напряжение на рис. 1.12*а* равно разности потенциалов на диоде и поэтому постоянно в широком диапазоне изменений входных напряжений.) 3. Как может быть названа степень стабилизации, создаваемая конкретной схемой? (Она может быть названа ее коэффициентом стабилизации.) 4. Как получают коэффициент стабилизации? (Коэффициент стабилизации получают путем измерения процентного изменения выходного напряжения, возникающего при заданном процентном изменении входного напряжения.)

VIII. Make up a plan of the text.

IX. Retell the text according to your plan.

X. Review the text in written form.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

permissible load current	эмиттерный повторитель
load robbing the diode current	избежать излишнего рассеивания
care must be taken	питать, подавать
involve considerable waste of power	допустимый ток нагрузки
avoid excess dissipation	необходимо обратить внимание
feed	нагрузка снижает диодный ток
emitter follower	включать значительный расход мощности

II. a) Give the initial forms of the following words. b) Find the sentences in the Text D with them and translate them.

Stabilizer, robbing, achieving, considerable, expensive, fortunately, dissipation, regulation, incorporating, adjusting, provision, reference, improvement, temperature, feeding.

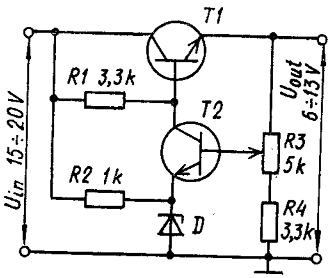


Fig. 1.13. The voltage stabilizer incorporating an error amplifier.

Text D

IMPROVED STABILIZATION

I. Read the following text and say what it is about.

The maximum permissible load current for the Zener stabilizer of Fig. 1.12*b* was about 8 mA, any greater load robbing the diode of current so that it could not give its normal Zener voltage. In most cases, load current is much greater than this must be supplied. One way of achieving this is simply to reduce the value of the series resistor *R* so that a greater current *I* flows to the diode and load; care must be taken, though, that the maximum rated power of the diode is not exceeded. This line of action can involve considerable waste of power and require an expensive high-power Zener diode. Fortunately, there is a more elegant solution to the problem of high current supplies.

If an emitter follower is added to the simple Zener stabilizer, the available output current is increased by the current gain of the transistor. In Fig. 1.12*c* such a circuit is shown. The maximum available output current is chiefly limited by the power dissipation of the transistor *T*; for a voltage drop of approximately 10 V, the output current should be limited to 80 mA to avoid excess dissipation. Lower voltage drops will allow greater currents to be drawn.

Regulation can be improved further by incorporating an amplifier in the circuit to compare the reference voltage from the Zener diode with a given fraction of the output voltage. Such a circuit, which also has provision for adjusting the output voltage, is shown in Fig. 1.13. Here, the voltage amplifier T_2 has R_1 as its collector load and feeds emitter follower T_1. The emitter T_2 is held at a constant voltage by Zener diode *D*. Potentiometer R_3 and resistor R_4 feed a given fraction of the output voltage to the base of transistor T_2. Since the emitter of T_2 is held at the Zener voltage, the circuit output voltage adjusts itself until the base of T_2 is 0.6 V (base-emitter drop) above the Zener voltage. By adjusting potentiometer R_3 and thus feeding back a different fraction, the output voltage may be varied.

Further improvement can be made by replacing T_2 with a differential amplifier (e. g. a 741 integrated circuit) and using a Darlington pair in the emitter follower instead of single transistor T_1. The differential amplifier virtually eliminates voltage drift with temperature, whilst the Darlington pair further lower the output impedance.

ASSIGNMENTS

I. Give the main idea of the Text D.

II. Answer the following questions embracing the contents of the text.

1. What was the maximum permissible load current for the Zener stabilizer of Fig. 1.12*b*? 2. When is the available output current increased? 3. What is the maximum permissible load current for the Zener stabilizer? 4. What is shown in Fig. 1.13? 5. At what voltage is the emitter T_2 held?

III. Make up the plan of the text.

IV. Retell the text according to your plan.

V. Speak on:

1. Stabilizer circuit used in the calculation.
2. Stabilizer incorporating an error amplifier.

VI. Prepare a dialogue on your own situation.

VII. Look through the latest magazines and find additional material about improved stabilisation. Discuss it.

III. GRAMMAR EXERCISES

I. Find Subjunctive Mood in the following sentences and translate them.

1. Although the same battery in the principle might be expected to give 40 A for 1 hour, in practice its capability would be very much reduced at this 1-hour rate. 2. The necessary d. c. supplies for electronic circuit might be drawn from batteries.

II. State the forms and functions of the Participles and translate the sentences with them.

1. Electrons, passing through the wire, create the current flow. 2. The discharge rate is often stated in terms of time, required to discharge the battery completely. 3. Experiments, being conducted in the field of electricity are based on Ohm's Law. 4. Studing the capacity of a battery we learned that it is expressed in ampere-hour (AH). 5. Having defined that a car battery may have a capacity of 40 AH at the 10 hour rate, we state that it can be deliver a current of 4 A for 10 hours. 6. If emitted by a strong source of light the rays will cast bright light. 7. I saw my neighbour examining his car. 8. I saw the car being examined by my neighbour. 9. Having been calculated the data is used in the experiment.

III. Pay attention to the Participial Absolute Construction in the following sentences and translate them.

1. Electrical energy being released, a force called electromotive force is developed. 2. An e. m. f. is present, whenever free electrons are moved from atoms, any of the above-named methods being used to produce such electron motion. 3. This charge being always negative, the e. m. f. is indirectional. 4. This field can be detected by the electroscope, the strength being measured by an electrometer. 5. If this is not provided for, electrons will accumulate at the end of the wire, their repulsion back along the wire stopping the current flow. 6. There two general methods by which a continuous supply of electrical charge is obtained; one being by means of a battery, and the other being by means of an electric generator.

Chapter II. ELECTRONIC DEVICES AND ELECTRONIC TECHNIQUE

Lesson 1. THERMIONIC VALVES

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Listen and repeat after the speaker. b) Practise the pronunciation of the following.

[i:] reach, field, meaning, increase, decrease, receive, heat, leader, lead, screen; [ai] might, sign, high, slightly; [ɔ:] bought, daughter; [ə:] term, third, circuit, certain, first.

II. a) Make sure that you know these words. Say what Russian words help you to guess their meanings. b) Repeat these words after the speaker.

Diode, electrode, cylindrical, positive, cathode, negative, electron, emission, voltage, thermionic, active, element, electronics, signal, diagram, symbol, proportion, anode, volt.

III. a) Listen, repeat and memorize the following words and word-combinations. b) Check if you know their meanings.

Thermionic diode вакуумный диод; thermionic valve электронная лампа; handle v. управлять; definite определенный; incandescent filament раскаленная нить накала (катод); velocity скорость; assisting field ускоряющее поле; negative space charge отрицательный пространственный заряд; repellent effect отталкивающий эффект; inhibiting effect сдерживающий, тормозящий эффект (влияние); for most small-scale amplification при усилении самого малого сигнала; high-power high-frequency signals мощные сигналы высокой частоты; it is usually held positive он обычно поддерживается положительным; with respect to the filament по отношению к нити накала (катоду); a small forward current flows протекает небольшой прямой ток.

IV. Analyse the constituents the following words consist of.

Cylindrical, emission, thermionic, electronics, amplifications, similarly, assisting.

Text A

THE TWO-ELECTRODE VALVE

I. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

The thermionic diode is a two-electrode valve. It consists of a plate and filament. The filament is surrounded by a cylindrical plate, normally termed the anode. It is usually held positive with respect to the filament (cathode). If the anode is negative with respect to the cathode no current flows. As the anode is made positive, the current increases. The increase of the current stops when the full electron emission of the cathode is reached. When there is zero voltage at the anode a small forward current flows.

2. Average Reading

Text B

THE THERMIONIC DIODE

I. a) Listen to the text. b) Read it (time limit is 3 min.). c) Find the part of it dealing with the current-voltage characteristic of a thermionic diode.

The thermionic valve was the first active element in electronics. Although obsolete for most small-scale amplification, the valve still finds a place where high voltages must be handled or high-power high-frequency signals are involved (e. g. in radio transmitters). Fig. 2.1*a* shows a diagram of the diode (two-electrode valve). The incandescent filament is surrounded by a cylindrical plate, normally termed the anode because it is usually held positive with respect to the filament. Similarly, the filament is usually called the cathode. The circuit symbol for the diode is shown in Fig. 2.1*b*.

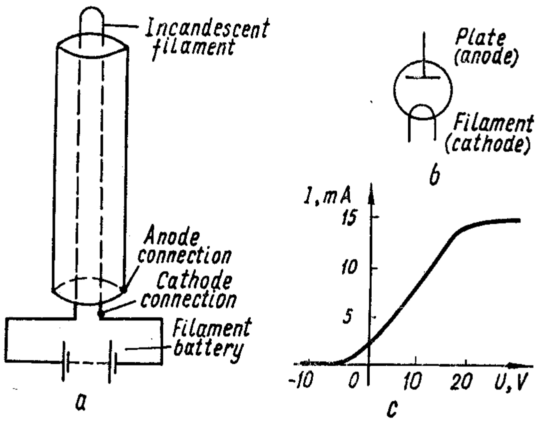


Fig. 2.1. The thermionic diode:
a the diagram; *b* the circuit symbol; *c* the typical current-voltage characteristic.

The current-voltage characteristic of a thermionic diode is shown in Fig. 2.1*c*. In the thermionic diode a small forward current flows when there is zero voltage across the device. This is because the electrons are emitted from the filament with a definite velocity. A small proportion of these electrons reaches the anode even when there is no assisting field.

As the anode is made slightly positive, more electrons are drawn towards it. If the anode is made negative with respect to the filament, the emitted electrons are repelled back to the cathode, and no current flows at all when the anode is several volt negative.

ASSIGNMENTS

I. a) Skim through the Text A and find the part of it dealing with the stop of the increasing of the current. b) Be ready to discuss the information about it.

II. Discuss the information about the two-electrode valve.

III. a) Find the part in the Text B containing information about the incandescent filament. b) Discuss it.

IV. Answer the questions embracing the contents of the Text A and the Text B.

1. What is the simplest thermionic valve? 2. What is a diode? 3. Why are electrons drawn toward anode? 4. What does the thermionic diode consist of? 5. What is the filament surrounded by? 6. How is it usually held with respect to the filament (cathode)? 7. When doesn't any current flow at all? 8. When does the current increase? 9. When does the increase of the current stop? 10. When does a small forward current flow? 11. Was the thermionic valve the first active element in electronics? 12. Why are the emitted electrons repelled back to the cathode?

V. a) Examine Figs. 2.1 *a*, *b*, *c* and describe them. b) Answer the questions.

1. What does Fig. 2.1*a* show? 2. What is the incandescent filament surrounded by? 3. Why is a cylindrical plate termed the anode? 4. How is the filament usually called? 5. What is shown in Fig. 2.1*b*? 6. Are the filament and plate clearly represented in Fig. 2.1*b*? 7. What is shown in Fig. 2.1*c*? 8. What current flows in the thermionic diode when there is zero voltage across the device? 9. Why does it happen?

VI. Make up a dialogue on one of the following situations.

1. A student wants to know about extensive usage of thermionic valves. A qualified specialist answers his questions on the topic.

2. Two students discuss the figures showing the diode.

VII. Speak on:

1. The usage of thermionic valves in electronic equipment.
2. The structure of the thermionic diode.

VIII. Translate the question-answer units into English. Work in pairs.

1. Что представляет собой диод? (Диод — это откачанная стеклянная колба с двумя электродами: катодом и анодом.)

2. Какая электронная лампа самая простая? (Самая простая электронная лампа — это диод.)

3. Когда электроны устремляются к аноду? (Электроны устремляются к аноду тогда, когда анод положительный.)

4. Когда эмиттированные электроны отталкиваются обратно к катоду? (Если анод отрицательный по отношению к катоду, то эмиттированные электроны отталкиваются обратно к катоду.)

5. Когда ток совсем не проходит? (Ток совсем не проходит в том случае, если анод имеет отрицательное напряжение в несколько вольт.)

X. Make a short summary of the Text B.

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these words.

Add добавлять; piece кусочек; ratio отношение; contain v. содержать; look like быть похожим; permit v. разрешать; allow v. позволять; thus таким образом; window screen оконная сетка.

II. Memorize these words and word-combinations used in their specialized meanings.

Control управлять; amplifier усилитель; ratio отношение; radio-receiver радиоприемник; frequency частота; capacity емкость; attract притягивать; rectifier выпрямитель; grid сетка.

III. Find these word-combinations and terms in the Text C and translate the sentences containing them.

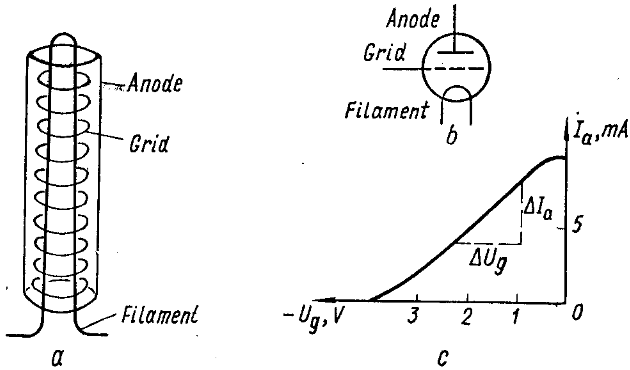


Fig. 2.2. The triode valve:
a a diagram; *b* the circuit symbol; *c* the typical transfer characteristics.

Amplification ratio коэффициент усиления; hi-fi [haifai] (high fidelity) высокая точность воспроизведения; triode valve триодная электронная лампа; audio frequency звуковая частота.

IV. a) Form new words with the following suffixes and define their functions. b) Translate them into Russian.

-al: addition, electric, magnetic; -ly: negative, positive, resistive; -er: rectify, amplify, receive; -ing: permit, act, allow; -tion: direct, add, amplify, rectify.

V. a) Put questions to the words and word-combinations in bold type. b) Translate the sentences.

1. A triode has **three parts.** 2. The additional part is called **a grid.** 3. The grid is used **to control** the electron flow **from cathode to plate.** 4. **The current** through the plate is **a function of the grid voltage.** 5. **In radioreceiver**, the signal that reaches the grid from an antenna is **high frequency a. c.**

VI. a) Find the verbs in the Passive Voice in the Text C. b) Translate sentences with them.

Text C

THE TRIODE

I. a) Read the text. b) Speak on the structure and function of a triode.

In 1907 a young American engineer, Lee De Forest, added a third part to the diode. Because it now has three parts, it is called a triode. This three-electrode device, or triode is shown in Fig. 2.2*a* and its circuit symbol in Fig. 2.2*b*.

The additional part is called a grid, since it looks like a piece of window screen. The grid is used to control the electron flow from cathode to plate. A negatively charged grid will repel some or all of the electrons emitted from the cathode. A positively charged grid will attract more electrons from the cathode. The current through the plate is a function of the grid voltage. Not only does the grid play the role of a rectifier by permitting current flow only in one direction, but it also acts as an amplifier, allowing large currents to flow when the grid is positive and smaller currents when the grid is negative.

The amplification ratio for a triode tube is the ratio of the change in plate voltage per unit change in grid voltage. Thus amplification $= \frac{\text{change in plate voltage}}{\text{change in grid voltage}} = \frac{U_p}{U_g}$.

In the amplifier of a hi-fi, radio, or TV, the amplification is provided by a triode. In a radioreceiver, the signal that reaches the grid from an antenna is high frequency (radio frequency) a. c. The rectification or detection of the radio signal is accomplished by means of a triode. The triode changes high frequency a. c. to radiofrequency if the grid circuit contains the correct capacitance and resistance.

ASSIGNMENTS

I. Read the Text C attentively and answer the following questions.

1. Who added a third part to the diode? 2. How many parts are there in a triode? 3. How is the additional part called? 4. What is the grid used to? 5. What attracts more electrons from the cathode? 6. What is the function of the grid voltage? 7. What is the amplification ratio for a triode?

II. a) Read the text again and ask additional questions embracing its contents. b) Combine your answers into a short summary of the text.

III. a) Find the part in the Text C containing information about grid. b) Discuss it.

IV. a) Read the text closely and pick out the key sentences. b) Thanslate them.

V. Pick out all technical terms from the Text C and translate them.

VI. Speak on the triode according to the denotative plan:

1. **Invention:** 1907; young American engineer Lee De Forest; add, third part to the triode; because; call; triode.

2. **Structure:** additional part; grid; look like; piece; window screen.

3. **Function:** control; the electron flow; cathode; plate; a negatively charged grid; repel; emit; positively charged grid; attract; current; through the plate; grid voltage; play the role; a rectifier; by permitting current flow; one direction; act; as an rectifier; allowing; smaller current, grid.

4. **The amplification ratio:** a triode tube, change, plate voltage, per unit charge, grid voltage.

5. **The provision of the amplification:** hi-fi; radio; TV; radioreceiver; signal; achieve; antenna; high frequency a. c.; audio frequency; contain; correct capacitance and resistance.

VII. Review the text in written form.

VIII. Translate the text to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

wire mesh	относительно
cut-off point	крутизна
transconductance	проволочная сетка
low tension	появляться
relative to	передача
appear	подсказывать
"hum" component	введение
eventually	в конечном счете
transfer	колебаться
fluctuate	точка отсечки
suggest	низкое напряжение
injection	фоновая составляющая

II. Pick out all technical terms from the Text D and translate the sentences with them.

III. Translate the following word-combinations from the Text D.

Held negative; with respect to; under which conditions; the emitted electrons; a certain fraction; through the space; the more negative ..., the more powerful ...; none of the emitted electrons; valve transfer characteristics; fluctuation in electrone current; relative to.

Text D

THE TRIODE CHARACTERISTICS

I. Read the text and say what it is about.

The grid in a triode normally held negative with respect to the filament, under which condition it repels some of the emitted electrons back to the filament, allowing only a certain fraction to reach the anode through the space in the wire mesh. The more negative the grid is made, the more powerful its repellent field becomes and the lower the anode current falls. Eventually, the cut-off point is reached when none of the emitted electrons reaches the anode and the current falls to zero. A typical triode valve transfer characteristics is shown in Fig. 2.2*c*. The transfer property of a valve is specified by its transconductance, g_m, where $g_m = \frac{\text{change in anode current}}{\text{change in grid voltage}} = \frac{\Delta I_a}{\Delta V_g}$ (usual units mA/V).

Early valve equipment used d. c., both for the high tension HT (anode supply) and for the filament supply (low tension or LT). It is very convenient, however, if the cathode can be heated by a. c. since this is readily available directly from a mains transformer. There are two problems associated with a. c. heated filaments. Firstly, the temperature of the filament may fluctuate in sympathy with the a. c. frequency, giving rise to a 100 Hz fluctuation in electron current with 50 Hz a. c. Secondly, because the input grid voltage is applied relative to the cathode, a proportion of the a. c. filament voltage will appear in the input signal, producing a 50 Hz "hum" component.

These two problems are overcome in the indirectly heated cathode which is used in almost all small valves. As the name suggests, the cathode is electrically insulated from the heating filament, avoiding the direct injection of a. c. into the input circuit.

ASSIGNMENTS

I. Answer the following questions embracing the contents of the Text D.

1. How can a thermionic amplifying device be produced? 2. Who added the third part to the triode? 3. How is a three-electrode device called? 4. What is the potential of the grid? 5. How is the transfer property of a triode valve specified? 6. By what can the cathode be heated? 7. What problems are associated with a. c. heated filaments?

II. Examine Fig. 2.1, 2.2 and describe them.

III. Discuss the problems of a triode.

IV. Prepare a dialogue on one of the following situations:

1. The lecturer in electronics is asking his students about the simplest amplifying devices.

2. Two specialists in electronics are discussing the problem of using d. c. and a. c. in valve equipment.

V. Speak on:

1. The structure of a triode.

2. Valve equipment using d. c. and a. c.

VI. Look through the latest magazines, find information on a triode and annotate it.

III. GRAMMAR EXERCISES

I. a) Give the main forms of the verbs from the Text C and the Text D. b) Translate the sentences with them.

Add, have, call, show, use, flow, emit, attract, play, act, be, provide, accomplish, reach, change, repel, can, heat, may, apply, appear, overcome.

II. Transform the sentences according to the model.

Model. The first grid **is called** a control grid.
Первая сетка *называется* управляющей сеткой.
The first grid **was called** a control grid.
Первая сетка *называлась* управляющей сеткой.
The first grid **will be called** a control grid.
Первая сетка *будет называться* управляющей сеткой.

1. The filament is surrounded by a cylindrical plate. 2. As the anode is made positive, the current increases. 3. A valve with a grid

between the filament and anode is called a triode. 4. The second grid is termed a screen grid. 5. The screen grid is placed between the anode and control grid. 6. The tetrode is used for amplification at low frequences.

III. Determine the function of Participle II in the following sentences and translate them.

1. The filament is surrounded by a cylindrical plate, normally termed the anode. 2. The third grid is introduced between the anode and the screen grid. 3. The pentode is widely used for amplification at high and low frequencies. 4. The grid placed between the anode and control grid is called the screen grid.

IV. Put questions to the words in bold type.

1. **The thermionic diode** is a two-electrode valve. 2. It **consists** of a plate and filament. 3. **The tetrode** consists of the **anode, cathode** and two **grids**. 4. **The pentode** comprises the anode, cathode and three grids. 5. The pentode is widely used **for amplification at high and low frequencies.**

V. Translate the following sentences and pay attention to the word-combinations in bold type.

1. The filament is usually held positive **with respect to** the filament. 2. **As the anode is made positive,** the current increases. 3. **Although obsolete for most small-scale amplification,** the valve **still** finds a place where high voltages must be handled. 4. **Similarly,** the filament is usually called the cathode. 5. The additional part is called a grid, **since it looks like** a piece of window screen. 6. The rectification or detection of the radio signal is accomplished **by means of** a triode.

VI. a) Find all verbs in the Text D and define their tense-forms. b) Translate the sentences into Russian.

Lesson 2. THE TETRODE AND PENTODE

I. Independent Work.
   In the Laboratory:
   1. *Skimming Reading.*
      Pre-text Exercises.
      Text A. The Tetrode Valve.
   2. *Average Reading.*
      Text B. The Secondary Emission.
      Assignments.
II. Classwork.
   3. *Close Reading.*
      Pre-text Exercises.
      Text C. The Pentode Valve.
      Assignments.
   4. *Searching Reading.*
      Pre-text Exercises.
      Text D. The Voltage Amplifier.
      Assignments.
III. Grammar Exercises.

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Listen and repeat after the speaker. b) Practise the pronunciation of the following.

I. [u:] soon, good; [aɪ] desired, amplifier, triode, strike; [i:] deal; screen, beam, need, been, mean, peak; [ɔ:] nor, normally; [au] allow, out, output.

II. Spurious ['spjuərɪəs], yet [jet], through [θru:], bias ['baɪəs], automatic [,ɔ:tə'mætɪk], inherently [ɪn'hɪər(e)ntlɪ], piezoelectric [paɪ,i:ʒo(u)ɪ'lektrɪk].

II. a) Make sure that you know these words. Say what Russian words help you to guess their meanings. b) Repeat them after the speaker.

Tetrode, triode, radio, kiloherz, signal, problem, electrostatic potential, anode, symbol, characteristic, emission, positive, electron, form, concentrated, pentode, alternative, piezoelectric.

III. Check if you know the meaning of these words and word-combinations.

Introduce вводить; similar to подобно чему-л.; to maintain поддерживать; tend стремиться; cause вызывать, быть причиной; extensively широко; performance характеристика; capacitance емкость; screen grid экранирующая сетка; undesirable «kink» нежелательный «изгиб» (излом); snag препятствие; leave a good deal to be desired оставляет желать лучшего; the gain fell rapidly коэффициент усиления резко уменьшался; generating spurious signal themselves автоматически образуя ложные сигналы; the main cause of the high-frequency shortcomings основная причина недостатков на высоких частотах; be connected to earth via a capacitor быть связанным с землей через конденсатор; as far as the a. c. signal is concerned что касается сигнала переменного тока; tend to dislodge стремиться выбить; thus robbing таким образом лишая.

IV. Convert the statements into questions according to the model.

Model. The screen grid is introduced to serve as an electrostatic screen between anode and grid.
What grid is introduced to serve as an electrostatic screen between anode and grid?
Is the screen grid introduced to serve as an electrostatic screen between anode and grid?
Why is the screen grid introduced?

1. The main cause of the high-frequency shortcomings of the triode is the capacitance between anode and grid. 2. A second grid or screen grid serves as an electrostatic potential. 3. Fig. 2.3 *a* shows the tetrode valve. 4. This is the four electrode valve. 5. An alternative solution to secondary emission is the introduction of a suppressor grid between screen grid and anode.

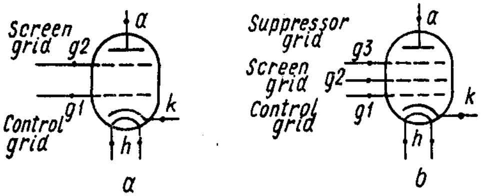


Fig. 2.3. Multigrid valves:
a tetrode; *b* pentode.

V. Give English equivalents to the following.

Широко использовать; желать много лучшего; для того, чтобы поддерживать; что касается сигнала переменного тока; таким образом; соединять обычно; за исключением; первоначально.

VI. Give initial forms of the following words.

Extensively, amplification, performance, rapidly, generating, electrostatic, robbing, overcoming, travelling, alternative.

Text A

THE TETRODE VALVE

I. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

When the triode became extensively used for amplification in radio work in the 1920s, it was soon realized that its performance at high frequencies, above a few tens kilohertz, left a good deal to be desired. At these frequencies the gain fell rapidly and some amplifiers would oscillate, generating spurious signals themselves. The main cause of the high-frequency shortcomings of the triode is the capacitance between anode and grid. To overcome this problem, a second grid or screen grid serves as an electrostatic potential similar to that of the anode in order to maintain the electron flow, but is connected to earth via a capacitor so that, as far as the a.c. signal is concerned, it is an earthed screen. Thus we have the tetrode valve, its circuit symbol being shown in Fig. 2.3*a*.

2. Average Reading

Text B

THE SECONDARY EMISSION

I. a) Listen to the text. b) Read it (time limit is 2 min.). c) Find the part of it dealing with the function of the tetrode.

Fig. 2.3*a* shows the tetrode valve. This is the four electrode valve. The second grid or screen grid is introduced to serve as an electrostatic screen between anode and grid. It is held at a positive d.c. potential similar to that of the anode in order to maintain the electron flow. When electrons strike a valve anode, they tend to dislodge other electrons and cause what is known as secondary emission.

One disadvantage of the tetrode is that these electrons can be drawn to the screen grid, thus robbing the anode of current and giving rise to an undesirable "kink" in the anode characteristic. One way of overcoming this snag is to form the electrons travelling towards the anode into a concentrated beam, using special beam-forming plates.

ASSIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about.

II. a) Skim through the Text B and find the part of it dealing with the disadvantage of the tetrode. b) Discuss the information with your fellow-students.

III. Answer the following questions embracing the contents of the Text A and the Text B.

1. When did the triode become extensively used for amplification in radio work? 2. Does the gain fell rapidly at the frequency above a few tens kilohertz? 3. What is the main cause of the high-frequency shortcomings of the triode? 4. What is introduced in the triode to overcome the main cause of the high-frequency shortcomings of the triode? 5. What is the function of the second or screen grid? 6. What advantages and disadvantages of the tetrode do you know? 7. What does Fig.2.3a show? 8. What is the tetrode? 9. Why is the second grid or screen grid introduced? 10. What potential is it held at? 11. What is known as secondary emission?

IV. Discuss the information obtained from the Text A and the Text B.

V. Be ready to discuss the information on the topic received at your lectures on speciality.

VI. Prepare a dialogue on one of the following situations:

1. Two specialists in electronics have a talk about the history of the development of thermionic valves.

2. The students are discussing the advantages and shortcomings of the tetrode and the pentode.

VII. Speak on:

1. How to overcome the main cause of the high-frequency shortcomings of the triode.

2. The structure and function of the tetrode and pentode.

VIII. Translate the question-answer units into English. Work in pairs.

1. В чем основная причина несовершенства триода на высоких частотах? (Основной причиной несовершенства триода на высоких частотах является емкость между анодом и сеткой.)

2. Что вводится в триод для того, чтобы устранить слабое место триода на высоких частотах? (Для преодоления этого недостатка между управляющей сеткой и анодом вводится вторая сетка.)

3. Какова функция второй или экранирующей сетки? (Вторая или экранирующая сетка служит электрическим экраном между анодом и сеткой.)

4. В чем слабое место тетрода? (Одним из слабых мест тетрода является то обстоятельство, что вторичные электроны могут проходить к экранирующей сетке, таким образом уменьшая поступление

на анод тока и приводя к нежелательному излому в анодной характеристике.)

5. Что называется пентодом? (Пентод — это пятиэлектродная электронная лампа.)

6. Как называется дополнительная сетка в пентоде? (Она называется защитной сеткой.)

7. К чему присоединяется защитная сетка? (Защитная сетка обычно присоединяется или к катоду, или к «земле».)

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these words.

Introduction введение; connect v. соединять; normally обычно; earth земля; repel v. отталкивать; allow позволять, разрешать; pass проходить; initially первоначально; fulfill выполнять; need нужда; exception исключение; slightly слегка; extensively широко.

II. Memorize the words and word-combinations used in their specialized meanings.

Solution раствор; suppressor grid защитная сетка; screen grid экранирующая сетка; stream n. поток; amplification усиление; noise шум; low frequency низкая частота.

III. Find these word-combinations and terms in the Text C and translate the sentences containing them.

Whilst allowing the more energetic electron stream to pass тем самым давая возможность потоку электронов с большей энергией проходить; with the exception of a slightly higher noise level за исключением немного более высокого уровня шума; the pentode has therefore been extensively used for пентод, следовательно, широко используется для.

Text C

THE PENTODE VALVE

I. a) Read the text. b) Find the part of it describing the suppressor grid. Translate it.

An alternative solution to secondary emission is the introduction of yet another grid — a suppressor grid between screen grid and anode. The supressor grid is normally connected either to the cathode or to earth so that it repels secondary electrons whilst allowing the more energetic electron stream to pass through from screen grid to anode. This five-electrode valve is the pentode; its circuit symbol is shown in Fig. 2.3*b*. Although the pentode was initially developed to fulfill the needs of high-frequency amplification, it turns out to have generally more useful characteristics than the triode, with the exception of a slightly higher noise level. The pentode has therefore been extensively used for amplification at high and low frequencies.

ASSIGNMENTS

I. Read the Text C attentively and answer the following questions embracing its contents.

1. What is an alternative solution to secondary emission? 2. What is the suppressor grid connected to? 3. What is a five-electrode valve called? 4. Where is the circuit symbol of a pentode shown? 5. Does the pentode have generally more useful characteristics than the triode? 6. Where has the pentode been extensively used? 7. At what frequency is the pentode extensively used?

II. a) Divide the Text C into logical parts. b) Choose the key sentences and translate them.

III. Comment on the author's attitude to the pentode valve.

IV. Combine your answers into a short summary of the text.

V. Comment on the description of Fig. 2.3*b*.

VI. Compare standard symbols for tetrode and pentode, used in the USSR with those used in the USA.

VII. Speak on the text according to the denotative plan:

1. **The place of a suppressor grid in a valve:** an alternative solution; secondary emission; introduction; yet; another grid; suppressor grid; screen grid; anode; normally; connect; either ... or; cathode; earth; repel; secondary electron; allow; stream; pass through.

2. **Pentode, its function:** initially; develop; fulfill; need; high-frequency amplification; turn out; useful characteristics; with the exception of; slightly higher noise level.

3. **The usage of pentode:** extensively; use; amplification; high; low; frequency.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

voltage amplifier circuit	соответствующий
output voltage signal	смещение
load resistor	резистор нагрузки
biasing	обратная связь
circuit feature	особенность цепи
suitable	порядка
negligible	шунтирующий конденсатор
before serious distortion occurs	незначительный
approximately	приблизительно
short-circuiting a. c. signals to earth	до того, как произойдет заметное искажение
inherently high input impedance	закорачивание переменных сигналов на «землю»
feedback	сигнал напряжения
of the order of	цепь усиления напряжения
bypass capacitor	присущее высокое входное полное сопротивление

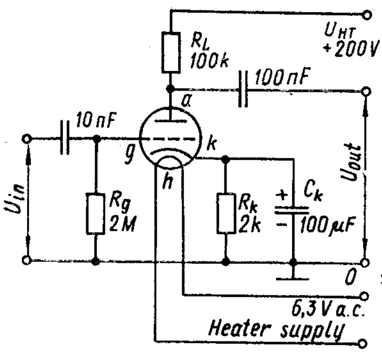


Fig. 2.4. The triode voltage amplifier.

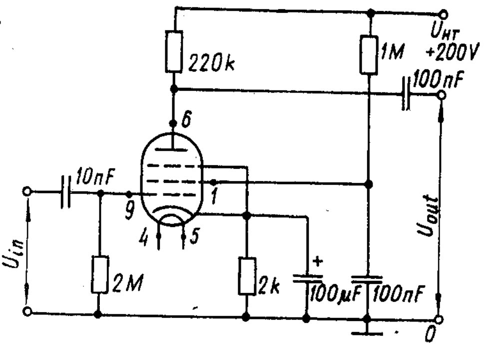


Fig. 2.5. The pentode voltage amplifier.

II. Give the main forms of the following verbs and translate them.
Show, give, find, use, develop, serve, know, prevent, appear, reduce, draw, have, supply, mean, handle, occur, can, produce.

III. a) Give initial forms of the following words and translate them. b) State the function of suffixes.
Amplifier, voltage, resistor, biasing, automatic, appear, opposing, independance, amplifying, bottoming, distortion, representative, equipment, connection, circuiting.

Text D

VOLTAGE AMPLIFIER

I. a) Read the text and say what it is about. b) Review the text.
The triode may be used in a voltage amplifier circuit. Fig. 2.4 shows such a circuit. The output voltage signal is developed across a load resistor R_L. The cathode resistor, R_k, serves a function for biasing. This circuit feature is known as automatic cathode bias. The 100 µF bypass capacitor prevents a. c. signals appearing across the cathode resistor; these would reduce gain by opposing the input signal (negative feedback).

The valve is a voltage-operated device which draws negligible input current. It therefore has an inherently high input impedance and is suitable for amplifying the output of piezoelectric and capacitor microphone. The need for a 200 V HT supply is a disadvantage, but it does mean that large amplitude signals can be handled before cut-off or bottoming occurs. A circuit such as Fig. 2.4 can produce output signals of the order of 100 V peak-to-peak before serious distortion occurs. A typical value for the voltage gain is 30.

A pentode voltage amplifier circuit is shown in Fig. 2.5. This circuit gives a voltage gain of approximately 300 and is representative of many circuits that are still to be found in valve equipment. Notice the connection between suppressor grid (g_3) and cathode, the screen grid (g_2) and HT supply via a 1 M resistor, and the 100 nF screen grid bypass (decoupling) capacitor short circuiting a. c. signals to earth.

ASSIGNMENTS

I. Answer the following questions embracing the contents of the Text C.

1. Where may the triode be used? 2. How is the output voltage signal developed? 3. What function does the cathode resistor, R_k, serve? 4. Is this circuit feature known as automatic cathode bias? 5. What draws negligible input current? 6. What input impedance has a voltage-operated device? 7. What can a circuit such as Fig. 2.4 produce? 8. What is a typical value for the voltage gain in triode amplifier? 9. What is shown in Fig. 2.5?

II. Prepare a dialogue on one of the following situations:

1. One of the engineers is explaining to the students the circuit feature known as automatic cathode bias.

2. Two students put questions to each other, using Fig. 2.4 and Fig. 2.5.

III. Speak on:

1. A voltage amplifier circuit.
2. The cathode resistor R_k as a function for biasing.
3. A voltage operating device.

IV. a) Examine Figs. 2.4, 2.5 and describe them. b) Discuss them with your fellow-students.

V. Make up a plan of the text.

VI. Give some additional informations about voltage amplifier.

VII. Look through the latest magazines and find additional information on the topic of the lesson. Discuss it.

III. GRAMMAR EXERCISES

I. a) Check if you know the function of the following suffixes and prefixes. b) Translate the words into Russian.

-tion: solution, introduction, amplification, exception, function, distortion, connection; **-ive:** alternative, representative; **-or, -er:** suppressor, amplifier, resistor, capacitor; **-ly:** normally, initially, generally, slightly, expressively; **-ing;** allowing, biasing, appearing, opposing, amplifying, using; **-ic:** energetic, characteristic, automatic, piezoelectric; **dis-:** disadvantage, disagreement, disappear, discharge; **un-** unknown, undesirable, unfortunately, unless.

II. a) Change the following sentences according to the model. Define the tense-forms of the verbs. b) Translate these sentences.

Model. The triode **is used** in a voltage amplifier circuit.
The triode **may be used** in a voltage amplifier circuit.

1. The output voltage signal is developed across a load resistor R_L. 2. This circuit feature is known as automatic cathode bias. 3. A large amplitude signals were handled before cut-off or bottoming

occurs. 4. A pentode voltage amplifier circuit is shown in Fig. 2.5. 5. Many circuits will be found in valve equipment. 6. The suppressor grid is normally connected either to the cathode or to earth. 7. The pentode was initially developed to fulfill the needs of high-frequency amplification.

III. a) Find Participle II in the Text C and in the Text D and state its function. b) Translate the sentences into Russian.

IV. Put questions to the words and word-combinations in bold type.

1. A **suppressor grid** is introduced between **screen grid and anode.** 2. The **suppressor grid** is normally connected either to the cathode or to earth. 3. The suppressor grid repels **secondary electrons.** 4. The suppressor grid allows the more energetic electron stream **to pass through from screen grid to anode.** 5. The pentode **turns out** to have generally more **useful** characteristics than the triode.

V. a) Translate the following sentences. b) Pay attention to the words and grammar-forms in bold type. Explain them.

1. Thus we have the tetrode valve, **its circuit symbol being shown in Fig. 2.3*a*.** 2. **To overcome** this problem, a second grid is introduced between the control grid and anode. 3. The second (screen) grid is held at a positive d. c. potential similar to that of the anode in order **to maintain** the electron flow, but is connected to earth via a capacitor so that, **as far as the a. c. signal is concerned,** it is an earthed screen.

VI. a) Find the sentences in the Text C and in the Text D containing the following verbs. Define their tense-forms. b) Translate the sentences into Russian.

Introduce, connect, repel, show, develop, turn out, use, serve, know, prevent, reduce, draw, handle, produce.

VII. a) Find attributes in the following word-combinations. Say by what parts of speech they are expressed. b) Translate them into Russian.

High frequency; a few tens kilohertz; generating spurious signals; the main cause; the high-frequency shortcomings of the triode; an electrostatic potential; an earthed screen; the tetrode valve; the circuit symbol; the four electrode valve; a positive d. c. potential; a concentrated beam; special beam-forming plate.

VIII. a) Write out all the verb-forms in the Passive Voice from the Text B and the Text C. b) Translate them.

IX. Complete the sentences and identify the verb-forms.

1. Fig. 2.3*a* shows ... 2. The second grid is, introduced ... 3. When electrons strike a valve anode, they ... 4. One disadvantage of the tetrode is that these electrons can be drawn... 5. One way of overcoming this snag is to perform ...

Lesson 3. THE P-N JUNCTION

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Listen and repeat after the speaker. b) Practise the pronunciation of the following.

I. [ʃn] Operation, depletion, migration, junction; [əː] occuring, external, reverse; [ʌ] junction, understand, result, underneath; [ɪə] near, clear.

II. Classify [faɪ], valence ['veiləns], transistor ['trænsɪstə], col'lector, com'pact, 'semicon'ductor, minimum ['mɪnɪmum], distribution ['dɪstrɪbjuʃn], classical [æ].

II. a) Listen and repeat after the speaker. b) State the function of the suffixes in the following words and translate them.

Operation, semiconductor, transistor, occurring, junction, placing, positive, negative, migration, relatively, typically, depletion, external, condition, breaking, temperature.

III. a) Listen, repeat and memorize the following word-combinations. b) Check if you know their meanings.

P-n junction p-n переход; semiconductor device полупроводниковый прибор; depletion layer обеднённый слой; external d. c. supply внешний источник питания постоянного тока; minority carriers неосновные носители; appropriate polarity соответствующая полярность; the same continuous crystal lattice такая же сплошная кристаллическая решетка; to fill some holes заполнить некоторые дырки;

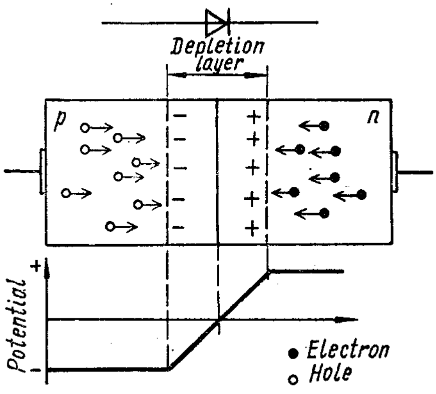


Fig. 2.6. The p-n junction with metallic contacts, its circuit symbol and variation of potential.

to leave behind a net positive charge оставлять (создавать) за собой общий положительный заряд; which opposes further migration которые противодействуют дальнейшему перемещению; a state of equilibrium is reached достигается состояние равновесия; relative clear of holes относительно свободный от дырок; due to thermal breaking of bonds in both p- and n-type materials обусловленный тепловым нарушением связей как в p-, так и в n-типах материала полупроводника.

IV. a) Find the verbs in the Text A and B and define their tense-forms. b) Translate the sentences with these verbs.

Text A

THE P-N JUNCTION DIODE

I. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

The operation of a semiconductor device such as the transistor depends on the effect occuring at the junction between p- and n-type materials. It is essential at this stage to understand that a semiconductor junction is a change from p- to n-type material within the same continuous crystal lattice. Simply placing a piece of p-type material in contact with a piece of n- type material will not normally result in a p-n junction.

Fig. 2.6 shows a p-n junction diode with a metallic contact on each side. Underneath the junction diagram is a simple graph showing how the potential varies through the junction.

2. Average Reading

Text B

THE OPERATION OF A JUNCTION

I. a) Listen to the text. b) Find the part of it dealing with the increasing and decreasing of the potential barrier at the depletion layer. Discuss it.

As soon as the junction is formed, some of the free electrons near the junction in the n-type material cross over to fill some holes in

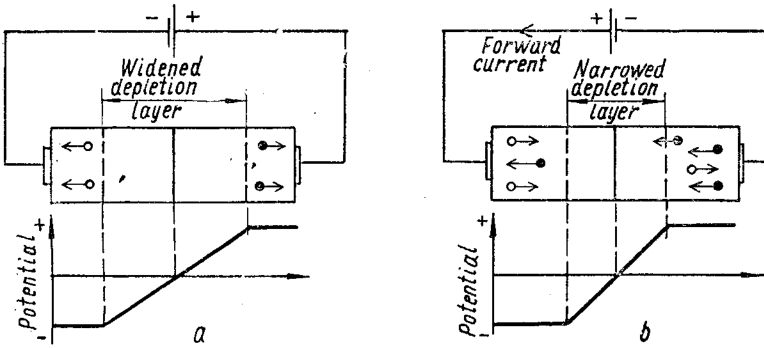


Fig. 2.7. The effect of the depletion layer of the p-n junction:
a reverse bias; *b* forward bias.

the p-type; in doing so, they leave behind a net positive charge, whilst at the same time giving the p-type material a negative charge. These charges form a potential barrier which opposes further migration of electrons across the junction so that a state of equilibrium is reached. In this state the region near the junction is relatively clear of holes and free electrons as a result of the initial migration. This is called a depletion layer and is typically less than one micron wide.

If an external d. c. supply is connected to a p-n junction, the potential barrier at the depletion layer is either increased or decreased depending on the polarity of the external supply or bias. Fig. 2.7 shows the two conditions of (a) reverse bias, where the potential barrier is reinforced and the depletion layer widened, and (b) forward bias, where the effect of the barrier is decreased and the depletion layer narrowed. Under reversed biased conditions the only current flowing across the junction is the tiny one due to thermal breaking of bonds in both p- and n-type materials. The minority carriers are of the appropriate polarity to be drawn across the junction. At room temperature this reverse current is, however, so small in a silicon junction (typically 1 nA) as to be negligible for most practical purposes. When the junction is forward-biased, however, the potential barrier is decreased in height, equilibrium is upset and some electrons in the n-region and holes in the p-region are able to cross the junction. The greater the forward-bias voltage, the lower the potential barrier becomes and the more electrons and holes cross the depletion layer. Hence a net current flow is established across the junction.

ASSIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about.

II. a) Skim through the Text B and find the part of it dealing with the minority carriers. b) Discuss the information with your fellow-students.

III. Find the part in the Text B containing information about the free electrons near the junction in the n-type material. b) Discuss it using the additional information from magazines and books on speciality.

IV. Answer the following questions embracing the contents of the Text A and the Text B.

1. What charges form a potential barrier which opposes further migration of electrons across the junction? 2. Is the region near the junction in this state relatively clear of holes and free electrons as a result of the initial migration? 3. What does the operation of a semiconductor device such as the transistor depend on? 4. What is a semiconductor junction? 5. What is called a depletion layer? 6. What is the current flowing across the junction under reversed-biased condition? 7. What is the magnitude of this reverse current at room temperature?

V. a) Examine Figs. 2.6 and 2.7. b) Answer the following questions.

1. What does Fig. 2.6 show? 2. What graph is underneath the junction diagram? 3. What does Fig. 2.7 show? 4. What is forward bias?

VI. Prepare a dialogue on one of the following situations:

1. A worker who worked with vacuum tubes in electronics wants to know about the function of a transistor. A specialist in the field is explaining to him the effect occurring at the junction between p- and n-type material.

2. Two students discuss what is shown in Fig. 2.6 and Fig. 2.7.

VII. Speak on:

1. The operation of a transistor;
2. Biased p-n junction.

VIII. Express your opinion of operation of a junction.

IX. Analyse the structure of the following word-combinations and memorize them.

A potential barrier потенциальный барьер; a state of equilibrium состояние равновесия; holes and free electrons дырки и свободные электроны; a depletion layer обеднённый слой; the polarity of the external supply or bias полярность внешнего источника или смещения; reverse bias обратное смещение; due to thermal breaking of bonds обусловленный тепловым нарушением связей; appropriate polarity соответствующая полярность.

X. Translate the question-answer units into English.

1. От чего зависит работа транзистора? (Работа транзистора зависит от явлений, происходящих в переходе между p- и n-типами материала.)

2. Что представляет собой полупроводниковый переход? (Полупроводниковый переход представляет собой изменение от p- до n-типа материала в одной и той же сплошной кристаллической решетке.)

3. Что называется обеднённым слоем? (Слой, в котором область около перехода относительно свободна от дырок и свободных электронов в результате первоначальной миграции, называется обеднённым слоем.)

4. Что представляет собой ток, проходящий через переход при условии его обратного смещения? (В случае обратного смещения

единственным током, проходящим через переход, является незначительный ток, обусловленный тепловым нарушением связей как в p-, так и в n-типах материала полупроводника.)

5. Какова величина этого обратного тока при комнатной температуре? (При комнатной температуре обратный ток так мал в кремниевом переходе, что им можно пренебречь для многих практических целей.)

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these words and word-combinations.

Explanation объяснение; depend on (upon) зависеть от чего-л.; distribution распределение; comprise включать, содержать; immediately немедленно; size размер; nearby близлежащий; separation отделение, разделение; bottom дно; низ; top вершина, верх; overlap перекрывать; sense смысл; refer относиться; behind за, позади; both ... and и ... и.

II. Memorize these words and word-combinations used in their specialized meanings.

Band зона, полоса; property свойство; solid твердое тело; jump переходить; hole дырка; carrier носитель; insulator изолятор; empty position свободное расположение.

III. Find these terms in the Text C and translate the sentences containing them.

Conduction band зона проводимости; valence band валентная зона; energy gap энергетическая щель; energy level энергетический уровень; band gap запрещенная зона.

IV. a) State the function of the suffixes in the following words. b) Translate them.

Explanation, distribution, highest, conduction, immediately, separation, insulator, reaching, classical, position, leaving.

Text C

ENERGETIC BANDS IN SOLIDS

I. a) Read the text. b) Find the part of it describing band's forms, insulators, semiconductors and holes.

The modern explanation of the different electrical properties of solids depends upon the distribution of the electrons in a solid into energy levels, called bands. The highest energy levels in a solid comprise the conduction band. The energy levels immediately below this band comprise the valence band. The properties of a material depend on the size of the energy separation between the bottom of the conduction band and the top of the valence band, called the band or energy gap. Materials that have large band gaps are insulators. If the two bands overlap, there is no band gap and the material is a conductor. When the band gap is small, the material is classified as a semiconductor.

Because the band gap in semiconductors is small, it is possible for a small quantity of energy, supplied by light, heat or a low voltage, to cause electrons to jump from the valence band to the conduction band. Electrons reaching the conduction band become free electrons, in a classical sense of the phrase. The empty position left behind by the electron in the valence band is called a hole. A nearby valence electron can jump into this hole, leaving behind an other hole. Thus a series of holes flow toward the negative terminal while electrons flow in the opposite direction. The holes are referred to as positive charge carriers. Semiconductors, therefore, have both negative and positive charge carriers.

ASSIGNMENTS

I. Divide the text into logical parts. Choose the key sentences and translate them.

II. Look through the text and find the part of it dealing with the electrons reaching the conduction band.

III. Read the Text C attentively and answer the following questions.

1. What does the modern explanation of the different electrical properties of solids depend upon? 2. What are called bands? 3. What do the valence bands comprise? 4. What do the properties of a material depend on? 5. What materials are called insulators? 6. What is a conductor? 7. What is classified as a semiconductor? 8. Why is the flow of holes equivalent to a positive current opposite to the electron flow? 9. Why is it possible to cause electrons to jump from the valence band to the conduction band? 10. When do electrons become free electrons? 11. What is called a hole? 12. Where do a series of holes flow? 13. Are the holes referred to as positive charge carriers? 14. What carriers do semiconductors have?

IV. Find in the Text C English equivalents for the following Russian words and word-combinations.

Возможно для небольшого количества энергии; побудить электроны переходить; электроны, достигая зоны проводимости; близлежащие валентные электроны; серия дырок; относиться к положительным зарядам; как отрицательные, так и положительные носители зарядов.

V. Speak on the following problems:

1. Distinguish between conductors and insulators in terms of their conduction and valence bands.

2. Explain the difference between holes and electrons in a semiconductor.

VI. Make a short written summary of the Text C.

VII. Find the verbs in the Text C and state their tense-forms.

VIII. Translate the Text C to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

apply v.	благодаря
increase v.	производить
reduction	проявлять, представлять
owing to	применять
produce	прямое напряжение
forward voltage	увеличивать
exhibit v.	значительно
nearly	вкратце
significantly	уменьшение
in brief	почти
conversion	точка
point	превращение, переход

II. Find the following word-combinations in the Text D and translate the sentences containing them.

The forward e. m. f.; the effective resistance; owing to the reduction; the potential barrier; applied voltage; forward direction; forward voltage; the forward and reverse characteristics; a silicon junction; germanium junction; a potential drop; infinite resistance.

III. a) Give the initial forms of the following words from the Text D and translate them. b) State the function of suffixes.

Junction, effective, resistance, reduction, potential, direction, typically, freely, rectification, conversion.

IV. Find the following verbs in the Text D and state their tense-forms.

Increase, decrease, result, produce, show, begin, exhibit, allow, present, point.

Text D

VOLT-AMPERE CHARACTERISTICS OF A DIODE

I. Read the text and say what it is about.

It is important to note that, as the forward e. m. f. applied across the junction is increased, so the effective resistance at the junction is decreased owing to the reduction of the potential barrier. The result is that a very small increase in applied voltage in the forward direction results in a large increase in current. Typically, in a small silicon diode, a forward voltage of 0.6 V produces a current of 1 mA, and a forward voltage of 0.8 V produces a current of 100 mA. The forward and reverse characteristics of a typical small silicon diode are shown on a graph of current against applied e. m. f. in Fig. 2.8. It is clear

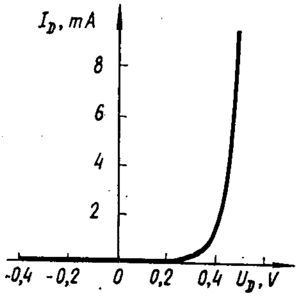


Fig. 2.8. Volt-ampere characteristics of a diode.

from the graph that a silicon junction does not begin to conduct significantly until a forward e. m. f. in the region of 0.5 V is present. Germanium junctions exhibit a smaller potential drop, in the region of 0.2 V.

In brief, a diode allows current to flow freely in one direction but presents a nearly infinite resistance the other way. This oneway characteristic points to an important use of diodes: rectification, the conversion of a. c. to d. c.

ASSIGNMENTS

I. Answer the following questions embracing the contents of the Text D.

1. What happens as the forward e. m. f. applied across the junction is increased? 2. What does a very small increase in applied voltage in the forward direction result in? 3. What is shown in Fig. 2.8? 4. What does germanium junction exhibit in the forward direction? 5. What does this one-way characteristic point?

II. Prepare a dialogue on your own situation.

III. Make up the plan of the Text D.

IV. Retell the text according to your plan.

V. a) Read the Text D closely. b) Discuss information about volt-amperes characteristics of a diode.

VI. Look through the latest magazines on the topic of the lesson and discuss it with your fellow-students.

VII. Make a short written summary of the topic.

III. GRAMMAR EXERCISES

I. Give the main forms of the following verbs and translate them.

Depend, comprise, become, leave, call, flow, refer, have, increase, decrease, result, produce, begin, exhibit, allow, present, point.

II. Compare the pairs of sentences, explain the use of tenses and translate them into Russian.

Indefinite Tenses	Continuous Tenses
1. We **build** new radio station every year.	1. They **are building** a new telecentre in our town.
2. That year the Moscow workers **built** a new TV tower.	2. They **were** still **building** the TV tower when you came to live in Moscow.
3. Next year they **will build** one more section of the TV studio.	3. What section of the studio **will** they **be building** next month?

Perfect Tenses	Perfect Continuous Tenses
1. The TV tower **has** recently **begun** to function.	1. Colour television in our country **has been functioning** since 1967.
2. The Moscow TV studio **had produced** a great number of colour TV films by 1970, when the Ostankino tower was built.	2. The Moscow TV studio **had been producing** colour TV films for three years before the Ostankino tower was built.
3. The new TV studio in our town **will have transmitted** its first program by the end of this year.	3. By 1977 our telecentre **will have been transmitting** programs for six years.

III. Pay attention to the compound pronouns in the following sentences and translate the sentences into Russian.

1. Whenever energy in any form is released, a force is developed. 2. Whenever an e. m. f. is developed, there is also a field of energy called an electrostatic field. 3. Anyone working in the field of electricity must be familiar with the principles of magnetism. 4. Everybody knows that the achievements of Soviet mathematics and physics have had a great effect upon the acceleration of scientific and engineering development. 5. Whenever an e. m. f. is present, free electrons are moved from atoms. 6. Whenever the two conducting bodies are separated by a dielectric they possess capacity and a combination is called a condenser. 7. Whenever an electric charge is at rest, it is spoken of as static electricity. 8. Whenever a current is induced, its magnetic field opposes the change of flux.

IV. Translate the following sentences paying attention to the grammar forms in bold types.

1. As soon as the junction **is formed** some of the free electrons near the junction in the n-type material cross over **to fill** some holes in the p-type; **in doing so,** they leave behind a net positive charge, whilst at the same time **giving** the p-type material a negative charge. 2. Under reverse-biased conditions, the only current **flowing** across the junction is the tiny one due to thermal **breaking** of bonds in both p-n-type material. 3. At room temperature this reverse current is, however, so small in a silicon junction as **to be negligible** for most practical purposes.

Lesson 4. THE BIPOLAR TRANSISTOR

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Listen and repeat after the speaker. b) Practise the pronunciation of the following.

[ɪ] in, since, consist, is, thin, which, trip; [ou] hole, most, whole, dope, no, close; [ɔ] also, offer, opposite, consist, cross, not; [aɪ] device, time, five, divide.

reverse [rɪ'və:s], barrier ['bærɪə], roughly ['rʌflɪ], typical ['tɪpɪkəl], junction ['dʒʌnkʃn], biasing ['baɪəsɪŋ], compensate, recombination.

II. a) Make sure that you know these words. Say what Russian words help you to guess their meanings. b) Repeat these words after the speaker.

Bipolar [baɪ'poulə], micron ['maɪkrən], 'concentrate [s], minority [maɪ'nɔrɪtɪ], combine [kəm'baɪn], base [beɪz], battery ['bætərɪ], compensate [,kɔmpən'seɪt], recombination ['rɪkəmbɪ'neɪʃn].

III. a) Listen, repeat and memorize the following words and word-combinations from the Text A and the Text B. b) Check if you know their meanings.

Sandwich of doped semiconductor material слоистая структура легированного полупроводникового материала (с примесями); common arrangement типовое устройство (слоев); common-emitter circuit схема (включения транзистора) с общим эмиттером; reverse-biased обратно смещенный; forward biased прямо смещенный; cross пересекать; «downhill run» «скатывание с горы вниз»; be rapidly swept быстро втягиваться, устремляться; gate ворота, вентиль, затвор; readily available широко использоваться.

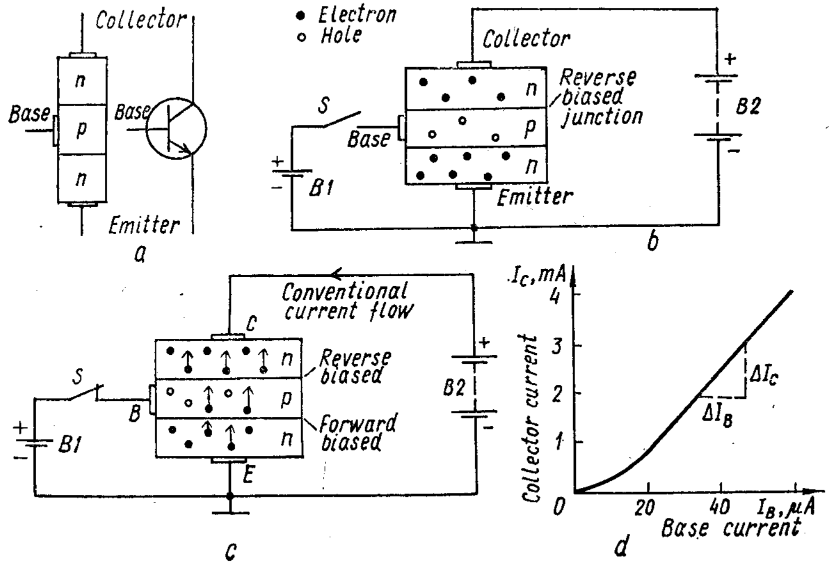


Fig. 2.9. The bipolar n-p-n transistor:
a the structure and its circuit symbol; *b* the simple common-emitter circuit with no base current; *c* the common-emitter circuit with base current flowing; *d* the collector-base current characteristic.

Text A

N-P-N AND P-N-P DEVICES

1. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

The bipolar junction transistor consists of two p-n junctions formed by a sandwich of doped semiconductor material. Fig. 2.9 shows the most common arrangements, the n-p-n transistor. A thin layer of slightly doped p-type material (the base) is sandwiched between two thicker layers of n-type material (emitter and collector); the p-type base layer may be as thin as one micron.

N-p-n devices are the most common. P-n-p devices are also readily available and are very useful in a whole range of complementary circuits since they offer characteristics identical to n-p-n transistors but with the opposite polarity of supply voltage. Whereas in the n-p-n transistor current consists of electrons, in p-n-p transistor it consists of holes. Likewise, the base current is an electron-flow instead of a hole-flow.

2. Average Reading

Text B

THE TRANSISTOR ACTION

1. a) Listen to the text. b) Read it (time limit is 3 min.). c) Find the part of the text dealing with electrons which reach the depletion layer. Translate it.

Fig. 2.9*b* and Fig. 2.9*c* show a n-p-n transistor connected into a simple common-emitter circuit. In Fig. 2.9*b* no base current is flowing whilst in Fig. 2.9*c* the switch *S* is closed, allowing a current to flow from battery B_1 into the base of the transistor. Consider Fig. 2.9*b* first of all. The important point to note is that the collector-base junction is reverse-biased with the resulting potential barrier preventing any flow of majority carriers. Thus, neglecting leakage, the current in the collector circuit is effectively zero with switch *S* open. Now consider what happens when *S* is closed (Fig. 2.9*c*). The base emitter junction becomes forward-biased whilst the collector-base junction remains reverse-biased. Owing to the forward bias on the base-emitter junction, electrons from the n-type emitter cross into the p-type base, where they diffuse across towards the depletion layer at the base-collector junction. Once the electrons reach the depletion layer being minority carriers in the base region, they have a «downhill run» through the potential barrier and are rapidly swept into the collector, thus establishing a collector current in the transistor. The action of forward-biasing the base-emitter junction is like opening a gate and allowing a current to flow in the collector-emitter circuit. This is transistor action.

ASSIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about.

II. a) Skim through the Text B. b) Discuss the main idea of it.

III. Skim through the Text B, choose the key sentences and translate them.

IV. Answer the following questions embracing the contents of the Text A and the Text B.

1. What does the bipolar transistor consist of? 2. When is the current in the collector circuit in Fig. 2.9*b* effectively zero? 3. What happens when *S* is closed? 4. What is the action of forward-biasing the base-emitter junction like? 5. Is the n-p-n transistor the most common arrangement? 6. What does Fig. 2.9 *a* show? 7. What is sandwiched between two thicker layers of n-type material (emitter and collector). 8. What size may the p-type base layer be? 9. What characteristics identical to n-p-n transistors do p-n-p devices offer? 10. What does p-n-p transistor consist of? 11. What is the base current?

V. Prepare a dialogue on one of the following situations:

1. Two students compare the function of thermionic valves and that of transistors in electronics.

2. A teacher in electronics is explaining to the students the transistor action and answer their questions.

VI. Prepare a dialogue on your own situation.

VII. Prepare dialogues using the figures of the Text A and the Text B.

VIII. Speak on:

1. The bipolar junction transistor.

2. Transistor action.

IX. Translate the question-answer units into English. Work in pairs.

1. Из чего состоит биполярный плоскостной транзистор? (Биполярный плоскостной транзистор состоит из трех легированных слоев полупроводникового материала p-n-p типов.)

2. Когда ток в коллекторной цепи на рис. 2. 9*b* практически равен нулю? (Ток в коллекторной цепи практически равен нулю тогда, когда ключ *S* разомкнут.)

3. Что происходит, когда ключ *S* замкнут? (Переход база-эмиттер становится прямо смещенным, в то время как коллекторно-базовый переход остается обратно смещенным.)

4. Что напоминает действие базо-эмиттерного перехода при прямом смещении? (Действие базо-эмиттерного перехода при его прямом смещении напоминает открывание ворот и позволяет току проходить в коллекторно-эмиттерную цепь. В этом заключается сущность работы транзистора.)

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these words.

Upset смещать, нарушать; capture захватывать; lightly слегка; at the same time в то же самое время; waylaid блокировать, преградить путь; supply обеспечивать; constitute составлять; equal равный; the number of ряд; successful trip успешный переход; region область; of the order of порядка.

II. Memorize these words and word-combinations used in their specialized meanings.

Be waylaid быть блокированным; holes дырки; low concentration of holes низкая концентрация дырок; doped легированный; ratio отношение.

III. Find these word-combinations and terms in the Text C and translate the sentences containing them.

current gain коэффициент усиления по току; base current базовый ток; current-controlled device управляемое током устройство; collector current коллекторный ток; silicon transistor кремниевый транзистор.

Text C

THE CURRENT GAIN

I. a) Read the Text C. b) Describe recombination of electrons in the base region.

Why do the electrons not recombine with holes in the p-type base region as they diffuse to the collector? The answer is that, by making the base of very lightly doped p-type material, that is with a low concentration of holes, and at the same time using a very thin base, there is only a small chance of an electron being waylaid by a hole and recombining. When an electron does recombine in the base region, it upsets for a moment the equilibrium, because the base has captured a negative charge. This is corrected by a hole supplied by base battery B_1. It is supply of holes to compensate for recombination in the base which constitutes the base current of the transistor. Thus the transistor is a current-controlled device. The current gain (h_{FE}) is the ratio of collector current to base current. This must be equal to the number of electrons per second making a successful trip from emitter to collector, dividing by the number which recombine. In a typical small silicon transistor, an electron in the base region has roughly a 1 in 100 chance of recombining, so that the current gain is of the order of 100.

ASSIGNMENTS

I. a) Divide the text into logical parts. b) Choose the key sentences and translate them.

II. Look through the Text C and find the part of it dealing with the transistor as a current-controlled device. Translate it.

III. Read the text attentively and answer the following questions.

1. Why has the base captured a negative charge? 2. What is corrected by the hole supplied by base battery B_1? 3. What is the transistor? 4. What does the base current of the transistor constitute? 5. What is the current gain (h_{FE})? 6. What must the current gain be equal to? 7. What chance of recombining has an electron in the base region?

IV. Prepare a dialogue on one of the following situations:

One of the students looking at Fig. 2.9 asks questions, the other answers them.

V. Make up a plan of the text.

VI. Retell the text according to your plan.

VII. Review the text in written form.

VIII. Translate the Text C to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

plot	сильная поддержка
plot against	искажение
relationship	наносить (на чертеж)
strong encouragement	инжектированные
injected	изображенный
	(в функции) от
distortion	взаимоотношение
sweep up by the field	случайным образом
the hole population	дырочная популяция

significant fraction	облегчаться
in random fashion	зд. пока не рекомбинируют
prey to recombination	захватывать полем
complementary circuit	существенная часть
be healthier	втягивать
build up	тратить впустую, зря расходовать
«waste»	дополнительная схема
draw	создавать

II. Give initial forms of the following words and translate them.

clearly, relationship, considering, encouragement, depletion, layer, diffusing, recombination, healthier, electric, population, heavily, fraction.

III. Give the main forms of the verbs from the Text D.

Plot, reduce, explain, cross, reach, sweep, diffuse, prey, encounter, inject, help, exhibit, begin, behave, dope, consist, go, lead.

Text D

SECOND-ORDER EFFECT

I. Read the following text and say what it is about. Review the text.

Fig. 2.9*d* shows a graph of collector current plotted against base current for a small silicon transistor; there is clearly a linear relationship between I_C and I_B over most of the collector current range. At low values of base current, however, the current gain is somewhat reduced. This is explained by considering the behaviour of electrons in the base: at very low base currents the electrons which cross from the emitter to the base region do not have any strong encouragement to reach the collector. It is only when they reach the collector-base depletion layer that they are swept up by the field; before this they are simply diffusing across the base in random fashion, prey to recombination with any hole they may encounter of the way. At higher values of base current, conditions are healthier for the electrons. The holes injected by the base current built up a slight electric field in the base which helps to draw the electrons into the depletion layer. Thus, at moderate collector currents of about 10 mA, a transistor will exhibit higher current gain than at low collector currents around 1.0 mA.

At very high collector current, when the hole population in the base is very high, gain begins to fall. The base behaves as if it were more heavily doped than it realy is, so that a significant fraction of the current across the base-emitter junction consists of holes going from base to emitter as well as the useful electrons going the other way towards the collector. Thus, more and more of the base current is «wasted» and the current gain falls. The effect of importance in power amplifier, where it can lead to waveform distortion at high collector currents.

I. a) Skim through the text and divide it into logical parts. b) Choose the key sentences and translate them.

II. Find the part of the text describing the reduction of the current gain.

III. Read the text attentively and answer the following questions.

1. What does Fig. 2.9*d* show? 2. When is the current gain reduced? 3. When are conditions healthier for the electrons? 4. When does gain begin to fall? 5. What electrons do not have any strong encouragement to reach the collector? 6. When do electrons reach the collector-base depletion layer? 7. What holes built up a slight electric field in the base? 8. What base helps to draw the electrons into the depletion layer? 9. Will a transistor exhibit higher current gain?

IV. Make up a plan of the text.

V. Discuss the problem of second-order effect.

VI. Make a short written summary of the text.

VII. Look through the latest magazines and find additional information about second-order effect.

VIII. Compare standard symbols used in the USSR for bipolar transistors with those used in the USA.

III. GRAMMAR EXERCISES

I. Translate the following words paying attention to the meanings of prefixes.

Bidirectional, biphase, biphone, bistable, bivalent; reconstruct, recombine, rewrite, recycle.

II. Translate the following sentences into Russian paying attention to «once».

1. Once the switch *S* is open no base current is flowing. Once the electrons reach the depletion layer, they have a "downhill run" through the potential barrier and are rapidly swept into the collector, thus establishing a collector current in the transistor.

III. Translate the following sentences into Russian paying attention to the functions of Participle I and Participle II.

1. The bipolar junction transistor consists of two p-n junctions formed by a sandwich of doped semiconductor material. 2. Fig. 2.9*b* shows a transistor connected into a simple common-emitter circuit. 3. No base current is flowing whilst the switch is closed, allowing the current to flow from battery into the base of the transistor. 4. The important point to note is that the collector-base junction is reverse-biased with the resulting potential barrier preventing any flow of majority carriers. 5. Neglecting leakage, the current in the collector circuit is effectively zero with switch *S* open.

IV. Translate the following sentences into Russian paying attention to Imperative Mood.

1. Consider Fig. 2.9. 2. Note the following phenomonon. 3. Avoid making mistakes. 4. Draw the graph and see the direction of electrons. 5. Examine the graph and explain it.

Lesson 5. THE FIELD-EFFECT TRANSISTOR

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Listen and repeat after the speaker. b) Practise the pronunciation of the following.

Previously, emphasized, negligible, advantage, piezoelectric, variation, particular, unipolar, susceptible, nuclear, microphone, insulator, diagrammatic, ohmic, alternative.

II. a) Make sure that you know these words. Say what Russian words help you to guess their meanings. b) Repeat these words after the speaker.

Ohmic, contact, normal, alternative, construction, type, negative, positive, unipolar, microphone, region.

III. a) Listen, repeat and memorize the following words and word-combinations. b) Check if you know their meanings.

Gate затвор; outline контур, очертание; current-controlled amplifying device усилительный прибор, управляемый током; field-effect transistor (FET) полевой транзистор; drawn by *зд.* поступающий в; transducer преобразователь; unable to supply не в состоянии создать; significant current значительный ток; junction field-effect transistor (JFET) полевой транзистор с p-n затвором; insulated gate field-effect transistor (IGFET) полевой транзистор с изолированным затвором; metal-oxide semiconductor field-effect transistor (MOSFET)

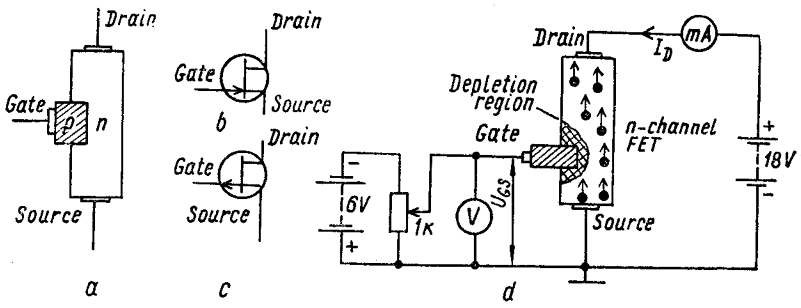


Fig. 2.10. The n-channel junction field-effect transistor (JFET): *a* the structure; *b* its circuit symbols; *c* the circuit symbols for p-channel JFET; *d* a test circuit.

полевой транзистор типа металл-окисел-полупроводник (МОП транзистор); source исток; drain сток; as these names suggest как следует из этих названий; variations in the size варианты размера; test circuit испытательная цепь, схема; heavily doped сильно легированный; exist entirely in the bar существует почти по всему кристаллу.

IV. Pay attention to the meaning of the prefix uni- and translate the following words into Russian.

Unipolar, unilateral, uniphase, uniselector, uniform.

V. a) Listen to the following parts of sentences. b) Find sentences with them in the Text A and the Text B and translate into Russian.

1. The p-type gate is **much more** heavily doped **than** the n-type bar; 2. **The wider** the depletion layer, **the narrow** the channel; 3. The **lower** contact on the bar is called the source and the **upper** contact the drain; 4. The p-type gate is **much more heavily** doped than the n-type bar; 5. This is **wider** at the top **than** the bottom.

Text A

THE N- AND P-CHANNEL IN JFET

I. Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

The n-channel junction field-effect transistor (JFET) is shown in Fig. 2.10*a* together with its circuit symbol in Fig. 2.10*b*.

An alternative type of construction is the p-channel device where the gate is made of n-type material. Fig. 2.10*c* shows the circuit symbol for a p-channel JFET.

Fig 2.10*d* shows as n-channel FET in a test circuit and includes an outline of the depletion layer. The p-type gate is much more heavily doped than the n-type bar, so that the depletion region exists almost entirely in the bar. The wider the depletion layer, the narrower the channel there is available for the flow of electrons from source to drain, since the depletion region itself behaves like an insulator.

2. Average Reading

Text B

THE JUNCTION FIELD-EFFECT TRANSISTOR ACTION

I. a) Listen to the text. b) Read it (time limit is 5 min.). c) Find the part of it dealing with the types of the field-effect transistors. Translate it.

It was previously emphasized that one of the main properties of the bipolar transistor is that it is a current-controlled amplifying device; the output current is controlled by a small input current. In the case of the field-effect transistor (FET) it is the input voltage which controls the output current. The current drawn by the input is usually negligible (it can be less than 1 pA). This is a great advantage where the signal comes from a device such as capacitor microphone or piezoelectric transducer, which is unable to supply a significant current.

FETs are basically of two types: the junction field-effect transistor or JFET and the insulated gate field-effect transistor or IGFET. The latter is more commonly known by a name metal-oxide semiconductor field-effect transistor (MOSFET) or MOS transistor.

The n-channel JFET is shown in diagrammatic form in Fig. 2.10*a* together with its circuit symbol in Fig. 2.10*b*. A bar of n-type silicon has an ohmic (non-rectifying) contact on each end. At a point along the bar a region of p-type silicon forms a p-n junction. In normal operation, the junction is reverse-biased. The lower contact on the bar is called the source and the upper contact the drain. As these names suggest, the electron current flows from source to drain and is controlled by the voltage applied to the p-region, called the gate.

An alternative type of construction is the p-channel device where the gate is made of n-type material. Fig. 2.10*c* shows the circuit symbol for a p-channel JFET.

The operation of the JFET depends upon variations in the size of the depletion layer at the reverse-biased gate junction. Fig. 2.10*d* shows an n-channel FET in a test circuit and includes an outline of the depletion layer. The p-type gate is much more heavily doped than the n-type bar, so that the depletion region exists almost entirely in the bar. The gate carries a negative bias voltage (V_{GS}) relative to the source which gives rise to the particular shape of the depletion region shown: this is wider at the top than the bottom, because the drain is held more positive than the source. The wider the depletion layer, the narrower the channel there is available for the flow of electrons from source to drain, since the depletion region itself being devoid of current carriers, behaves like an insulator. Hence, for a given drain-source voltage, the drain current is dependent upon the input voltage V_{GS}.

Unlike the bipolar transistor, the FET employs only majority carriers for its operation. It is therefore sometimes called the unipolar transistor and is less susceptible than the bipolar type to temperature changes and nuclear radiation, since these chiefly effect minority carriers.

ASSIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about.

II. Skim through the Text B and find the part of it dealing with the p-channel device.

III. Find the part of the Text B containing information about two types of FET. Discuss it.

IV. Answer the following questions embracing the contents of the Text A and the Text B.

1. What type of material is the gate made? 2. Is the p-type gate much more heavily doped than the n-type bar? 3. Where does the depletion region exist? 4. How does the depletion region behave? 5. What is the main property of the bipolar transistor? 6. What are the types of FETs? 7. What is the other name of IGFET? 8.What does the operation of the JFET depend upon? 9. What is the difference between bipolar and unipolar transistors?

V. Describe Fig. 2.10 and discuss it with your fellow-students.

VI. Prepare a dialogue on one of the following situations:

1. Two specialists in radioelectronics have a talk on the main types of FET.

2. The teacher is asking the student about the n-channel JFET in a test circuit.

VII. Prepare a dialogue on your own situation.

VIII. Speak on:

1. The main types of FET.
2. Construction and operation of FET.

IX. Make up a plan of the Text B.

X. Retell the text according to your plan.

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Make sure that you know these words.

Layer слой; with respect to по отношению к; flow v. протекать; distinguish отличать; consider рассматривать; repel отталкивать; behind за (пределами); narrow узкий; provide обеспечивать; path путь; arrow стрелка; internally внутренне; indicate показывать; respectively соответственно; unfortunately к сожалению.

II. Find the following word-combinations and terms in the Text C and translate the sentences containing them.

Substrate=substratum нижний слой, основа, подложка; reverse-biased обратно смещенный; source junction переход истока; insula-

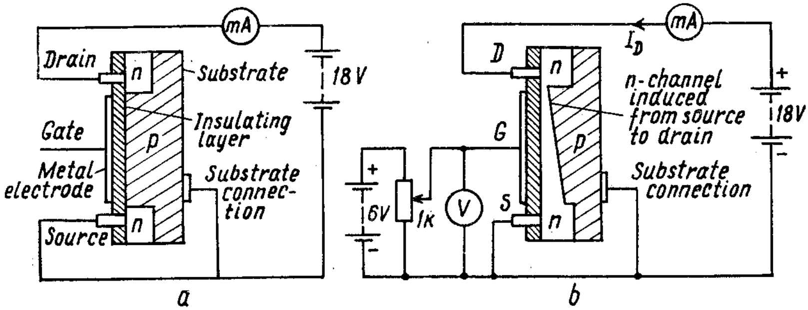


Fig. 2.11. The base structure of n-channel metall-oxide semiconductor field-effect transistor (MOSFET):
a with zero gate bias; *b* with positive bias.

ting layer изоляционный слой; back-to-back встречно включенный; depletion type n-channel n-канал с обеднением; enhancement-mode n-channel n-канал с обогащением; break *эд.* разрыв.

III. a) Find the following verbs in the text and define their tense-forms. b) Translate the sentences with them.

Show, form, draw, flow, reverse, reverse-biased, make, provide, connect.

Text C

THE MOSFET

I. a) Read the text. b) Find the part of it dealing with the conditions when no supply current flows.

Fig. 2.11*a* shows the basic construction of an n-channel MOSFET. The drain and source are the n-type region formed in the p-type silicon bar, which is known as the substrate. The gate is a metal electrode insulated from the silicon bar by a layer of silicon oxide.

The MOSFET is drawn connected in a simple circuit with the drain positive with respect to the source. Under these conditions, no supply currents flow, because the drain-substrate p-n junction is reverse-biased. Even if the supply polarity were reversed, there would still be no current flowing, since the source junction would then be reverse-biased.

Now consider Fig. 2.11*b* where the gate has been made positive with respect to the source. The field of the positive gate repels holes in the p-type substrate away from the insulating layer, leaving behind a narrow channel of n-type silicon. This narrow channel provides a conducting path from source to drain.

In this way, given a certain positive voltage on the gate to make the device conduct, the drain current is under the control of the gate voltage.

Circuit symbols for MOSFETs shown in Fig. 2.12*a* is a depletion-type n-channel device.The substrate connection (often marked «b» for «bulk») carries an arrow showing channel polarity. The

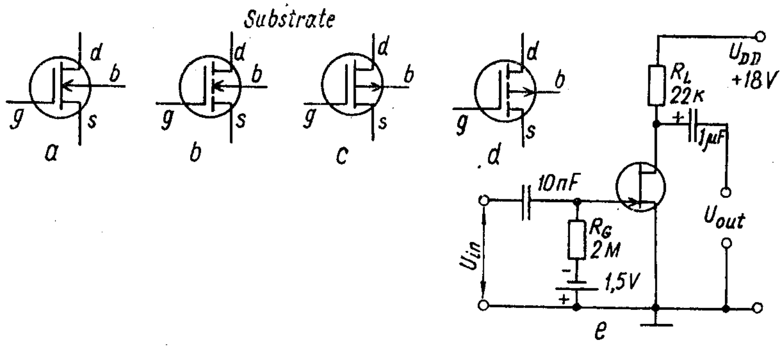


Fig. 2.12. MOSFET circuit symbols and its use:
a the n-channel depletion type; *b* the n-channel enhancement type; *c* the p-channel depletion type; *d* the p-channel enhancement type; *e* a simple FET voltage amplifier.

substrate is normally connected to the source, a connection sometimes made internally. Fig. 2.12*b* shows an enhancement-mode n-channel MOSFET and differs from Fig. 2.12*a* by showing breaks in the channel, indicating that there is normally no conducting path between source and drain. Fig. 2.12*c* and Fig. 2.12*d* show depletion- and enhancement-type p-channel MOSFETs respectively; notice the reversal of the substrate arrow to distinguish them from the n-channel device. In all the MOSFET symbols, the gate is clearly shown insulated from the channel.

ASSIGNMENTS

I. Divide the text into logical parts. Choose the key sentences and translate them.

II. Find the part of the text describing conditions under which no supply currents flow. Translate it.

III. Read the Text C attentively and answer the following questions.

1. What does Fig. 2.11*a* show? 2. What is known as the substrate? 3. Is the gate a metal electrode insulated from the silicon bar by a layer of silicon oxide? 4. How is the MOSFET drawn? 5. Does supply current flow under these conditions? 6. What does the narrow channel in Fig. 2.11*b* provide? 7. Where are circuit symbols for MOSFETs shown? 8. What does the substrate connection carry? 9. What is substrate normally connected to? 10. What does Fig. 2.12*b* show? 11. Is there conducting path between source and drain? 12. Where are the depletion- and enhancement-type p-channel MOSFETs respectively shown?

IV. a) Describe Fig. 2.12. b) Discuss it with your fellow-students.

V. Prepare a dialogue on your own situations.

VI. Make up a plan of the text.

VII. Retell the text according to your plan.

VIII. Review the text in written form.

IX. Translate the Text C to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

ability	обогащение
enhancement	пенный пластик (пенопласт)
low-leakage gate	зажим, фиксатор
vulnerable	уязвимый
clip	способность
foam plastic	затвор с малым током утечки
safely soldered	безопасно впаянный
break-down	разрыв

II. Give the initial forms of the following words from the text and translate them.

Electrometer, furthermore, low-leakage, break-down.

III. Give the main forms of the following verbs and translate them.

Make, work, show, connect, mean, remove, arise, incorporate, degrade.

Text D

USE OF MOSFETs

I. Read the following text and say what it is about.

A MOSFET will make an even better electrometer than a JFET. Furthermore, because of its ability to operate in an enhancement as well as the depletion mode, an n-channel MOSFET will work well in amplifier circuits of the simple type shown in Fig. 2.12*e*, but without the bias battery, R_G being connected directly to earth.

The low-leakage gate insulation means that MOSFETs are very vulnerable to static charges, which can build up high gate voltages and break-down the insulation. For this reason, MOSFETs are supplied with the leads short-circuited by a metal clip or piece of conducting foam plastic. This short circuit should not be removed until the device is safely soldered into circuits. If there is a risk of excessive gate voltages arising in the circuit then a protection network (e.g. "back-to-back" Zener diodes) should be incorporated between gate and earth. This technique does unfortunately degrade the very high input resistance of the MOSFET. Some MOSFETs actually incorporate protection diodes and are not therefore as susceptible to break-down as the unprotected devices.

ASSIGNMENTS

I. Give the main idea of the Text D.

II. Skim through the text and find the part of it dealing with the low-leakage gate insulation.

III. Read the text attentively and answer the questions.

1. Does a MOSFET make a better electrometer than a JFET? 2. Where will an n-channel MOSFET work well? 3. What does Fig. 2.12*c* show? 4. What does the low-leakage gate insulation mean? 5. With what are MOSFETs supplied? 6. Should the short circuit be removed until the device is safely soldered into circuits? 7. When should a protection network be incorporated between gate and earth? 8. What does this technique degrade? 9. What do any MOSFETs actually incorporate?

IV. Prepare a dialogue on your own situation.

V. Make up a plan of the text.

VI. Speak on the text according to your own plan.

VII. Look through the latest magazines and find additional material about using of MOSFETs in the foreign and Soviet techniques. Discuss it with your fellow-students.

III. GRAMMAR EXERCISES

I. Define the tense-forms of the verbs and translate them.

1. The wider the depletion layer, the narrow the channel there is available for the flow of electrons from source to drain. 2. Even if the supply polarity were reversed, there would still be no current flowing, since the source junction would then be reverse-biased. 3. An n-channel MOSFET will work well in amplifier circuits of the simple type shown in Fig. 2.12*e*, but without the bias battery, R_G being connected directly to earth. 4. This short circuit should not be removed until the device is safely soldered into circuits. 5. Some MOSFETs actually incorporate protection diodes and are not therefore as susceptible to break-down as the unprotected device.

II. Give the initial forms of the verb from Participle II and translate them.

Shown, made, showed, doped, controlled, drawn, insulated, biased, called, applied, formed, known.

III. a) Pick out from the Text D and the Text C sentences with Infinitives and Participles. b) Define their functions and translate the sentences.

IV. Define the attributes in the following word-combinations, translate them into Russian.

Circuit symbol; alternative type of construction; depletion region; main property; bipolar transistor; a current-controlled amplifying device; output current; input current; field-effect current; capacitor microphone; significant current; junction field-effect transistor; metal-oxide semiconductor field-effect transistor.

V. Analyse the constituents the following words consists of.

Output, diagrammatic, outline, heavily, entirely, narrower, previously, significant, arising, voltage, resistance.

VI. Write out from the Text C and the Text D all the verb-forms in the Passive Voice and translate them.

Lesson 6. AMPLIFICATION AND THE TRANSISTOR

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Listen and repeat after the speaker. b) Practise the pronunciation of the following.

[ʃn] function, amplification, application, junction; [aɪ] device, tiny, derive, diode; [ɪ] single, resistor, which, input, signal, simply, switch; [ʌ] function, such, under, junction, current, but, interrupt, bulb, much; [eɪ] base, make, operate; [æ] as, thanks.

II. Make sure that you know these words. Say what Russian words help you to guess their meanings. b) Repeat these words after the speaker.

Electronics, active, component, resistor, transistor, passive, signal, elements, battery, bipolar, base, voltage, product, symbol; but: control управлять.

III. a) Listen, repeat and memorize the following words and word-combinations. b) Check if you know their meanings.

Whereby посредством чего; tiny input signal очень слабый входной сигнал; aerial антенна; power involved введенная мощность; draw from зд. получать от; extinguish v. погашать; give rise to повышать что-л.; a. c. mains основной источник переменного тока; simple light-operated switch простой, работающий от света переключатель; cadmium-sulphate photocell фотоэлемент на сернистом кадмии; coil of a relay обмотка реле.

IV. a) Find the following word-combinations in the Text A and the Text B. b) Translate the sentences with them.

Under the heading of passive components под названием пассивные компоненты; in reasonably bright light при достаточно ярком свете; turning the cell to face the bulb поворачивание элемента «лицом» к лампе; remain lit оставлять зажженным, горящим; interrupt the light path прервать путь света; clip off voltage surge ограничить обратный выброс напряжения.

V. a) Define the part of speech of each word. b) Underline the suffixes and translate the words.

Amplification, electronic, generally, active, amplifying, resistance, turning, voltage, connections.

VI. Analyse the following words from the viewpoint of their structure and translate them.

Everyday, loudspeaker, bipolar, current-controlled, light-operated, photocell, base-emitter, collector-emitter, anything.

VII. Give English equivalents to the Russian words and word-combinations in brackets and translate the sentences into Russian.

1. The bipolar junction transistor is (наиболее активно используемый прибор) in electronics. 2. If a small current (проходить) between the base and emitter, it (повышать) to a much larger current between collector and emitter. 3. To extinguish the «candle», it is only necessary (прервать) the light path between bulb and photocell. 4. The diode (соединенный) across the relay coil serves to clip off voltage surge in the coil inductance when the current (выключать).

Text A

ACTIVE DEVICES IN ELECTRONICS

I. Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

The single most important function in electronics can be expressed in one word: amplification. This is the process whereby the power of a signal is increased in magnitude.

Electronic amplification devices are known generally as active components to distinguish them from non-amplifying circuit elements such as resistors, capacitors and inductors, which are grouped under the heading of passive components.

The most everyday application of electronic amplification is the ordinary radio, which receives a tiny input signal at its aerial (typically less than one microwatt) and yet can turn out a power of several watts to the loudspeaker. The extra power involved is drawn from a battery or the a. c. mains.

The bipolar junction transistor, better known simply as the transistor, is the most common active device in electronics. The transistor is a current-controlled amplifying device: if a small current flows between the base and emitter, it gives rise to a much larger current between collector and emitter. The name transistor is in fact derived

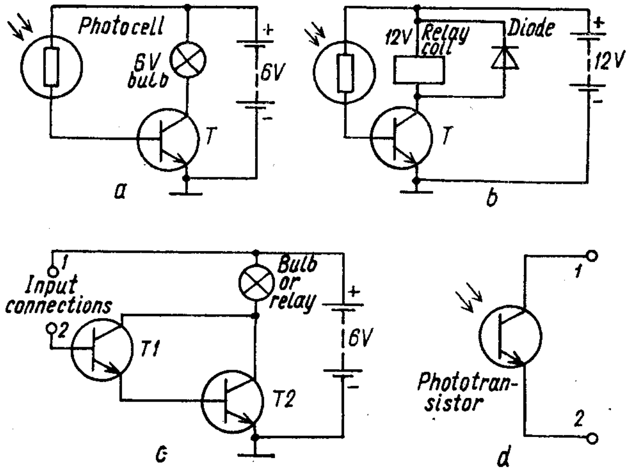


Fig. 2.13. The use of light-operated devices:
a a light-operated switch; *b* a light-operated relay coil; *c* a light-operated relay coil with Darlington pair of transistors; *d* the connection of phototransistor to Darlington pair.

from the two words transfer-resistor; a small base current is transferred to the high resistance collector circuit in greatly magnified form.

2. Average Reading

Text B

AMPLIFICATION IN TRANSISTOR STAGES

I. a) Listen to the text. b) Read it (time limit is 5 min.). c) Find the part of it dealing with the usage of the collector current.

The circuit of Fig. 2.13*a* shows the amplification stage with using the transistor to make a simple light-operated switch. The transistor base circuit is completed here by the cadmium-sulphate photocell which behave as a light-dependent resistor. When the cell is in the dark, its resistance is several megohms accordingly negligible-base current flows in the transistor. In reasonably bright light, the cell resistance falls to a few kilohms and the base current of about a milliampere lights the lamp, thanks to the amplification of the transistor.

Turning the cell to face the bulb makes an "electric candle": in the dark, the bulb is out, but if light momentarily falls on the cell, the bulb lights and remains lit, the photocell current being sustained by its light. To extinguish the "candle", it is only necessary to interrupt the light path between bulb and photocell.

In Fig. 2.13*b* the collector current is used to operate the coil of a relay, the relay contacts can then be used to switch on or off any required device, such as a motor to open a garage door when the car headlamps illuminate the cell. The diode connected across the relay coil serves to clip off voltage surge in the coil inductance when the current is switched off. A diode should always be connected across a solenoid which is transistor-controlled; the voltage surge can otherwise cause breakdown in the transistor.

Fig. 2.13*c* shows a way of further increasing the current gain of a circuit. Known as a Darlington pair, the two transistors give a current gain equal to the products of their individual current gains. This is because the base-emitter current of T_2 is equal to the collector-emitter current of T_1. If the connections 1 and 2 are held, one in each hand, the bulb will light brightly; the circuit is much more sensitive than that of Fig. 2.13*a*. The extra current gain means that a phototransistor can be used as a light sensor if connected as shown in Fig. 2.13*d*.

The current gain of a transistor is normally given the symbol h_{FE}, and its value may be anything from 10 to 1000 depending on the type of transistor. The current gain of the transistor usually lies in the range 100 to 400; current gain is not a closely controlled parameter. In the Darlington pair, $h_{FE\ total} = h_{FE_1} \cdot h_{FE_2}$.

ASSIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about.

II. a) Skim through the text B and find the part of it dealing with an «electronic candle». b) Discuss the information with your fellow-students.

III. a) Find the part of the Text B containing information about the collector current. b) Discuss it.

IV. Answer the following questions embracing the contents of the Text A and the Text B.

1. What is amplification? 2. What is the most everyday application of electronic amplification? 3. What is the most common active device in electronics? 4. From what is the name transistor derived? 5. What does the diode connected across the relay coil serve?

V. Convert the statements into questions according to the model.

Model. Fig. 2.13 *c* shows a way for further increasing of the current gain of a circuit.
What does Fig. 2.13 *c* show?
Does Fig. 2.13 *c* show a way for further increasing of the current gain of a circuit?

1. The single most important function in electronics can be expressed in amplification. 2. The most everyday application of electronic amplification is the ordinary radio. 3. The bipolar junction transistor is the most active device in electronics. 4. The transistor is a current-controlled amplifying device. 5. The circuit of Fig. 2.13*a* shows the amplification stage with using the transistor to make a simple light operated switch.

VI. Prepare a dialogue on your own situation.

VII. Describe Fig. 2.13 and discuss it.

VIII. Speak on:

1. Amplification.
2. The transistor as an amplifying device.
3. Amplification in transistor stages.

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these words.

Behave v. вести себя; like подобно, похоже; possess владеть, обладать; appear появляться; temporarily временно; store накапливать; change v. изменять; perform выполнять; double удваивать; roughly грубо; by half наполовину.

II. Memorize these words and word-combinations used in their specialized meanings.

A reverse-biased p-n junction обратно смещенный p-n переход; a collector-base junction коллекторно-базовый переход; depletion layer обедненный слой; forward-biased p-n junction прямо смещенный переход; capacitance емкость; carrier носитель; signal frequency частота сигнала.

III. Find these word-combinations and terms in the Text C and translate the sentences containing them.

Finite speed of the minority carriers конечная скорость неосновных носителей; temporarily stored временно запоминаемые (сохраняющиеся; akin близкий, похожий; reactance of the base emitter capacitance реактивное сопротивление емкости эмиттерного перехода; "cut off" frequency частота среза (предельная частота транзистора); transition frequency граничная частота; logarithmic scale логарифмический масштаб; gain-band-width-product произведение коэффициента усиления на полосу пропускания.

IV. Pay attention to the meaning of the prefix semi- "полу"- and translate the following words.

Semiconductor, semioscillation, semiprotected, semiconductive, semicolonial.

V. Find in the Text C English equivalents to the following Russian word-combinations. Translate the sentences with them.

Емкость зависит от; скорость большинства носителей; внешне приложенный сигнал изменяется быстро; что касается внешнего сигнала; по мере того, как частота сигнала увеличивается; задача управления; уменьшить частоту, при которой h_{FE} падает до единицы.

Text C

HIGH FREQUENCIES AND THE BIPOLAR TRANSISTOR

I. a) Read the text. b) Find the part of it describing the effective capacitance of a forward-biased p-n junction. Translate it.

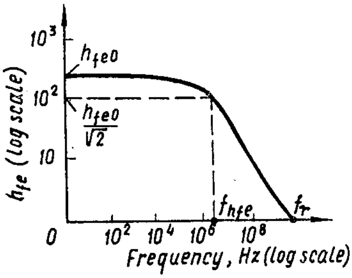


Fig. 2.14. The frequency characteristics of small signal current gain.

A reverse biased p-n junction, such as a collector-base junction, behaves like a capacitor, where the capacitance is dependent on the junction area and the width of the depletion layer. A forward-biased p-n junction such as a base-emitter junction also possesses capacitance, C_{be}, which appears in parallel with its normal forward resistance. The effective capacitance of a forward-biased p-n junction arises from two basic cases. The first is simply the capacitance of the depletion layer. The second components of capacitance arises from the finite speed of the minority carriers as they diffuse across the junction. These carriers, because the diffusion is relatively slow, appear to be temporarily stored in the semiconductor material when the external applied signal changes quickly; the effect as far as the external signal is concerned is akin to the storage of change by a conventional capacitor. The effective capacitance of the base-emitter junction of a small silicon transistor is typically of the order of 100 pF to 1000 pF.

As signal frequency is increased, there comes a point where the reactance of the base-emitter capacitance is comparable with the base-emitter resistance h_{FE}, and much of the base current which should be performing the normal task of controlling the collector current is instead flowing in the base-emitter capacitance C_{be}. The result is a fall in current gain (Fig. 2.14). The "cut-off" frequency, $f_{h_{FE}}$, is reached when the reactance of C_{be} is equal to the input resistance, h_{ie}, and the current gain thus falls by the factor $\sqrt{2}$ (3 dB). Above $f_{h_{FE}}$ most of the "base" current is actually flowing in C_{be} and every time the frequency is doubled the current gain falls by half. Expressed on a logarithmic scale, h_{FE} falls by 6 dB for each octave (doubling) of frequency. If the graph is extrapolated, we can deduce the frequency at which h_{FE} falls to unity; this is termed the transition frequency, f_T, above which the transistor is of little use as an amplifier. Transition frequency f_T is also called the gain-band-width product, since, in the region between $f_{h_{FE}}$ and f_T, the product of current gain and signal frequency is roughly constant and equal to f_T, i. e.

$$f_T \approx h_{FE} \cdot f_{h_{FE}}.$$

ASSIGNMENTS

I. Read the Text C attentively and answer the following questions.

1. How does a reverse-biased p-n junction, such as a collector-base junction, behave? 2. From what basic causes does the effective capacitance of a forward-biased p-n junction arise? 3. What is the effective capacitance of the base-emitter junction of a small silicont

transistor? 4. When is the "cut-off" frequency, f_{hFE}, reached? 5. What is termed the transition frequency?

II. Describe Fig. 2.14 and discuss it.

III. Translate the following Russian questions and answers into English. Work in pairs.

1. Что показано на рис. 2.14? (На рис. 2.14 показан график зависимости коэффициента передачи тока h_{FE} от частоты.)

2. Какой масштаб использован здесь по обеим осям? (По обеим осям здесь использован логарифмический масштаб.)

3. Какие частоты отмечены на рис. 2.14? (На рис. 2.14 отмечены предельная частота транзистора $f_{h_{FE}}$ и граничная частота транзистора f_T).

4. Что такое частота f_T? (При частоте f_T, называемой граничной частотой усиления транзистора, коэффициент передачи тока равен 1.)

IV. Speak on:

1. Base emitter capacitance.
2. Transition frequency.

V. Prepare a dialogue on your own situation.

VI. Translate the question-answer units into English. Work in pairs.

1. Как ведет себя обратно смещенный p-n переход, подобный переходу коллектор-база? (Обратно смещенный p-n переход, подобный переходу коллектор-база, ведет себя как конденсатор, емкость которого зависит от площади перехода и ширины обедненного слоя.)

2. Какая основная причина появления эффективной емкости прямо смещенного p-n перехода (Эффективная емкость прямо смещенного перехода возникает по двум основным причинам. Первая — это просто емкость обедненного слоя, вторая появляется вследствие конечной скорости движения неосновных носителей, когда они диффундируют через переход.)

3. Какая эффективная емкость базо-эмиттерного перехода малого кремниевого транзистора? (Эффективная емкость базо-эмиттерного перехода малого кремниевого транзистора в типичном случае порядка 100—1000 pF).

4. Когда достигается предельная частота транзистора $f_{h_{21э}}$? Предельная частота транзистора $f_{h_{21э}}$ достигается тогда, когда $x_{cэ}$ реактивное сопротивление становится равным входному сопротивлению $h_{11э}$, и коэффициент передачи тока падает в $\sqrt{2}$ раз (на 3 dB.)

5. Как определяется граничная частота усиления транзистора? (Если график экстраполировать, мы сможем получить частоту, при которой $h_{21э}$ уменьшается до единицы — она и называется граничной частотой усиления транзистора, выше которой транзистор как усилитель используется редко.)

VII. Analyse the sentences giving the main idea of the text.

VIII. Comment on the author's attitude to high-frequencies and the bipolar transistor.

IX. Express your own opinion of high-frequencies and the bipolar transistors.

X. Translate the Text C to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English word-combinations with the Russian ones.

high conductivity semiconductor material	достаточное количество энергии для преодоления потенциального барьера
enough energy to pass the potential barrier	полупроводниковый материал с высокой проводимостью
a pick value	заделка корпуса
acceptor and donor impurities	линейный малошумящий усилитель
mounting	акцепторные и донорные примеси
linear low-noise amplifier	наибольшая величина

II. Find the following word-combinations in the Text D and translate the sentences with them.

Mechanical tunnelling phenomenon; a high concentration of acceptor; as the current through the diode increases; it assumes a negative resistance characteristics; the diodes are available with peak valley current ratios from 2—15; the frequency limitations of the tunnel diode are due to parasitic capacitance and inductance.

Text D

TUNNEL DIODE

I. Read the following text and say what it is about. Review the text.

The tunnel diode is a semiconductor device that depends for its operation on a quantum mechanical tunnelling phenomenon and provides a set of electrical characteristics that are unique. It is a two terminal single p-n junction that is fabricated with very high conductivity semiconductor material having a high concentration of acceptor and donor impurities. The width of the depletion layer is so small (of the order of 10^{-6} inch) that is posssible for electronics to "tunnel" through the junction even though they don't have enough energy to pass the potential barrier across it. The electrical characteristic of a typical 1 mA germanium tunnel diode is shown in Fig. 2.15. As the current through the diode increases, it reaches a pick value called the "pick current" at a voltage called the "peak voltage", after which it assumes a negative resistance characteristic until it draws a current called the "valley current" at a voltage called the "valley voltage". From the point the characteristic is that of a normal forward biased diode. In germanium, the peak and valley points occur at 50 mV and 350 mV respectively, the diodes are available with peak valley current ratios from 2—15. The actual peak current depends on the junction area, and diodes are available with peak currents of anything between

10 mA to 10 A. Silicon and gallium arsenide tunnel diode are also available with peak and valley voltages that are slightly higher.

Quantum mechanical tunnelling has theoretical frequency limit of 10^7 Mc/s and is inherently higher frequency mechanism than the diffusion mechanism in conventional transistor and diode operation. In practice, the frequency limitations of the tunnel diode are due to parasitic capacitance and inductance. The peak point is theoretically very stable, though practical measurements on commercially available diodes seem to indicate a considerable variation of peak currents with temperature. This is presumably due to the limitations in the methods of manufacture and mounting.

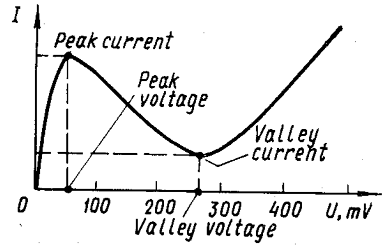


Fig. 2.15. The volt-ampere characteristics of a typical germanium tunnel diode.

The two major applications of the tunnel diode are in switching and logical circuits, where device is switched from the peak to the valley point by an input current, and in linear low-noise amplifier and oscillators for extremely high frequency, where the tunnel diode is biased in its negative resistance region.

ASSIGNMENTS

I. Answer the following questions embracing the contents of the Text D.

1. What is the tunnel diode? 2. What is the tunnel diode fabricated with? 3. What does the tunnel diode depend on? 4. Does the tunnel diode provide a set of electrical characteristics that are unique? 5. What is the width of the depletion layer? 6. What is shown in Fig. 2.15? 7. What does the actual peak current depend? 8. What are the frequency limitations of the tunnel diode due to? 9. What are the two major applications of the tunnel diode?

II. Describe Fig. 2.15 and discuss it.

III. Speak on:

1. The tunnel diode as a semiconductor device.
2. Quantum mechanical tunnelling.
3. The application of the tunnel diode.

IV. Prepare a dialogue on your own situation.

V. Look through the latest magazines and find additional information on tunnel diode. Discuss it.

III. GRAMMAR EXERCISES

i. a) Analyse the structure of the following words and give their initial forms. b) Translate them.

Operation, conductivity, concentration, resistance, voltage, diffusion, theoretically, measurement, limitation, application.

II. a) Find in the Text C and in the Text D the sentences containing the following verbs. b) Define their tense-forms and translate them into Russian.

Behave, possess, appear, arise, change, concern, increase, flow, reach, fall, explorate, call, depend, show, assume, occur, switch, bias.

III. Translate the following sentences paying attention to the structure of the terms in bold type and their meanings.

1. The tunnel diode is a two terminal single p-n junction that is fabricated **with very high conductivity semiconductor material** having a high concentration of acceptor and donor impurities. 2. In germanium **the peak and valley points** occur at 50 mV and 350 mV respectively. 3. In practice, the frequency limitations of the tunnel diode are due to **parasitic capacitance and inductance.**

IV. a) Analyse the functions of ing-forms and the Infinitive. b) Translate the sentences into Russian.

1. Electronic amplifying devices are known generally as active components to distinguish them from non-amplifying circuit elements such as resistors, capacitors and inductors which are grouped under the heading of passive components. 2. To extinguish the "candle", it is only necessary to interrupt the light path between bulb and photocell. 3. In Fig. 2.13*b*, the collector current is used to operate the coil of a relay. 4. The circuit of Fig. 2.13*a* shows the amplification stage with using the transistor to make a simple light-operated switch. 5. Fig. 2.13*c* shows a way of further increasing the current gain of a circuit.

V. a) Analyse the following sentences. b) Translate them.

1. These carriers appear to be temporarily stored in the semiconductor material. 2. Much of the base current which should be performing the normal task of controlling the collector current is flowing in the base emitter capacitance C_{be}. 3. As signal frequency is increased, there comes a point where the reactance of the base-emitter capacitance is comparable with the base-emitter resistance h_{ie}. 4. Expressed on a logarithmic scale, h_{FE} falls by 6 dB for each octave (doubling) of frequency.

Chapter III. COMPUTER TECHNOLOGY

Lesson 1. THE TRANSISTOR AS A SWITCH

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Listen and repeat after the speaker. b) Practise the pronunciation of the following.

[ɑ:] start, part, car, far; [ə:] inverter, referred, terminal, third, circuit, turn, curve; [ɔ:] short, perform, form, for, nor; [ɛə] compare, declare, fare, care; [aɪ] high, design, sign, aquire; [au] out, output, ground, found.

II. a) Make sure that you know these words. b) Say what Russian words help you to guess their meanings.

Basic, element, system, logic, voltage, general, bipolar, transistor, resistor, inverter, fabrication, emitter, electrical, diode, schemetic, configuration, potential, collector, relay, impedance.

III. a) Listen, repeat and memorize the following words and word-combinations. b) Check if you know their meanings.

Logic inverter логический преобразователь; require требовать; input вход; output выход; vice versa наоборот; receive получать; usage использование; to receive general usage получить общее применение; to yield a NOR gate образовать элемент ИЛИ-НЕ; with as many as eight с максимумом до восьми; relay реле; impedance импеданс, сопротивление; turn on (off) включить (выключить) lack недостаток; various различный; output current выходной ток; emitter lead эмиттерный вывод (провод); conventional current обычный ток; saturation насыщение; terminal зажим, вывод; forward voltage drop прямое падение напряжения; common-emitter circuit схема с общим эмиттером; basic circuit configuration конфигурация базовой схемы; common-collector circuit схема с общим коллектором; to operate out of saturation работать без насыщения; manual switches ручные ключи, переключатели; speed of operation скорость работы; cutoff отсечка; diode AND function функция И на диодах; grounded-emitter circuit схема с заземленным (общим) эмиттером.

IV. a) Analyse the constituents the following words consist of. b)Translate these words into Russian.

Connection, usage, development, bipolar, fabrication, multi-emitter, operation, input, output, electrical, electronics, arrowhead, direction, designer, respectively, appearing, switching, saturation, representation, monolithic, schemetic.

V. a) Repeat the following word-combinations after the speaker. b) Memorize these abbreviations.

IC integrated circuit;
RTL resistor-transistor logic;
DTL diode-transistor logic;
TTL transistor-transistor logic.

VI. Make up sentences using the English equivalents of the following word-combinations.

Это означает; наоборот; с тех пор как; так ... и; спустя некоторое время; широко используемые; соответственно; как показано; обычно.

Text A

FORMS OF DIGITAL INTEGRATION CIRCUITS

I. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

A basic element of most digital systems we start with is a switch so called the logic inverter.

The logic inverter requires that with the input in one logic state, the output is in the opposite state. That is, with a logic 0 at the input, the output is a logic 1, or vice versa. Using voltage levels and positive logic that means that with a low voltage at the input, the output is at a high voltage level, or vice versa.

The first form of digital integrated circuits (digital ICs) to receive general usage when they were introduced in 1962 was a simple connection of bipolar transistor inverter circuit to yield a NOR gate. Since the circuit consisted of only resistors and transistors, it was named resistor-transistor logic (RTL). An IC development a short time later consisted of a diode AND circuit followed by a bipolar transistor inverter. This was called diode-transistor logic (DTL). Both RTL and DTL were IC versions of logic circuits made with discrete diodes, transistors, and resistors that had long been popular with digital circuit designers.

The first "new" digital design made possible by the IC fabrication process was transistor-transistor logic (TTL). In these circuits the diode AND function of DTL was performed by a multi-emitter transistor, a bipolar transistor with as many as eight emitters. The output of TTL circuit was from a transistor inverter.

2. Average Reading

Text B

TRANSISTOR CIRCUIT CONFIGURATIONS

I. a) Listen to the text. b) Read it (time limit is 3 min.). c) Find the part of it dealing with the switches in electrical circuits.

Various types of computer and control operations can be performed with switches which have two distinct levels of output current or voltage. In electrical circuits, these switches may be relays, manual switches, or electronic switches. The electronic switches are the transistor and the diode. These two devices, compared to the relay and manual switch offer less impedance to the flow of current when turned off and have a larger forward voltage drop when turned on. Two advantages of these electronic switches are their speed of operation and their lack of moving parts. Widely used schemetic representations for the n-p-n and p-n-p transistors are shown in Fig. 3.1*a*. The emitter lead of each transistor type is seen to have an arrowhead which points in the direction of conventional current flow in the emitter lead.

Transistors have three terminals and may be connected into a circuit in one of several different configurations. Input connections may be made to any two terminals, with the output appearing across the third terminal and one of the input terminals. Fig. 3.1 shows three basic circuit configurations. Circuits shown in Fig. 3.1 *b* to *d* are designated common-emitter, common-base, and common-collector (or emitter-follower) circuits, respectively. When the common input-output terminal is connected to ground potential, as shown in the figure, the three circuit configurations are often referred to as grounded-emitter, grounded-base, and grounded collector circuits, respectively.

The switching circuits are of the type in which the transistor is in saturation when ON and at, or close to, collector-current cutoff when OFF.

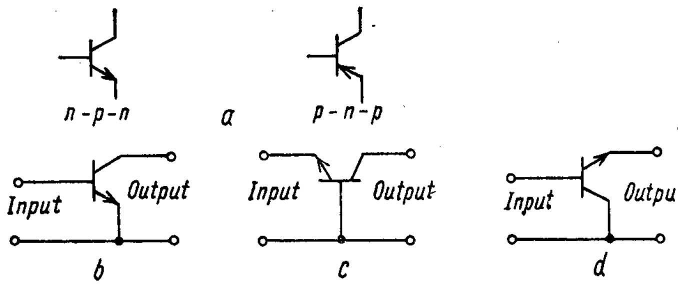


Fig. 3.1. Transistor symbols and basic circuit configurations: *a* n-p-n and p-n-p; *b* a common emitter; *c* a common base; *d* a common collector.

The grounded-emitter and grounded-base switching circuits can be made to operate from saturation to cutoff.

The grounded-collector switch is usually designed to operate out of saturation.

ASSIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about.

II. Skim through the Text B and find the part of it dealing with the terminals of transistors. Discuss it.

III. Find the part of the Text B containing information about the switching circuits. Translate it.

IV. Answer the following questions embracing the contents of the Text A and the Text B.

1. What does the logic inverter require? 2. What is the output with the logic 0 at the input? 3. What is the first form of digital ICs to receive general usage? 4. Why was the circuit named RTL? 5. What was called DTL? 6. What was both RTL DTL? 7. What was the diode AND function of DTL in TTL circuits performed by? 8. What levels have switches? 9. What type may these switches be in electrical circuits? 10. What are the electronic switches? 11. What are the advantages of these electronic switches? 12. What is it necessary in order to provide the two distinct signal levels? 13. What are shown in Figs. 3.1*a* and 3.1 *b*. 14. How many terminals have transistors? 15. In what way may input connections be made to any two terminals? 16. How is the grounded-collector switch usually designed?

V. Examine Fig. 3.1 and comment on:

1. N-p-n and p-n-p.
2. A common emitter.
3. A common base.
4. A common collector.

VI. Make up a dialogue on your own situation using Fig. 3.1.

VII. Speak on:

1. The transistor as a switch.
2. Basic circuit configurations.

VIII. Retell the text according to your own plan.
IX. Make a short written summary of the Text B.

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these words and word-combinations.

Conversely обратно, наоборот; plot наносить (на схему); invert инвертировать, преобразовывать; voltage drop падение напряжения; aid помощь; relationship зависимость; vary отличаться; comprise включать; magnitude величина.

II. Memorize these words and word-combinations pertaining to switches.

Collector current коллекторный ток; base-current базовый ток; collector-emitter voltage напряжение коллектор-эмиттер; input voltage напряжение на входе; base terminal of the transistor базовый вывод транзистора; transistor collector characteristics коллекторные характеристики транзистора; ground potential потенциал заземления; collector leakage current коллекторный ток утечки; base-input signal базовый входной сигнал.

III. Find these word-combinations in the Text C and translate the sentences containing them.

Loop equation уравнение контура; collector supply voltage напряжение коллекторного питания; load resistor сопротивление нагрузке; infinite impedance бесконечно большое сопротивление; quiescent operating point of the circuit статическая рабочая точка схемы.

Text C

COMMON-EMITTER SWITCH

I. a) Read the text. b) Speak on common-emitter switch.

A simple transistor switching circuit is shown in Fig. 3.2*a*. The input signal varies between ground potential and U_1 as shown. A loop equation can be written that portion of the circuit comprising the collector supply voltage, load resistor and transistor to give

$$U_{CC} - I_C \cdot R_L - U_{CE} = 0 \qquad (3.1)$$

This equation schows that if there were no voltage drop across the transistor, the collector current would become $I_{C_{max}} = \frac{U_{CC}}{R_L}$. Conversely, if collector current were equal to zero, there would be no voltage drop across R_L and, from Eq. (3.1) $U_{CE_{max}} = U_{CC}$, when the transistor is at cutoff.

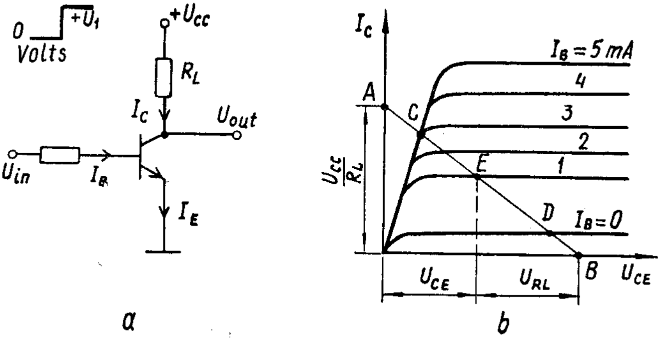


Fig. 3.2. The common emitter switch:
a a simple switching circuit; *b* operating curves of switch.

Operation of the circuit of Fig. 3.2*a* is explained with the aid of the transistor collector characteristics curves given in Fig. 3.2*b*. These curves show the relationship between base-current, collector-current, and collector-emitter voltage.

The magnitude of collector-current $I_{C_{max}}$ and the collector-emitter voltage $U_{C_{max}}$ are plotted in Fig. 3.2 *b* as points *A* and *B*, respectively.

When the input voltage of Fig. 3.2*a* rises to U_1, current flows into the base terminal of the transistor, and the device is turned on. In order for the transistor to be in saturation when in the ON state, an adequate magnitude of base current must be supplied to cause the circuit to operate at point *C*.

When the input voltage in Fig. 3.2*a* falls to ground potential, the transistor base is connected to ground through a resistor: the transistor is at cutoff, collector leakage current is equal to I_{CE0}, and the quiescent operating point of the circuit is at point *D* of Fig. 3.2*b*. The collector characteristic curves show that although the transistor is off, it does not present an infinite impedance to current flow in the circuit. The magnitude of collector leakage current is dependent upon operating temperature of the transistor and the value of series resistance in the base circuit.

For the base-input signal at ground potential, only a small collector leakage current flows, and the collector voltage is close to the U_{CC} potential. The maximum positive level of base-input signal causes the collector-emitter voltage to be at its minimum value. Thus, the transistor switch of Fig. 3.2*a* inverts an input signal and is properly referred to as an «inverter». Inversion is always obtained when the transistor operates as a grounded-emitter switch.

ASSIGNMENTS

I. Answer the following questions embracing the contents of the Text C.

1. What is shown in Fig. 3.2*a*? 2. How is operation of the circuit in Fig. 3.2*a* explained? 3. What do the curves in Fig. 3.2*b* show?

4. When does current flow into the base terminal of the transistor? 5. When is the transistor base connected to ground through a resistor? 6. What do the collector characteristic curves show? 7. What is the magnitude of collector leakage current dependent upon? 8. What causes the collector-emitter voltage to be at its minimum value? 9. When is inversion obtained?

II. Read the Text C again and ask additional questions.

III. Combine your answers into a short summary of the text.

IV. Find the part of the text containing information about the transistor base connected to ground through a resistor. Translate it.

V. Examine Fig. 3.2 and comment on:

1. A simple switching circuit.
2. Operating curves of switch.

VI. Pick out the key sentences from the Text C and translate them.

VII. Speak on operating curves of switches and discuss it.

VIII. Review the text in written form.

IX. Translate the Text C to be sure you understand it well.

X. Compare standard symbols for common-emitter switch used in the USA with those used in the USSR.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

assure	уместный, подходящий
suitable	окончательный выбор
final choice	в меньшей степени
pertinent	ухудшать, портиться
performance	паразитная емкость схемы и проводов
circuit wiring capacitance	предположительно
negative-going edge	перераспределение
positive-going edge	утверждать
conceivably	«раскачка» напряжения (изменение напряжения)
to a lesser extent	пригодный
redistribution	характеристика
deteriorate v.	спад
voltage swing	нарастание

II. Pick out all technical terms from the Text D and translate sentences with them.

III. Translate the following words and word-combinations from the Text D.

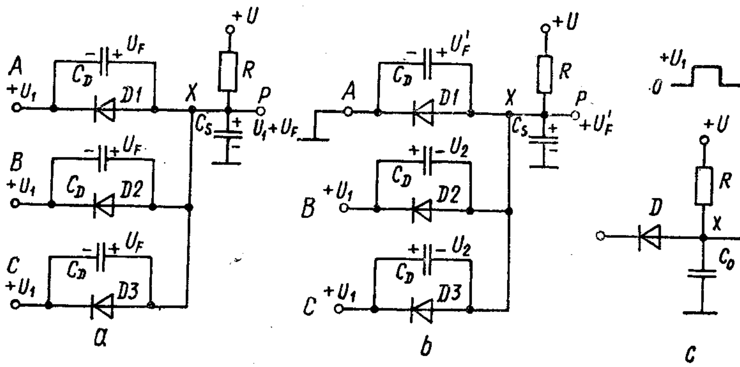


Fig. 3.3. The diode AND/OR gate:
a voltage distribution when all input signals are positive; *b* when one input signal of ground potential; *c* equivalent circuit for one varied input.

Both d. c. and a. c. considerations; most suited for a. c. operation; so that; together with; slightly larger; instantaneously increased; hence.

Text D

DIODE GATES

I. Read the text and give short information about voltage destribution in diode gates.

Design of a logical circuit involves both d. c. and a. c. considerations. The final choice of circuit parameters is often a compromise between values most suited for a. c. operation and different values which give optimum d.c. performance. Pertinent d. c. and a. c. design considerations are presented below for the AND diode circuit.

Output voltage of the above AND gate is clamped to one diode drop above the lowest input signal level. If an external-load current flows from the output terminal of the gate, the current causes a voltage drop across R. The circuit parameters are selected so that output voltage remains at the clamped level.

Capacitive effects limit operating speed of a diode gate. Fig. 3.3*a* shows the diode gate together with diode capacitance C_D and circuit wiring capacitance C_S. For all input terminals are $+U_1$ volts, output voltage of the circuit is at $(U_1+U_F)=U^1$ volts, and each diode capacitance is charged to U_F volts; this voltage is determined by the diode type, i. e., silicon or germanium, and, to a lesser extent, by the magnitude of current flowing through the diode. Consider that input voltage at terminal A decreases from $+U_1$ to $U^0=0$ volts. Fig. 3.3*b* shows the steady-state circuit conditions which are established some time after terminal A is connected to ground potential. The grounded cathode of diode D_1 causes increased forward current flow in this diode, and voltage drop U'_F is slightly larger than U_F. Output voltage of the circuit has decreased to the $U'_F=U^0$ level, and voltage drops across diodes D_2 and D_3 have reversed polarity. However, as D_1 presents a relatively low impedance path to ground when terminal A is grounded, the negative-going edge of the output voltage waveform is generally deteriorated only slightly by capacitive effects.

Capacitance of the above circuit has a pronounced effect upon the positive-going edge of the output-voltage waveform. If voltage at input terminal A is instantaneously increased from ground potential to $+U_1$ volts, the various capacitance must charge to the polarities and levels shown in Fig. 3.3*a*. Hence, the capacitance are in parallel with each other and can be represented by a single equivalent capacitance C_0 from node X to ground. Output voltage of the gate rises to the steady-state level at a rate determined by $+U$, R and C_0.

Fig. 3.3*c* shows an equivalent circuit of the above diode gate; this circuit is useful for both a d. c. and an a. c. analysis. The one diode shown has an input-voltage level which varies from 0 to $+U_1$ volts. Total circuit capacitance is represented by capacitance C_0. Diode leakage currents are neglected, as they are not significant in the present discussion.

ASSIGNMENTS

I. Answer the following questions embracing the contents of the Text D.

1. What considerations does design of a logic circuit involve? 2. What is the final choice of circuit parameters? 3.Where are pertinent d. c. and a. c. design considerations presented? 4. What is clamped to one diode drop above the lowest input signal level? 5. What does the current cause if an external-load current flows from the output terminals of the gate? 6. How are the circuit parameters selected? 7. Do capacitive effects limit operating speed of a diode gate? 8. What does Fig. 3.3*a* show? 9. What does the grounded cathode of diode D_1 cause? 10. When does D_1 present a relatively low impedance path to ground? 11. What can the capacitance in parallel with each other be represented by? 12. At what level does the output voltage of the gate rise?

II. Examine Fig. 3.3 and comment on:

1. Voltage distribution when all input signals are positive.
2. When one input signal of ground potential.
3. Equivalent circuit for one varied input.

III. Discuss the problem of diode gates.

IV. Prepare a dialogue on your own situation.

V. Speak on:

1. Design of a logical circuit.
2. Capacitance effects limit operating speed of a diode gate.
3. Capacitance of the circuit.
4. An equivalent circuit of the diode gate.

VI. Look through the latest magazines, find some articles on a diode gate and make a summary of it.

III. GRAMMAR EXERCISES

I. a) Analyse the following sentences and define the functions of the Infinitive and the Participle. b) Translate these sentences.

1. Using voltage levels and positive logic this means that with a low voltage at the input, the output is at a high voltage level, or vice versa. 2. The first form of digital ICs to receive general usage was a simple connection of bipolar transistor inverted circuits to yield a NOR gate. 3. Since the circuit consisted of only resistors and transistors, it was named RTL. 4. An IC development consisted of a diode AND circuit followed by a bipolar transistor inverter. 5. The first "new" digital design made possible by the IC fabrication process was TTL. 6. Widely used schemetic representation for the n-p-n and p-n-p transistors are shown in Fig. 3.1*a*. 7. The emitter lead of each transistor type is seen to have an arrowhead which points in the direction of conventional current flow in the emitter lead. 8. Input connections may be made to any two terminals, with the output appearing across the third terminal and one of the input terminals. 9. The grounded-emitter and grounded-base switching circuits can be made to operate from saturation to cutoff.

II. Define the tense-forms of the verbs in the following sentences and translate them.

1. This was called DTL. 2. The first form of digital ICs was introduced in 1962. 3. The circuit with only resistors and transistors was named RTL. 4. Both RTL and DTL had long been popular with digital circuit designers. 5. In this circuit the diode AND function of DTL was performed by a multi-emitter transistor, a bipolar transistor with as many as eight emitters. 6. Various types of computers and control operations can be performed with switches which have two distinct levels of output current or voltage. 7. Transistors have three terminals and may be connected into a circuit in one of several different configurations. 8. Input connections may be made to any two terminals. 9. The grounded-collector switch is usually designed to operate out of saturation.

III. a) Analyse the structure of the following sentences. b) Translate these sentences.

1. When the input voltage in Fig. 3.2*a* falls to ground potential, the transistor base is connected to ground through a resistor: the transistor is at cutoff, collector leakage current is equal to I_{CE0}, and the quiescent operating point of the circuit is at point D of Fig.3.2*b*. 2. This equation shows that if there were no voltage drop across the transistor, the collector current would become $I_C = \frac{U_{CC}}{R_L}$. 3. Conversely if collector current were equal to zero, there would be no voltage drop across R_L and, from Eq. (3.1) $U_{CE} = U_{CC}$, when the transistor is at cutoff.

Lesson 2. BINARY NUMBER SYSTEM AND BOOLEAN ALGEBRA

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Listen and repeat after the speaker. b) Practise the pronunciation of the following.

I. [ʌ] multiplied, number, product, hundred, discussion; [ju] numeral, constitute, utilize, tube, cube; [ɪ] system, analogy, binary, this, is, in, bit, him; [i:] each, read, field, yield.

II. Various [ˈvɛərɪəs], sequence [ˈsi:kwəns], yield [ji:ld], immediately [iˈmi:djətlɪ], interpret [ɪnˈtə:prɪt], extreme [ɪksˈtri:m].

II. a) Make sure that you know these words. Say what Russian words help you to guess their meanings. b) Repeat these words after the speaker.

Symbolic, logic, analogy, arabic, summed, positive, binary, system, decimal, analysis, position, bit, relay, elements, contact, algebra, analyze, synthesize.

III. Check if you know the meaning of these words and word-combinations.

Numbering system система счисления; binary (decimal) number system двоичная (десятичная) система счисления; constitute v. составлять; utilize v. использовать; digit (десятичная) цифра, разряд (десятичного числа); sequence последовательность; familiar знакомый; integer целый; shorthand notation сокращенная запись; in proper manner должным образом; extreme left (right) крайний левый (правый); by a power of 10 на степень десяти; the various products are then summed together затем различные произведения складываются; multiply v. умножать; numeral цифра; yield v. производить, создавать omit v. опускать; extreme крайний; convention зд. условие.

IV. a) Give initial forms of the following words and define the function of suffixes. b) Translate these words.

Notation, symbolic, numbering, actually, summation, generally, combining, convention, additional, summarising.

V. Make up sentences using the following word-combinations and translate them.

The binary number system; utilize the arabic numerals; be summed together; a given sequence of numerals; the only digit used; in the proper manner; in order to represent a decimal number; each addition position; from left to right.

VI. Listen and repeat after the speaker the following numbers and arithmetic steps with them.

10^3 ten in the third power;
10^1 ten in the first power;
10^2 ten in the second power (ten squared);
$1 \times 10^3 + 3 \times 10^2 + 5 \times 10^1 + 2 \times 10^0 - 4$. One multiplied by ten in the third power plus three multiplied by ten squared plus five multiplied by 10 in the first power plus two multiplied by ten in zero power minus four.

Text A

CONCEPTION ABOUT NUMBER SYSTEM

I. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

Symbolic logic uses only the numerals 0 and 1. These two digits constitute a numbering system known as the "binary number system".

The binary number system can best be described by analogy to the decimal number system. The decimal number system utilizes the arabic numerals 0 to 9 in a shorthand notation for certain arithmetic operations. Each digit in a decimal number is actually multiplied by a power of 10; the various products are then summed together to yield the decimal quantity. The power of 10 by which a digit is multiplied is determined by the position of the digit within a given sequence. For instance, the sequence of numerals 1,352 is interpreted as $1 \times 10^3 + 3 \times 10^2 + 5 \times 10^1 + 2 \times 10^0$; the various products can be formed to yield $1{,}000 + 300 + 50 + 2$. Summation of the last group of digit yields the quantity one thousand three hundred fifty-two. Because the decimal number system is so familiar, the above arithmetic steps are generally omitted and a given sequence of numerals is immediately interpreted as a particular quantity.

2. Average Reading

Text B

BINARY NUMBER SYSTEM

I. a) Listen to the text. b) Read it (time limit is 3 min.). c) Find the part of it dealing with the various bits in a binary sequence. Speak on them.

In the binary number system, the arabic numerals 0 and 1 are the only digits used. By combining these binary digits, or bits, in the proper manner, decimal numbers can be represented. For the present analysis, only integer decimal values will be considered. In order to represent a decimal number, the bits 0 and 1 are written in a sequence. The various bits in a binary sequence are multiplied by power of 2, and the position of a bit determines the power of 2 by which the bit is to be multiplied. The sequence is often written from right to left, with the most significant bit to the extreme left. This convention will be followed in the present discussion. Let the bit position at the extreme right in the sequence represent $2^0 = 1$; then the second bit position from the right represents $2^1 = 2$. Each additional position to the left represents an additional power of 2. The binary number 1011 is interpreted, from left to right, as $1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0$, which is equal to the decimal number 11.

ASSIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about.

II. a) Skim through the Text B and explain how decimal numbers can be represented by binary digits.

III. Answer the following questions embracing the contents of the texts.

1. What numerals does symbolic logic use? 2. What do these two digits constitute? 3. How can the binary number system best be described? 4. What numerals does the decimal number system utilize? 5. By what is each digit in decimal number multiplied? 6. Are the various products then summed together to yield the decimal quantity? 7. By what is the power of 10 by which a digit is multiplied determined? 8. What are the only digits used in the binary number system? 9. How can decimal numbers be represented? 10. How are the bits 0 and 1 written in order to represent a decimal number? 11. By what are the various bits in a binary sequence multiplied? 12. What does the position of a bit determined?

IV. Prepare a dialogue using information of the Text A and Text B.

V. Speak on:

1. Symbolic logic.
2. Binary number system.

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these words.

Application применение; design проект, конструкция; describe описывать; respectively соответственно; provide обеспечивать; network сеть; stable стабильный, устойчивый; profound глубокий, сильный; expression выражение; subject v. подвергать, подчиняться; assign определять; extensively широко; refer v. относиться.

II. Memorize these terms.

Relay switching network релейная переключающая цепь; network design построение цепи (схемы); circuit arrangement схемная конфигурация; straight forward method простой и очевидный метод; switching elements переключающие элементы; refer to as "logic circuits" относиться к «логическим цепям».

III. Find these word-combinations in the Text C and translate sentences containing them.

Relay contacts релейные контакты; to provide a straightforward method обеспечить простой метод; a mathematical expression to describe математические выражения для описания; a profound effect сильный эффект.

IV. Analyse the structure of the following words and give their initial forms.

Application, switching, network, straightforward, writing, expression, arrangement, simplification, extensively, bistable, magnetic, operation.

V. Find in the Text C the English equivalents of the following Russian word-combinations.

Написать статью о применении: открытое и закрытое положение; описаны в выражениях; два устойчивых положения; подвергаться определенным правилам упрощения; для того, чтобы уменьшить.

Text C

BOOLEAN ALGEBRA AND SWITCHING CIRCUITS

I. a) Read the text. b) Find the part of it describing a simply stated network design. Translate it.

In 1938, Shannon wrote a paper on the application of Boolean algebra to the design of relay switching networks. Open and closed states of relay contacts were described in terms of 1 and 0, respectively. The mathematics of logic was shown to provide a straitforward method of designing networks composed of switching elements having two stable states. Simply stated network design consisted of writing a mathematical expression to describe a circuit arrangement of relay contacts; the expression could then be subjected to certain rules of simplification in order to reduce the total number of relay contacts.

The above application of Boolean algebra had a profound effect upon future designs of switching networks. This algebra has since been used extensively to analyze and synthesize circuits which contain elements having two stable states; these elements may be relays, vacuum tubes, transistors, bistable magnetic devices, or other bistable electrical devices. The above circuits perform operations which are described by the algebra of logic and are often referred to as "logic circuits".

ASSIGNMENTS

I. Answer the following questions embracing the contents of the Text C.

1. When was a paper on the application of Boolean algebra to the design of relay switching networks written? 2. Had the application of Boolean algebra a profound effect upon future designs of switching networks? 3. How has this algebra been used? 4. What elements have two stable states? 5. What are referred to as "logic circuits"?

II. Combine your answers into a short summary of the text.

III. a) Divide the text into logical parts. b) Choose the key sentences and translate them.

IV. Comment on the author's attitude to Boolean algebra and switching circuits.

V. Speak on Boolean algebra applied to switching circuits.

VI. Translate the Text C to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

associative, commutative and distributive laws	с черточкой над буквой
	прямой, простой
evaluate v.	соседний
proposition	знак
straightforward	круглые скобки
in honour	не A
parentheses pl.	таблица истинности
truth table	применять
substitute v.	оценить
employ v.	высказывание
likewise	в честь
with the bar over the letter	тем не менее, подобно
sign	по отношению к
adjacent	по крайней мере
with respect to	точка (над чем-либо)

at least	заменять
dot	ассоциативный, коммуникативный и распределительный законы
$\bar{A}$ (not A)	

II. Make sure that you know these word-combinations.

In order to evaluate для того чтобы оценить; generally known общеизвестно; in general вообще; an expression such as выражение, такое как; with respect to по отношению к; it is seen видно; both terms оба терма, обе величины; a listing of various values перечень разных величин; in accordance with в соответствии с; for instance например; although a further simplification хотя дальнейшее упрощение.

III. Give the main forms of the following verbs and translate them.

Develop, denote, know, write, employ, read, give, use, include, see, yield, take, determine, combine, obtain, apply, exist, have, represent, evaluate, show, obtain, reduce, allow.

IV. a) Give the initial forms of the following words and translate them. b) State the function of suffixes.

Generally, description, logical, notation, expression, operation, equation, variable, resulting, listing, distributive, associative, commutative, multiplication, containing, interpretation, relationship.

Text D

BOOLEAN ALGEBRA

I. Read the text and state briefly Boolean algebra.

In order to evaluate logical propositions in a straightforward manner a mathematics of logic was developed. This mathematics is generally known as "Boolean algebra", in honour of George Boole, who in 1854 wrote a description of this logical language.

Two mathematical operations OR and AND are employed in Boolean expressions. In general, the OR function is denoted by + and the AND function is denoted by ×, a dot, parentheses, or simply no notation between two adjacent symbols. The expression $A+B$ is read «A or B» and the expression AB is read «A and B». An expression such as $(A+B)\cdot(C+D)$ is read «A or B and C or D».

Six postulates, or rules, of Boolean algebra are given below. These postulates can be used to evaluate various logical expressions.

$$0+0=0 \quad (1) \qquad 0\times 0=0 \quad (4)$$
$$0+1=1 \quad (2) \qquad 0\times 1=0 \quad (5)$$
$$1+1=1 \quad (3) \qquad 1\times 1=1 \quad (6)$$

With respect to postulates that include the OR operation, it is seen that the result is 1 if at least one of the terms on the left side of the expression is 1. The AND operation yields 1 only when both terms on the left are 1.

Letters are often used in the equations of Boolean algebra to represent variable quantities. Each of these letters may take on a value of 1 or of 0. The expression $A+B=C$ (7) indicates that the value of C is determined by an OR operation upon values of A and B. A listing of various values of A and B, together with each resulting value of C, is referred to as a «truth table».

Truth Table for $A+B=C$

A	B	C
0	0	0
1	0	1
0	1	1
1	1	1

Truth Table for $AB=C$

A	B	C
0	0	0
1	0	0
0	1	0
1	1	1

If there letters A and B are combined in the AND function, the expression is written $AB=C$. (8)

As in ordinary algebra, equivalent expression may be obtained by factoring, combining or expanding terms. The associative, commutative, and distributive laws of ordinary algebra apply to the OR and AND operations. From the associative laws for addition and multiplication:

$$A+(B+C)=(A+B)+C \tag{9}$$
$$A(BC)=(AB)C \tag{10}$$

The commutative laws for addition and multiplication give

$$A+B=B+A, \tag{11}$$
$$AB=BA. \tag{12}$$

The distributive law yields

$$A(B+C)=AB+AC. \tag{13}$$

Several differences exist between ordinary algebra and Boolean algebra. A Boolean expression containing a variable and the number 1 or 0 represents a logical operation and must be evaluated in accordance with postulates (1) to (6). For instance, postulates (2) and (3) show that $A+1=1$ (14)
and postulates (5) and (6) show that

$$A\times 1=A. \tag{15}$$

The six postulates can also be used to obtain

$$A+A=A \tag{16}$$
and
$$A\times A=A. \tag{17}$$

In ordinary algebra, the expression $AB+B$ can be reduced to $B(A+$ $+1)$. The above reduction is also valid in Boolean algebra, although a further simplification can be made. Equation (14) shows $A + 1$ is equal to 1; this reduces the expression to $B \times 1$ which from Eq. (15), yields B alone. The above steps give the Boolean identity $AB + B = B$. (18)

Since a binary number must be either 0 or 1, the two numbers are said to be complements of each other. A letter used to represent a binary number has a complement. If the letter represents 1, the complement to this letter is 0. Likewise, the complement of the letter takes on the value 1 when the letter itself represents 0. The complement of a letter is the "inverse" of the letter and is usually denoted by the same letter primed or with a bar over the letter; the bar notation will be used throughout the book. The letter A has as its complement the letter $\bar{A}$; this letter symbol is read "not A". One interpretation of the symbol A and $\bar{A}$ is that the former represents the true state of the variable and the latter represents the false, or complementary, state of the variable.

Two useful relationships between the true and complementary states of a variable are given below:

$$A + \bar{A} = 1, \tag{19}$$

$$A \times \bar{A} = 0. \tag{20}$$

Postulates (2) and (3) can be used to varify Eqs. (19) and (20), respectively. An OR function can be written in the form of an AND function by use of complements. Likewise, complementary notation allows an AND function to be modified to the form of an OR function. The identities can be varified by use of truth tables:

$$ABC\ldots = \overline{\bar{A} + \bar{B} + \bar{C}\ldots}, \tag{21}$$

$$A + B + C\ldots = \overline{\bar{A}\,\bar{B}\,\bar{C}}\ldots. \tag{22}$$

ASSIGNMENTS

I. Answer the following questions embracing the contents of the text.

1. Upon what is Boolean algebra based? 2. What operations are employed in Boolean expressions? 3. How are OR and AND functions denoted? 4. Are letters used in the equations of Boolean algebra? 5. What value may each of the letters take? 6. What does the expression $A + B = C$ indicate? 7. What is referred to as a "truth table"? 8. To what do the associative, commutative, and distributive laws of ordinary algebra apply? 9. What represents a logical operation? 10. How must a Boolean expression be evaluated? 11. What is one interpretation of the symbol A and $\bar{A}$?

II. Prepare a dialogue on the topic.

III. Make up a plan of the Text D.

IV. Speak on the text according to your plan.

V. Look through the latest magazines and find additional information on Boolean algebra. Discuss it.

III. GRAMMAR EXERCISES

I. a) Analyse the following sentences, find out the subject and the predicate. b) Translate the sentences.

1. For the present analysis, only integer decimal values will be considered. 2. Since a binary number must be either 0 or 1, the two numbers are said to be complements of each other. 3. The various bits in a binary sequence are multiplied by power of 2, and the position of a bit determines the power of 2 by which the bit is to be multiplied. 4. Let the bit position at the extreme right in the sequence represent $2^{\circ}= 1$.5. The power of 10 by which digit is multiplied is determined by the position of the digit within a given sequence. 6. It is necessary that there be a detectable difference in voltage or current levels between the two stable states of a transistor switch in order for the correct binary interpretation to be made.

II. a) Define the function of the Participle. b) Translate the sentences.

1. A given sequence of materials is immediately interpreted as a particular quantity. 2. In the binary number system, the arabic numerals 0 and 1 are the only digits used. 3. A Boolean expression containing a variable and the number 1 or 0 represents a logical operation.

III. Pick out all sentences in the Text D containing modal verbs with the Passive Infinitive and translate them.

IV. Change the following sentences according to the model and translate them.

Model. The expression **was subjected** to certain rules of simplification.
The expression **could be subjected** to certain rules of simplification.

1. This algebra was used extensively to analyze and synthesized circuits. 2. A mathematics of logic was developed. 3. Two mathematical operations OR and AND are employed in Boolean expressions. 4. The OR function is denoted by + and the AND function is denote by x.

V. Define the function of the Gerund and translate sentences.

1. By combining these binary digits, or bits, in the proper manner, decimal numbers can be represented. 2. The mathematics of logic was shown to provide a straightforward method of designing networks of switching elements having two stable states. 3. Simply stated network design consisted of writing a mathematical expression to describe a circuit arrangement of relay contacts; the expression could then be subjected to certain rules of simplification in order to reduce the total number of relay contacts. 4. As in ordinary algebra, equivalent expressions may be obtained by factoring, combining or expanding terms.

VI. Define the tense-forms of the verb in these sentences and translate them.

1. Various products are then summed together to yield the decimal quantity. 2. Only integer decimals will be considered. 3. The bits 0 and 1 were written in sequence. 4. The sequence is often written from

right to left. 5. This convention will be followed in present discussion. 6. Each digit in a decimal number is actually multiplied by a power of 10.

Lesson 3. LOGIC CIRCUITS

I. INDEPENDENT WORK

In the Laboratory.

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Listen and repeat after the speaker. b) Practise the pronunciation of the following.

[ei] name, make, operation, gate, range; [æ] as, fact, that, and, can, maximum; [ai] describe, type, whilst, diode, wide, primarily, spike; [i] initial, is, different, give, still, system, which, input, single, chip; [i:] be, field, descrete, speed, achieve, increase; [ou] whole, so low, most, approach, slow; [ɔ] logic, only, on, cost, popular, all, not; [ju:] use, calculate, popular; [ʌ] supplement, multiple, function, such, consumption, currently; [oi] noise, avoid.

supplement ['sʌpləmənt], availability [əˌveilə'biliti], deliberately [di'lıbərıtlı], environment [ın'vaıərənmənt], precaution [prı'kɔ:ʃən], immunity [i'mju:niti], elaborate [ı'læbərıt], virtue ['və:tju:].

II. Make sure that you know these words. Say what Russian words help you to guess their meanings. b) Repeat these words after the speaker.

Logic, descrete, resistor, transistor, diode, popular, computer, maximum, equivalent, propagation, serious, compact, calculator, base, function, voltage, perform.

III. a) Listen, repeat and memorize the following words and word-combinations. b) Check if you know the meaning of these words.

Abbreviation сокращение; describe описывать; supplement добавлять, дополнять; availability (при)годность, наличие; low cost низкая стоимость; capability способность; deliberately обдуманно; precaution предостережение, предосторожность; in noise immunity помехоустойчивость; incorporate помещать, включать; permissible допустимый; margin грань, предел, граница поля; elaborate тщательно разработанный, выработанный; complementary дополнительный, добавочный; chief virtue главное достоинство (свойство); extremely чрезвычайно; consumption потребление; gate input вход элемента (вентиля); fast noise spikes быстрые шумовые всплески; pocket calculator chips кристаллы для карманных калькуляторов; IC computer ЭБМ на интегральных схемах; CMOS system система логики на основе К-МДП транзисторов.

IV. a) Listen and repeat after the speaker the following terms. b) Memorize them and their abbreviations.

multiple-emitter transistor (MET) многоэмиттерный транзистор (МЭТ); emitter-coupled logic (ECL) логика с эмиттерной связью (ЭСЛ);high-level logic (HLL) высокоуровневая логика; high-noise immunity logic HNIL) высокопороговая логика, не восприимчивая к высоким шумам логика (НВШЛ); resistor-transistor logic (RTL) резисторно-транзисторная логика (РТЛ);diode-transistor logic (DTL) диодно-транзисторная логика (ДТЛ); transistor-transistor logic (TTL) транзисторно-транзисторная логика (ТТЛ); IC computer ЭВМ на интегральных схемах; random-access memories (RAMs) ЗУ со случайной выборкой (ОЗУ); CMOS system система логики на основе К-МДП транзисторов.

V. Make up sentences using the following word-combinations from the Text A and the Text B and translate them.

Extensive use широкое применение; whilst it uses в то время, как он использует; makes it popular делает его известным; the fact remains, however, that однако сущность заключается в том, что; such as такие, как; it also makes possible это также делает возможным; in addition в дополнение; however однкао.

VI. a) Give initial forms of the following words. b) Translate them.

Abbreviations, supplement, giving, availability, counting, operating, operation, achieving, achievement, typically, saturation, approaching, capability, deliberately, particularly, permissible.

Text A

TYPES OF LOGIC CIRCUITS

I. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

Extensive use is made of abbreviations in the logic field. A whole series of initials is used to describe different types of logic circuits. If the discrete circuits use only resistors and a transistor, so they are described as resistor-transistor logic (RTL) whilst it uses diodes on the input to supplement the transistor and are termed diode transistor logic (DTL). The diode at the input may be fabricated in the form of a special multiple-emitter transistor, giving the circuit its name of transistor-transistor logic (TTL). The wide availability and low cost of TTL makes it popular for all logic and counting function. The fact remains, however, that it is primarily designed for fast operating in large computer. Still faster types of logic, such as Schottky TTL and emitter-coupled logic (ECL) are currently used, these achieving extra speed (typically 2ns delay per gate) by avoiding transistor saturation. Most logical control and counting operations do not require operating speeds even approaching the capability of TTL.

2. Average Reading

Text B

LOGIC CIRCUITS FOR SLOW OPERATION

I. a) Listen to the text. b) Read it (time limit is 3 min.). c) Find the part of it dealing with the using of MOS logic. Translate it.

Several logic systems are available which are deliberately designed for slow operation, making them particularly useful in noisy environments without special precautions. High-level logic (HLL) and high-noise immunity logic (HNIL) both use a modified form of diode-transistor logic (DTL). A Zener diode is incorporated in the gate input to raise the maximum permissible logic 0 input level to 5 V, giving increased margin over the equivalent 0.8 V range of TTL. A higher supply voltage of 12 V to 15 V gives increased margin of 4 V to 7 V at the logic I threshold. Gate propagation times are some 20 times greater than with TTL, so that fast noise spikes are no longer a serious problem.

Elaborate logic functions can be fabricated on a single chip using MOSFET transistor, which are very compact, some 5000 devices being possible on a chip 4 mm square.

MOS logic is used for pocket calculator chips; it also makes possible the IC computer or micro-processor and random-access memories (RAMs). This very popular range of IC logic uses complementary MOSFET transistors. The chief virtue of the CMOS system is its extremely low power consumption (typically 10 nW per gate). In addition it offers very good noise immunity. However MOS logic has low speed of operation.

ASSIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about.

II. Skim through the Text B and find the part of it dealing with HLL and HNIL. b) Discuss information about several logic systems with your fellow-students.

III. a) Find the part of the text containing information about gate propagation times. b) Discuss it using your knowledge on the topic.

IV. Answer the following questions embracing the contents of the Text A and the Text B.

1. What is used to describe different types of logic circuits? 2. What is described as resistor-transistor logic? 3. In what form may the diodes at the input be fabricated? 4. What makes TTL popular for all logic and counting functions? 5. For what is TTL primarily designed? 6. What computers are currently used? 7. What operations do not require operating speed? 8. What logic systems are designed for slow operation? 9. What form of diode transistor logic do both high-level logic and high-noise immunity logic use? 10. What can elaborate logic functions be fabricated on? 11. For what is MOS logic used? 12. What is the chief virtue of the CMOS system?

V. Prepare a dialogue on the topic.

VI. Speak on:

1. TTL integrated circuit logic.
2. High-level logic.

VII. Express your opinion of logic circuits and their using for different types of operations.

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these words and word-combinations.

Advent приход; relatively относительно; approximately приблизительно; recently недавно; brief краткий; alter v. изменять(ся), переделывать; convey v. передавать, выражать; especially особенно; realize осуществлять; application применение; verify v. подтверждать, проверять.

II. Memorize the following abbreviations.

SSI small-scale integration	малый уровень интеграции;
LSI large-scale integration	большой уровень интеграции;
PLA programmable logic array	программируемая логическая матрица.

III. Find these word-combinations in the Text C and translate; sentences containing them.

Multiple sums of products многократные суммы произведений; by making or ommiting устанавливая или пропуская; at intersection point в точках пересечения; not convey the same meaning не иметь того же значения; digital controller цифровой контроллер; product terms члены в виде произведений (в булевой алгебре); random logic произвольные логические схемы.

IV. a) State the function of each suffix in the following words. b) Translate these words.

Transistorized, relatively, desirable, cheaper, programmable, combinational, especially, implementation, realization, usually, application, realizing, regularity, equivalent.

Text C

DIODE LOGIC AND THE PROGRAMMABLE LOGIC ARRAYS (PLA)

I. a) Read the text. b) Find the part of it describing the forms of SSI logic. Translate it.

The first transistorized digital circuits used individually packaged ("discrete") diodes and transistors in a circuit form known as diode logic. Diode logic uses relatively few transistors and many more diodes, a desirable situation in those days when diodes were much cheaper than transistors. With the advent of small-scale integrated (SSI) digital circuits, the cost of diodes and transistors were approximately equalised, so circuit forms using more transistors were economical. The forms of SSI logic in wide use today are transistor-transistor logic (TTL), emitter-coupled logic (ECL), and complementary metal-oxide semiconductor (CMOS) logic.

Recently, an evolutionary form of diode logic has come into use in large-scale integrated (LSI) microprocessors and other circuits. It is known by a new name, programmable logic array (PLA).

The programmable logic array (PLA) is a combinational circuit for finding multiple sums of products. The word programmable in the name refers to the fact that the logic function is altered by making or omitting logic connections at intersection points within a rectangular array of orthogonal conductors. In this context, the word programmable does not convey the same meaning as it does when referring to a programmable computer.

PLAs are widely used today, both as individual LSI circuits and as subcircuits within LSI microprocessors and digital controllers. They are especially efficient for realizing control logic functions. Usually in control applications, less than all the possible product terms are needed. PLAs are less efficient for realization of arithmetic logic, in which all product terms are likely to be used. Efficiency here is defined as the silicon chip area of a PLA as compared to gate logic for realization of a specific logic function. The regularity of the PLA as contrasted with the irregular "random logic" nature of gate logic implementations always makes it easier to design and verify than the equivalent function designed with gates.

ASSIGNMENTS

I. a) Divide the text into logical parts. b) Choose the key sentences and translate them.

II. Look through the Text C and find the part of it dealing with programmable logic array (PLA). Comment on the point.

III. Answer the questions embracing the contents of the Text C.

1. What are transistorized digital circuits? 2. What does diode logic use? 3. What is the cost of diodes and transistors? 4. What are the forms of SSI logic in wide use today? 5. What is known as a programmable logic array (PLA)? 6. What does the word programmable in the name refer to? 7. Are PLAs widely used today? 8. What are PLAs especially efficient for? 9. Where are PLAs less efficient? 10. How is efficiency of PLA defined here? 11. What makes PLA easier to design and verify than the equivalent function designed with gates?

IV. Summarize your answers into a short summary of the text.

V. Make up a plan of the Text C and speak on the topic according to your own plan.

VI. Find the verbs in all sentences in the Text C and state their tense-forms.

VII. Translate the Text C to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following words and word-combinations with the Russian ones.

a sink	управлять, направлять
shift v.	из-за
distribution	достаточно
because of	насыщать, пропитывать
sufficiently	распределение
saturate	сдвигать
current-hogging effect	сток, поглотитель
steer v.	эффект неравномерности токов («искривления» токов)

II. Give the initial forms of the following words from the Text D and translate them.

Relatively, independent, principally, leakage, generally, driving, succeeding, cutoff, development, coupling, connection, increasingly, identical.

III. State the tense-forms of the following verbs from the Text D.

Insert, serve, determine, add, refer, combine, apply, amplify, transform, connect, show, utilize, make, flow, become, rise, steer, perform.

Text D

TRANSISTOR-RESISTOR LOGIC AND OTHERS

I. Read the text and give short information about transistor-resistor logic.

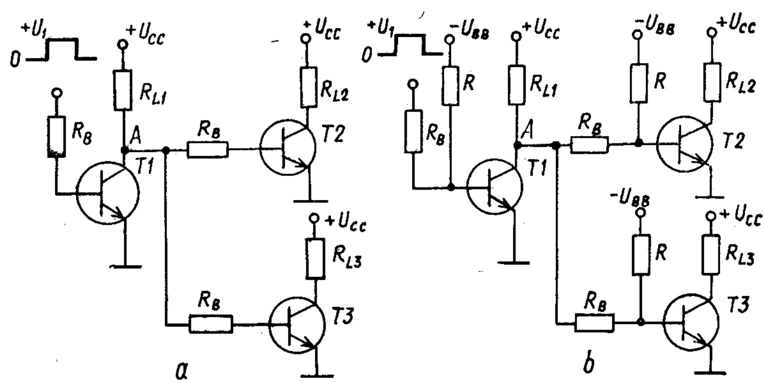


Fig. 3.4. Logic circuits of RTL-type:
a a circuit without base bias; *b* a circuit with base bias.

Resistors can be inserted between the collector of a transistor and the bases of fan-out transistor, as shown in Fig. 3.4*a*. These resistors serve to make base current to a transistor relatively independent of the base-emitter diode characteristic of the device. Hence, base currents to T_2 and T_3 in the above figure are determined principally by the magnitude of R_B and R_{L1}. In order to reverse bias T_1, T_2, T_3 in the OFF state and also to provide a sink for collector-base leakage current of these devices, resistor R and supply voltage — U_{BB} can be added to the inputs, as shown in Fig. 3.4*b*. This latter circuit is generally referred to as either a "transistor-resistor logic (TRL)" or as a "resistor-transistor logic (RTL)" stage.

The diode logic circuits can be combined with transistors to form "diode-transistor logic (DTL)" circuits. In effect, the output of diode gate is applied to the base of a grounded-emitter transistor; the transistor amplifies the signal and shifts it to the proper voltage level for driving a succeeding stage.

Both the OR/AND and AND/OR diode gates can be combined with the transistor; the base-input-voltage level to the transistor is inverted, and the complete circuit function is the inverse of that for the diode gate alone. Hence, the OR/AND gate is transformed to a NOR/NAND circuit, and the AND/OR gate becomes a NAND/NOR gate.

Fig. 3.5*a* shows a NOR/NAND DTL stage. A diode OR/AND gate is connected to the input of a single-transistor inverter. When the transistor is at cutoff, resistance R_L and supply voltage U_{CC} serve as a current source to N_0 fan-out transistors. Resistor R_B is connected in series with the transistor base to give an equal distribution of forward connected to a single inverter; this prevents the current-hogging effect.

One of the more recent developments in transistor logic circuits is shown in Fig. 3.5*b*. This logic circuit, which utilizes a multiple-emitter transistor as the coupling element between stages, is variously referred to as a "transistor-coupled logic (TCL) circuit", a "transistor-

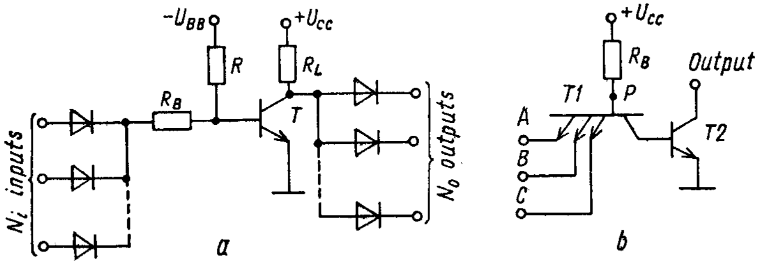


Fig. 3.5. Logic circuits of DTL- and TTL-types:
a the DTL circuit with simple inverter; *b* the TTL circuit identical to *a*.

transistor-logic (TTL) circuit", or "a transistor-squared logic (T^2L) circuit". Because of the requirement for a multiple-emitter transistor, this form of logic circuit is generally available only in integrated form.

Consider, for a moment, that an input signal is applied only to emitter *A* in the circuit of Fig. 3.5*b*, no connections are made to emitter *B* and *C*. When the input signal is at ground potential, current from the U_{CC} supply flows through R_B, into the base terminal of T_1, and out of emitter *A*. There is no forward base current to transistor T_2, as the voltage level at point *P* is not sufficiently positive to forward-bias both the base-collector diode of T_1 and the base-emitter diode of T_2.

Let the input signal level at emitter *A* now become increasingly positive. The voltage level at point *P* eventually becomes sufficiently positive for a portion of the base-input current of T_1 to flow through the base-collector junction of T_1 and into the base of T_2. When the voltage level at terminal *A* rises above the two diode drops seen to the right of point *P*, the entire current through R_B is steered through the collector of T_1 and into the base of T_2; forward base current to T_2 is now sufficiently large to saturate this device. The multiple-emitter transistor performs a logic function which is identical to that of the diode AND gate.

ASSIGNMENTS

I. Answer the following questions embracing the contents of the Text D.

1. What do the resistors shown in Fig. 3.4*a* serve? 2. How are base currents to T_2 and T_3 in the above figure determined? 3. What does a base speed up capacitor improve? 4. What can be combined with transistors to form "diode-transistor logic" (DTL) circuits? 5. What gates can be combined with the transistor? 6. What does Fig. 3.5*a* show? 7. When does resistance R_L and supply voltage U_{CC} serve as a current source to N_0 fan-out transistors? 8. How is resistor R_B connected with the transistor base to give an equal distribution of forward connected to a single inverter? 9. Does it prevent the current-hogging effect? 10. Where does current from the U_{CC} supply flow when the

input signal is at ground potential? 11. What is a diode OR gate connected to?

II. Prepare a dialogue on your own situation, describing the popularity of TTL and showing how to avoid transistor saturation.

III. Make up a plan of the Text C and retell the text according to your plan.

IV. Examine Figs. 3.4 and 3.5. Comment on:

1. A circuit without base bias.
2. A circuit with base bias.
3. The DTL circuit with simple inverter.
4. The TTL circuit identical to *a*.

V. Speak on:

1. TRL stages.
2. Diode transistor logic.

VI. Make a short written summary of the Text D.

VII. Look through the latest magazines on the topic of this lesson and discuss an additional material with your fellow-student as a problem of nowadays.

III. GRAMMAR EXERCISES

I. a) Find the following word-combinations in the Text D and translate them. b) State the attributes in all of them.

Base-emitter diode, reverse-bias, OFF state, collector-base leakage currents, transistor-resistor logic, resistor-transistor logic, diode-logic circuits, grounded-emitter transistor, OR/AND and AND/OR diode gates, base-input-voltage level, NOR/NAND circuit, AND/OR gate, NAND/NOR gate, NOR/NAND DTL stage, single-transistor inverter, fan-out transistor, transistor-coupled logic circuits, multiple-emitter transistor, base-input current.

II. Translate these sentences with the verbs in the Passive Voice.

1. Extensive use is made of abbreviation in the logic field. 2. The discrete circuits are described as resistor-transistor logic (RTL) when they use only resistors and transistors. 3. TTL is primarily designed for fast operating in large computer. 4. Schottky TTL and ECL are currently used. 5. Several logic systems are designed for slow operation. 6. MOS logic is used for pocket calculator chips.

III. Pay attention to modal verbs with the Passive Infinitive while translating these sentences.

1. The diode at the input may be fabricated in the form of a special multiple-emitter transistor. 2. Elaborate logic functions can be fabricated on a single chip using MOSFET transistor.

IV. a) Find the Participle and the Gerund in these sentences. b) Define their functions and translate them.

1. The wide availability and low cost of TTL makes it popular for all logic and counting functions. 2. Still faster types of logic, such as Schottky TTL and emitter-coupled logic (ECL) are currently used, these achieving extra speed by avoiding transistor saturation. 3. Most logical control and counting operations do not require operating speeds even approaching the capability of TTL. 4. A Zener diode is incorpora-

ted in the gate input to raise the maximum permissible logic 0 input level to 5 V, giving increased margin over the equivalent 0.8 V range of TTL. 5. Elaborate logic functions can be fabricated on a single chip using MOSFET transistor, which are very compact, some 5000 devices being possible on a chip 4 mm square.

V. a) Analyse the following sentences. b) Find subjects and predicates in the principle and subordinate clauses. c) Translate these sentences.

1. Diode logic uses relatively few transistors and many more diodes, a desirable situation in those days when diodes were much cheaper than transistors. 2. In order to reverse bias T_1, T_2, T_3 in the OFF state and also to provide a sink for collector-base leakage currents of these devices, resistor R and supply voltage — U_{BB} can be added to the inputs, as shown in Fig. 3.4*b*. 3. When the input signal A in Fig. 3.5*b* is at ground potential, current from the U_{CC} supply flows through R_B, into the base terminal of T_1 and out of emitter A.

Lesson 4. FLIP-FLOP CIRCUITS

I. Independent Work.
In the Laboratory:
1. *Skimming Reading.*
   Pre-text Exercises.
   Text A. Combinational and Sequential Logic Circuits.
2. *Average Reading.*
   Text B. Flip-flop Operation.
   Assignments.

II. Classwork.
3. *Close Reading.*
   Pre-text Exercises.
   Text C. SR Flip-flop.
   Assignments.
4. *Searching Reading.*
   Pre-text Exercises.
   Text D. Clocked SR Flip-flop and Other Types.
   Assignments.

III. Grammar Exercises.

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Listen and repeat after the speaker. b) Practise the pronunciation of the following.

[s] piece, except, place; [k] capacity, circuit, describe, directly, combination, class, common; [dʒ] voltage, logic, register, stage; [g]

grid, propagation, negative, going, signal, regulate; [tʃ] such, which, each, change, achieve; [k] characteristic, orchestra; [ʃ] show, short, should, shall; [ð] there, another, that, then, than; [θ] theory, theme, three.

Simultaneous [ˌsiməl'teinjəs]; indeterminate [ˌɪndɪ'tə:mɪnɪt].

II. a) Make sure that you know these words. Say what Russian words help you to guess their meanings. b) Repeat these words after the speaker.

Combinational, class, nonregenerative, analyse, transistor, positive, negative, voltage, practical, method, signal, symbol, construct, configuration, terminal, energize, line, diagram, identical, normally, music, adapt, basic, pulse, data.

III. a) Listen, repeat and memorize the following words and word-combinations from the Text A and the Text B. b) Check if you know their meanings.

Combinational комбинационный; sequential последовательный; common example обычный (простой) пример; previous предшествующий; immediately previous input data непосредственно предшествующие входные данные; as well as также, как; intentionally намеренно, умышленно; sufficiently positive to saturate transistor T_2 достаточно положительное для насыщения транзистора T_2; logic-circuit representation of this flip-flop представление этого триггера как логической схемы; sufficiently достаточно; considerably значительно.

IV. Memorize these terms and their Russian equivalents.

Delay задержка; lack v. испытывать недостаток; clock counter счетчик с параллельным переносом (синхронный счетчик); data register цифровой регистр; clock oscillator тактовый генератор; time delay circuit схема временной задержки; characteristic of sequential circuits характерное свойство последовательных схем; output node выходной узел; inverter stage инверторный каскад; bistable circuit схема с двумя устойчивыми состояниями; flip-flop circuits триггерные схемы; cross-coupled перекрестносвязанный; transient response переходная функция; speedup capacitor ускоряющий конденсатор.

V. Pay attention to the translation of the terms.

NOR stage (NOR = NO : OR) каскад ИЛИ/НЕ; cross-coupled single-input NOR stage одновходовые каскады ИЛИ/НЕ с перекрестной связью; OR-gate input вход элемента ИЛИ; NOR-type flip-flop триггер на элементах ИЛИ/НЕ; AND-NOT logic логика И-НЕ; NAND-type flip-flop триггер на элементах И-НЕ; DTL NAND gates ДТЛ элементы И/НЕ.

VI. a) Find attributes in these word-combinations and say by what parts of speech they are expressed. b) Translate them.

Combinational logic circuits; internal connections; clock counter; positive feedback; inverter stage; bistable circuit; each stage; above operating conditions; circuit application; techniques described; small capacitors; positive or negative-going signal; the above speedup capacitors; cross-coupled single-input NOR stages; the output terminal of this circuit.

VII. Translate the following pairs of words paying attention to the meanings of prefixes.

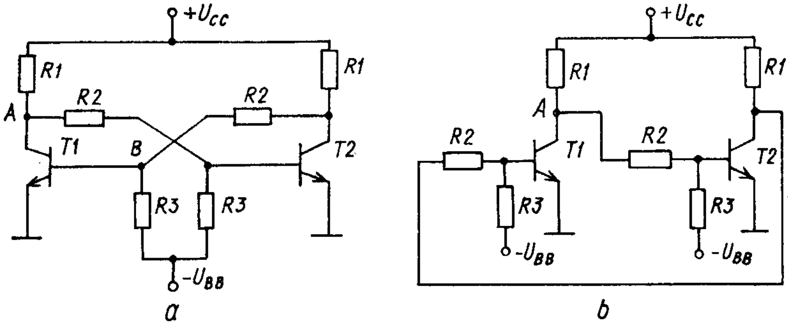


Fig. 3.6. Flip-flop:
a a basic circuit; b the basic circuit redrawing as two RTL stages.

Draw — redraw; drawing — redrawing; connect — reconnect; connect — disconnect; increase — decrease.

Text A

COMBINATIONAL AND SEQUENTIAL LOGIC CIRCUITS

I. **a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.**

In all the logic circuits that have so far been described, at any point in time the output has been directly related to the input by some logic combination, except for some short propagation delay. Hence, as a class these circuits are known as combinational logic circuits. Common examples of this type of circuit are the simple digital gates NOR, NAND, etc. Combinational circuits, which lack intentional connections between output and inputs, are also known as non-regenerative circuits.

There is another class of circuits, known as sequential logic circuits, in which not only immediately previous input data affect the outputs. Outputs also are dependent on preceding values of input data. These circuits also find ready application in digital systems. Examples are clock counters and data register as well as clock oscillators and time delay circuits. A characteristic of sequential circuits is that one or more output nodes are intentionally connected back to inputs to give positive feedback, or regeneration.

Basic to sequential circuits is the bistable circuit. Two inverter stages, cross-coupled as shown in Fig. 3.6*a*, provide a basic form of bistable circuit, or "flip-flop" circuit. The above circuit may be analyzed by redrawing it as in Fig. 3.6*b*, which shows that the flip-flop is simply a connection of two TRL NOR stages, with the output of each stage serving as the input to the other stage. When transistor T_1 is cut off, voltage at point *A* is sufficiently positive to saturate transistor T_2. Voltage at point *B* is now slightly negative, and T_1 is reverse-biased to cutoff. The above operating conditions for T_1

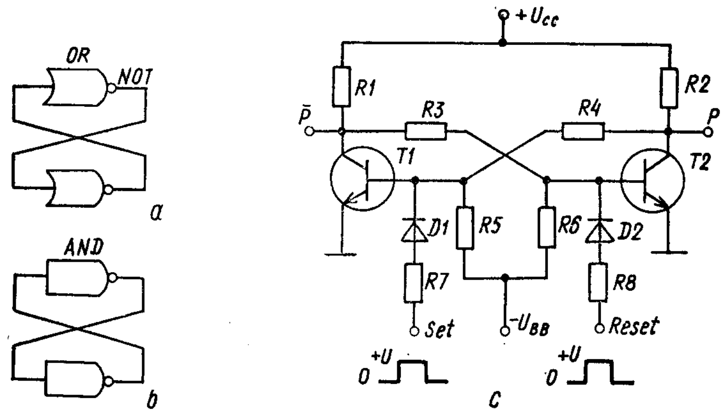


Fig. 3.7. A logic-circuit diagram:
a for NOR-type flip-flop; *b* for NAND-type flip-flop; *c* flip-flop as in Fig. 3.6 *a*, but with two input signal lines.

and T_2 represent one stable state of the flip-flop. A second state exists when T_1 is in saturation and T_2 is at cutoff.

2. Average Reading

Text B

FlIP-FLOP OPERATION

I. a) Listen to the text. b) Read it (time limit is 5 min.). c) Find the part of it dealing with cross-coupled single-input NOR stages used in the flip-flop circuits. Translate it.

Consider, for instance, that the flip-flop circuit of Fig. 3.6*a* is at the stable state where T_1 is on and T_2 is off. The circuit will change to the other stable state (T_1 off and T_2 on) for any one of the following:

1. Disconnect T_1 from the circuit and then reconnect it (this causes T_2 to turn on. When T_1 is again connected the $U_{CE(sat)}$ collector voltage of T_2 prevents T_1 from turning on).
2. Apply a positive-voltage level to the base of Q_2 (Q_2 turns on, and Q_1 turns off.)
3. Apply a negative-voltage level to the base of T_1 (T_1 turns off and T_2 turns on).
4. Temporarily ground the collector of T_2 (This removes the base drive to T_1, and the base of T_2 becomes forward-biased).
5. Connect a low resistance from the collector of T_1 to the+ Ucc supply. (The increase in collector current forces T_1 out of saturation).

Methods 1 and 5 are not practical for most circuit applications of the flip-flop. The techniques described in 2 to 4 are widely used to change the operating of a flip-flop.

Small capacitors are often connected across the R_2 resistors in Fig. 3.6*a* and 3.6*b*. These capacitors serve to couple a positive- or negative-going signal from the collector of one transistor to the base of the other transistor. Transient response of the circuit is improved considerably by use of the above speedup capacitors.

Cross-coupled single-input NOR stages are used in the above flip-flop circuit. A logic circuit representation of this flip-flop connection is shown in Fig. 3.7*a*; symbols for the OR and NOT (invert) operations are indicated in the figure. This form of basic flip-flop is referred to here as a NOR-type flip-flop.

Flip-flop stages can also be constructed with AND-NOT logic as shown in the diagram of Fig. 3.7*b*; the stage is considered to be a NAND-type flip-flop. This circuit configuration can be implemented by cross-coupling single-input DTL NAND gates.

ASSIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about.

II. a) Skim through the Text B and choose the key sentences. b) Translate the sentences.

III. a) Divide the Text B into logical parts. b) Give the main idea of each part.

IV. Answer the questions embracing the content of the Text A and the Text B.

1. What has the output been directly related in all the logic circuits to? 2. What circuits are known as combinational logic circuits? 3. What are common examples of combinational logic circuits? 4. Why combinational circuits are known as non-regenerative circuits? 5. Is there another class of circuits, known as sequential logic circuits? 6. Are outputs dependent on preceding values of input data? 7. Where do these circuits find ready application? 8. What are examples of sequential logic circuits? 9. What is a characteristic of sequential circuits? 10. What is the bistable circuit? 11. What do the inverter stages, cross-coupled as shown in Fig. 3.6*a*, provide? 12. What does Fig. 3.6*b* show? 13. What do the above operating conditions for T_1 and T_2 represent? 14. Are method 1 and 5 practical for most circuit applications of the flip-flop? 15. Where are cross-coupled single-input NOR stages used?

V. Examine Fig. 3.7 and comment on a logic-circuit diagram:

1. For NOR-type flip-flop.
2. For NAND-type flip-flop.
3. Flip-flop as in Fig. 3.6*a*, but with two input signal lines.

VI. Prepare a dialogue on your own situation.

VII. Speak on:

1. Combinational and sequential logic circuits.
2. Two inverter stages, cross-coupled as shown in Fig. 3.6*a*.
3. Flip-flop operation.

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these words.

Flip-flop триггер; binary storage двоичная память; true истинный, настоящий; complement дополнение; at a time в данное время; represent представлять; consider рассматривать; store накапливать; saturation насыщение; reduce уменьшать; continue продолжать; change изменять (ся); maintain поддерживать; simultaneously одновременно; refer относиться; "latch" circuit "фиксаторная" схема, схема-защелка; set-reset (SR) flip-flop RS-триггер (с раздельными входами R и S); clocked RS flip-flop синхронный RS-триггер; depend upon зависеть от; allow разрешать; associate связывать; value величина.

II. Find the following word-combinations in the Text C and translate them with the sentences they are involved.

Input signal lines; output terminals; ground potential; set line; forward-biased; input signal; reset line; last stable states; SR stage; logic circuit diagram; logic configuration; external signal; NOR-type SR flip-flop; input binary level; NAND-type SR flip-flop.

III. Give the main forms of the verbs from the Text C and translate them.

Show, be, represent, consider, store, held, provide, reduce, energize, remain, clear, maintain, ground, indetermine, refer, depend, allow, describe, reverse, reset.

Text C

SR FLIP-FLOP

I. a) Read the text. b) Describe a logic-circuit diagram of the SR flip-flop.

Fig. 3.7*c* shows a flip-flop having two input-signal lines. The output terminals of this circuit are shown as P (true) and $\bar{P}$ (complement). When T_2 is off, voltage at P is positive and represents a binary 1; the circuit is now considered to be storing a 1. For T_2 turned on, voltage at P is close to ground potential, and the circuit stores a 0. Consider that the set line is at the $+U$ level and that the reset line is held at ground potential. Diode D_1 is forward-biased and provides base current to T_1; this transistor is in saturation while T_2 is cutoff, and P is at a positive voltage level. The circuit is presently set to 1 state. If the input signal on the set line is reduced to ground potential, the flip-flop continues to store a 1. If the reset line is then energized with the $+U$ level and the set line remains at ground potential, diode D_2 provides forward base current to Q_2; this transistor turns on, and the flip-flop changes states. The flip-flop is now reset, or cleared,

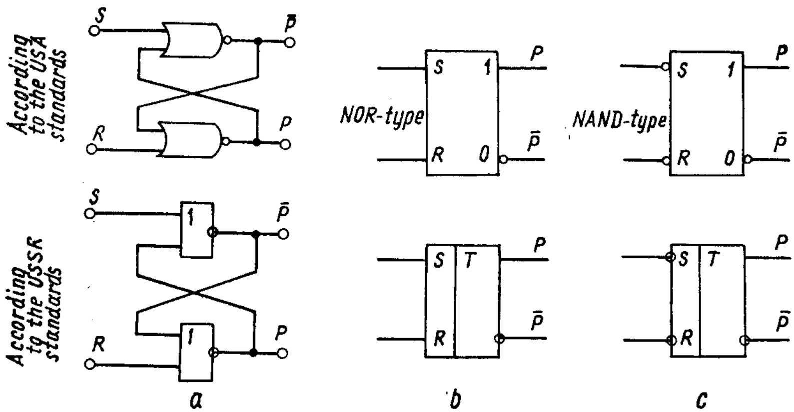


Fig. 3.8. Logic-circuit diagrams and their symbols:
a a diagram for SR flip-flop NOR-type; *b* the symbol for SR flip-flop NOR-type; *c* the symbol for SR flip-flop NAND-type.

to the 0 state. This last state is maintained when the reset line is rounded. If both the set and reset lines are simultaneously at the $+U$ level, the final state of the flip-flop indetermined. Hence, only one input signal at a time can be positive. Because the present flip-flop configuration can be set to 1 and reset to 0, the circuit is generally referred to as a "set-reset" (SR) flip-flop. The SR stage is sometimes referred to as a "latch" circuit. This name results from the circuit's ability to latch in one state or the other depending upon which of two input lines is energized.

A logic-circuit diagram of the above SR flip-flop is shown in Fig. 3.8*a*. The logic configuration is identical to that of Fig. 3.7*a*, except that each OR gate now has two input terminals. The added input terminal at each gate allows external signals to change the state of the circuit.

Fig. 3.8*b* shows a symbol for the NOR-type SR flip-flop described above. The output lines are shown to have the binary values associated with the storage of a 1. These output binary levels are reversed when a 0 is stored in the flip-flop. Symbol for the NAND-type SR flip-flop is shown in Fig. 3.8*c*.

ASSIGNMENTS

I. a) Divide the text into logical parts. b) Choose the key sentences and translate them.

II. Look through the text and find the part of it dealing with diode D_1 which is forward-biased and provides base current to Q_1.

III. Answer the following questions embracing the contents of the Text C.

1. What does Fig. 3.7*c* show? 2. How are the output terminals of this circuit show? 3. When is the circuit considered to be storing a 1? 4. For what is voltage at *P* close to ground potential? 5. When is the

transistor T_1 in saturation? 6. When does the flip-flop continue to store a 1? 7. When does diode D_2 provide forward base current to T_2? 8. What is the final state of the flip-flop if both the set and reset lines are simultaneously at the $+U$ level? 9. Why is the SR stage sometimes referred to as "latch" circuit?

IV. Put questions to the words in bold type.

1. Consider that the **set line** is at the $+U$ level and that the reset line is held **at ground potential**. 2. Hence, only **one input signal** at a time **can be positive**. 3. **A logic-circuit diagram** of the above SR flip-flop is shown in Fig. 3.8*a*.

V. Examine Fig. 3.8 and comment on:

1. A diagram for SR flip-flop NOR-type.
2. The symbol for SR flip-flop NOR-type.
3. The symbol for SR flip-flop NAND-type.

VI. Make up a plan of the Text C and retell the text according to your plan.

VII. Review the text in written form.

VIII. Translate the Text C to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

clocked RS flip-flop	отвечать на
regular train of clock pulses	обычно обозначается
orchestra conductor maintains the best with his baton ensuring that all the players keep in time with the music	счетчик
logic 1 pulse	неопределенный выход
clock pulse input (CP)	вход синхроимпульса (СИ)
indetermined output	цифровой отсчет (считывание)
respond to	наоборот
digital read-out	это соединяется
it is wired	это осуществляется через инвертор
counter	регулярная последовательность тактовых (синхронизирующих) импульсов
shift register	двухступенчатая структура (структура основной-вспомогательный или хозяин-раб)
this is accomplished via an inverter	триггер с раздельной установкой (RS-триггер)
vice versa	сдвигающий регистр
by convention labbeled	синхронный RS-триггер
master-slave arrangement	логический единичный импульс
simultaneously	одновременно
set-reset (SR) flip-flop	дирижер оркестра поддерживает

порядок своей палочкой, добиваясь, чтобы все музыканты играли слаженно

II. Give initial forms of the following words and translate them.

Digital, usually, exactly, operation, normally, ensuring, basic, according, simultaneously, undeterminate, useful, application, counter, register, arrangement, convention, directly, inverter, storing.

III. Translate the following word-combinations from the Text D.

Orchestra conductor; set-reset flip-flop; clock pulse input; basic flip-flop; a clocked SR flip-flop; an indeterminate output; clock input; this useful little memory; digital read-out; many flip-flop applications; a master-slave arrangement; the master flip-flop.

Text D

CLOCKED SR FLIP-FLOP AND OTHER TYPES

I. Read the following text and say about different types of flip-flop.

In digital systems, we usually require to determine exactly when an operation is to take place. For instance, if data is to be stored in a flip-flop, it is often essential that the time when the data was entered should be known. This is normally achieved in a computer by a regular train of clock pulses, which control the sequence of events rather as an orchestra conductor maintains the best with his baton, ensuring that all the players keep in time with the music.

The circuit of Fig. 3.9*a* is a set-reset flip-flop adapted so that it can change state only when the clock pulse input(CP) receives a logic 1 pulse. Whilst the CP input is at 0, the NOT gate ensures that each OR gate has an input at 1; both *S* and *R* on the basic flip-flop are held at 1 and the *Q* and $\bar{Q}$ outputs cannot change. As soon as CP goes to 1, however, the OR gates each have an input at zero, so that *S* and *R* on the flip-flop depend only on the logic levels at the external *S* and *R* inputs; the flip-flop will therefore set its state according to the truth table. In this way the clocked SR flip-flop can only respond to the *R* and *S* inputs during a logic 1 clock pulse.

The *D*, or data, flip-flop is a clocked RS flip-flop operated from just one input. This has the advantage that *S* and *R* cannot simultaneously be set to 0 and give an undeterminate output. It is wired as in Fig. 3.9*b*, where the rectangular represents a clocked RS flip-flop. The output is held until the clock input goes from 0 to 1, when whatever logic level is on the *D* input is transferred to the *Q* output, which stores the logic level present when the clock returns to zero. This useful little memory finds particular application in instruments with a digital read-out, where the output must be held steady long enough to be read.

For many flip-flop applications, such as counters and shift registers, it is essential that there can be no change in the output whilst the clock pulse is high, no matter what happens to the data inputs

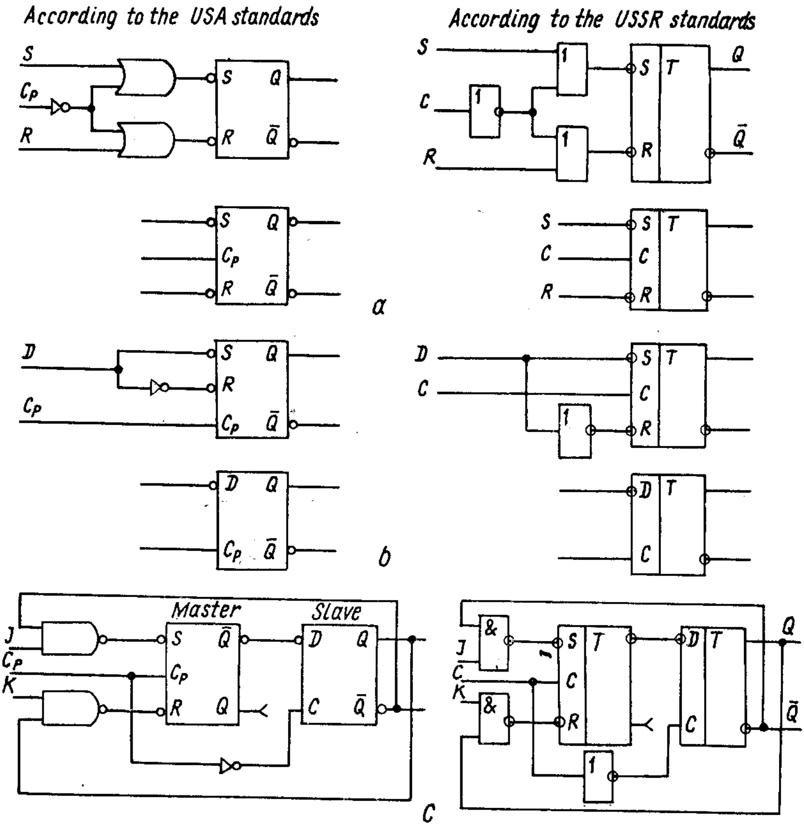


Fig. 3.9. Logic-circuit diagrams and symbols:
a for a clocked SR flip-flop; *b* for D-type flip-flop; *c* for clocked JK flip-flop master-slave type.

during that period. This is accomplished by using two flip-flops together in a master-slave arrangement. The master flip-flop responds to data from the input whilst the clock is high, but this is only passed on to the slave (output) flip-flop as the clock goes back to zero. One such arrangement is shown in Fig. 3.9*c*.

The two inputs are by convention labelled *J* and *K*. A clocked SR flip-flop on the left acts as the master, whilst the *D* flip-flop on the right acts as the slave. Note the clock input goes directly to the master flip-flop but via an inverter to the slave. This means that whilst the clock input is low, the slave is receiving a logic 1 at its CP input and the *Q* output is ready to respond to any change in the *D* input. There cannot, however, be any change here whilst the clock is low, because the master flip flop is locked, storing whatever input it had when the clock was last high.

ASSIGNMENTS

I. a) Skim through the Text D and divide it into logical parts. b) Choose the key sentences and translate them.

II. Find the part of the text describing application of flip-flop.

III. Answer the following questions embracing the contents of the Text D.

1. What is essential if data is to be stored in a flip-flop? 2. How is this normally achieved? 3. What does Fig. 3.9*c* show? 4. When can SR flip-flop change state? 5. What does the NOT gate ensure whilst the CP input is at 0? 6. What is the *D*, or data, flip-flop? 7. What application does the useful little memory of flip-flop find? 8. What does the master flip-flop respond to?

IV. Ask additional questions on the Text D.

V. Discuss the problem of different types of flip-flops.

VI. Examine Fig. 3.9 and comment on:

1. For a clocked SR flip-flop.
2. For *D*-type flip-flop.
3. For clocked JK flip-flop master-slave type.

VII. Make up a plan of the Text D and give a short summary of it.

VIII. Look through the latest magazines and find additional information on flip-flops. Discuss it.

III. GRAMMAR EXERCISES

I. Pay attention to the Perfect Passive forms while translating these sentences.

1. In all the logic circuits that **have** so far **been described**, at any point in time the output **has been** directly **related** to the input by some logic combination, except for some short propagation delay. 2. Simple digital gates NOR, NAND, etc. **have been described** in the previous lessons.

II. Put questions to the words in bold type.

1. **In digital system,** we usually require to determine exactly when an operation is to take place. 2. **The clocked SR flip-flop** can only respond to the *R* and *S* inputs during a logic 1 clock pulse. 3. The output is held **until the clock input goes from 0 to 1**. 4. This is accomplished using two flip-flops together **in a master-slave arrangements**. 5. The two inputs **are** by convention **labelled *J* and *K***.

III. Define the tense-forms in the Passive Voice and translate the sentences with them.

1. Combinational circuits are also known as non-regenerative circuits. 2. Q_1 is reverse-biased to cutoff. 3. The techniques described in 2 to 4 are widely used to change the operating of a flip-flop. 4. Small capacitors are often connected across the *R* resistors in Fig. 3.6*a* and 3.6*b*. 5. Transient response of the circuit is improved considerably by use of the above speedup capacitors. 6. Cross-coupled single-input

NOR stages are used in the above flip-flop circuit. 7. Symbols for the OR and NOT (invert) operations are indicated in the figure. 8. If the input signal on the set line is reduced to ground potential, the flip-flop continue to store a 1. 9. This last state is maintained when the reset line is grounded.

IV. Pay attention to modal verbs with the Passive Infinitive while translating these sentences.

1. The above circuit may be analysed by redrawing it as in Fig.3.6*b*. 2. Flip-flop stages can also be constructed with AND-NOT logic as shown in the diagram of Fig. 3.7*b*. 3. This circuit configuration can be implemented by cross-coupling single-input DTL NAND gates. 4. Because the present flip-flop configuration can be set to 1 and reset to 0, the circuit is generally referred to as a "set-reset" (SR) flip-flop.

V. Define the forms and functions of the Infinitive in the following sentences and translate them.

1. The stage is considered to be a NAND-type flip-flop. 2. The circuit is now considered to be storing a 1. 3. The output lines are shown to have the binary values associated with the storage of a 1. 4. If data is to be stored in a flip-flop, it is often essential that the time when the data was entered should be known. 5. The output must be held steady long enough to be read.

VI. Define the forms and functions of the Participle in these sentences and translate them.

1. Fig. 3.7*c* shows a flip-flop having two input-signal lines. 2. The *D*, or data, flip-flop is a clocked RS flip-flop operated from just one input. 3. This is normally achieved in a computer by a regular train of clock pulses, which control the sequence of events rather as an orchestra conductor maintains the best with his baton ensuring that all the players keep in time with the music.

Lesson 5. CONTROL IN A COMPUTER

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Listen and repeat after the speaker. b) Practise the pronunciation of the following.

I. [ou] road, load, foam; [oɪ] oil, point, alloy; [u] book, look, took, through; [u:] tool, food, root; [ɔ:] door, floor, thought, coarse, source, store, perform; [au] out, output, outgrowth, allow, however; [a:] heart, hard, class; [eɪ] main, obtain.

II. Approximately [ə'prɔksɪmɪtlɪ], subsequent ['sʌbsɪkwənt], sequential [sɪ'kwenʃəl], consecutive [kən'sekjutɪv], synchronize ['sɪŋkrənaɪz].

II. a) Make sure that you know these words. Say what Russian words help you to guess their meanings. b) Repeat these words after the speaker.

Functional, machine, minimize, generated, structure, equivalent, categories, function, identify, unique, instruction, decode, data, signal, activity, elementary, action, typically.

III. a) Listen, repeat and memorize the following words and word-combinations. b) Check if you know the meaning of these words.

Hardware аппаратура, аппаратное обеспечение; in hardware схемно (с помощью схем, аппаратуры); outgrowth продукт; the heart of the system основа, основной узел системы; implementation осуществление, выполнение; execute выполнять; interprete переводить.

IV. a) Find and learn the following terms from the Text A and the Text B. b) Translate the sentences with them.

A general purpose CPU универсальный центральный процессор; memory facility устройство памяти; I/0 section устройство ввода / вывода; main memory основная память; conventional or random logic обычная или случайная логика; programmable logic array программируемая (перестраиваемая) логическая матрица; microprogram control микропрограммное управление; instruction decode расшифровка команды; operand fetch выборка операнда; logic gates логические вентили; instruction execute выполнение команды; instruction fetch выборка команды (из ЗУ); inctruction set набор команд; data fetch выборка данных; address modification logic логические схемы модификации адреса; stored instruction хранимая (в памяти) команда; the descrete component era эра дискретных компонентов; the LSI (large scale integration) approach to random logic подход к построению произвольной логики на больших микросхемах; common control sequence общая управляющая последовательность; to share the same hardware использовать то же оборудование; flow of instructions поток команд.

V. Analyse the following words from the viewpoint of their structure.

Microprogram, outgrowth, irregular, hardware, throughout, well-organized, relationship.

VI. Give English equivalents to the Russian words in brackets and translate the sentences into Russian.

1. (Применение) of the instruction set, which is unique to each design, (определять) the control section of the machine. 2. (Количество) operand fetches (зависеть) on the instruction set. 3. Since each (команда) performs a unique function, the control sequence (отличаться) from instruction to instruction. 4. Fig. 3.10*a* (показывать) the relationship of basic control (функции). 5. The address modification (применяться) to both operand and instruction fetches. 6. Fig. 3.10*b* illustrates (поток данных) of instruction from the main (память). 7. The address modification logic for program (или данные) normally (разделять) the ALU hardware.

Text A

A CONTROL SECTION IN THE COMPUTER

I. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

A general purpose CPU may be considered as being divided into four function units: a control section, a memory facility, an arithmetic logic unit (ALU), and I/0 section. The control section is the heart of the system; it interprets and executed stored instructions from main memory. The implementation of the instruction set, which is unique to each design, defines the control section of the machine.

Three techniques are used to implement the control section in hardware: conventional or random logic, programmable logic array (PLA), and microprogram control. Random logic is an outgrowth of the descrete component era; logic gates are minimized to reduce the hardware cost. This gave rise to an irregular structure; control signals are scattered throughout the entire machine in an apparently random manner. An LSI approach to random logic is the PLA. The logic structures generated by random logic and the PLA's are equivalent.

Control operations may be classified into four basic categories: instruction fetch, instruction decode, operand fetch, and instruction execute. These operations dictate the necessary control signals required to implement the control functions defined by the instruction set of a computing machine.

The instruction fetch operation, which provide the control linkage from instruction to instruction, allows a continuous flow of instructions to be executed. The decode function identifies the various classes of instructions that have common control sequence. This permits different instructions with identical operations to share the same hardware. A data fetch (commonly referred to as an operand fetch) is required to obtain the prescribed data from memory. The number of operand fetches depends on the instruction set.

2. Average Reading

Text B

CONTROL SIGNALS

I. a) Listen to the text. b) Read it (time limit is 3 min.). c) Find the part of the text dealing with the relationship of basic control functions. Translate it.

To implement an instruction, various control signals are required to coordinate the activities occurring at different times. Each action is an elementary operation and, by itself, may not accomplish the desired result. However, the "orchestration" of the various actions into a well-organized sequence results in the operation specified by the instruction. The number of control signals for a given instruction depends on its complexity and the internal structure of the machine. Since each instruction performs a unique function, the control sequences differ from instruction to instruction.

Fig. 3.10*a* shows the relationship of basic control functions. They implement not only the execution of instructions but also perform the addressing of sequencing from instruction to instruction to form a program sequence. The address modification applies to both operand and instruction fetches. Many ways of altering an instruction sequence or performing a data fetch illustrate the strength and flexibility provided by a stored program. Fig. 3.10*b* illustrates the flow of data of instruction from the main memory. The address modification logic for program or data normally shares the ALU hardware indexing operations are to be performed under the control of the execution logic.

ASSIGNMENTS

I. Choose the key sentenses from the text A and compare them with the title of the text. b) Say what the text is about.

II. a) Skim through the Text B and find the part of it dealing with the number of control signals for a given instruction. b) Discuss it with your fellow-student.

III. a) Find the part of the Text B containing information about ways of altering an instruction sequence. b) Make a short written summary about it.

IV. Answer the following questions embracing the contents of the texts.

1. How may a general purpose computer be considered? 2. What function units has a general purpose CPU? 3. What is the function of the control section? 4. What does the implementation of the instruction set define? 5. What techniques are used to implement the control section in hardware? 6. What four basic categories may control operation be classified into? 7. What does the instruction fetch operation allow? 8. What is required to obtain the prescribed data from memory? 9. What does the number of operand fetches depend on? 10. What are required to coordinate the activities occurring at different times? 11. What does the number of control signals for a given instruction

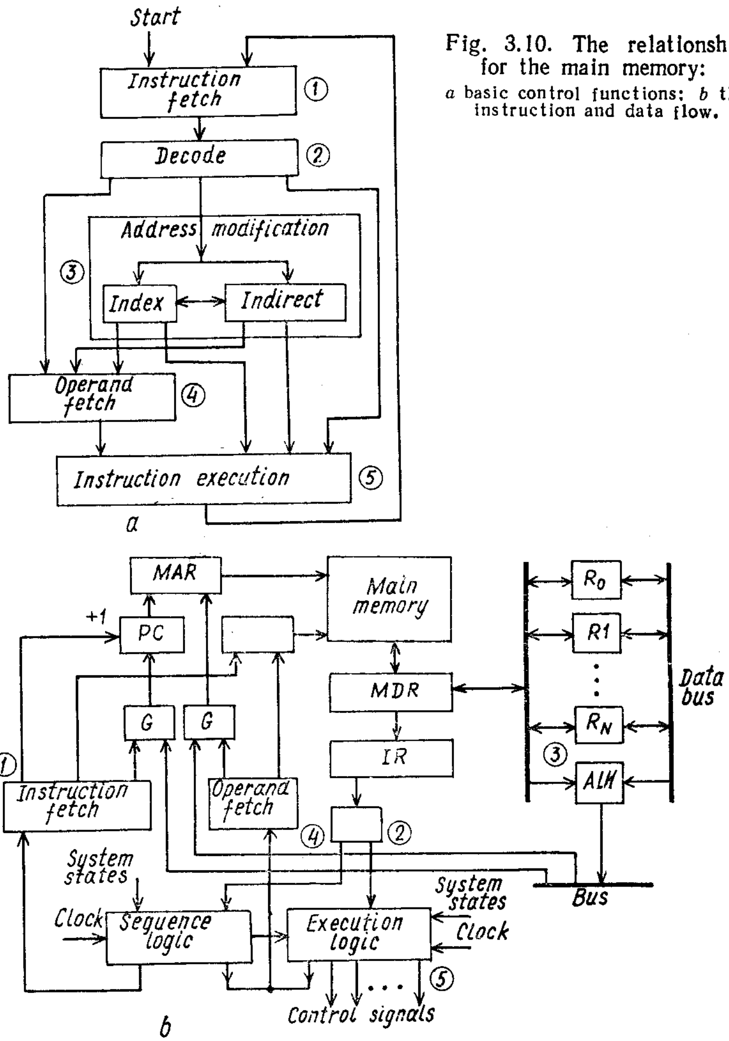


Fig. 3.10. The relationship for the main memory:
a basic control functions; *b* the instruction and data flow.

depend on? 12. What does Fig. 3.10*a* show? 13. What do the basic control functions implement? 14. To what does the address modification apply? 15. What figure illustrates the flow of data of instruction from the main memory?

V. Examine Fig. 3.10 and comment on:

1. Basic control functions.
2. The instruction and data flow.

VI. Speak on:

1. Control operations.
2. Functional units of a general purpose CPU.

VII. Make a short written summary of the Text B.

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these words.

Approximately приблизительно; destroy разрушать; restore восстанавливать; nearly приблизительно; imply значить, подразумевать; coincide совпадать; realize осуществляться; correspond соответствовать; sequential последовательный, являющийся продолжением; consecutive последовательный.

II. Find these word-combinations and terms in the Text C and translate sentences with them.

Execution circuitry исполнительные схемы; the memory cycle цикл (работы) памяти; machine cycle time длительность машинного цикла; the access time время обращения; core memory system система памяти (ЗУ) на магнитных сердечниках; sense v. считывать; in the range в диапазоне; either destroyed or cleared либо разрушается, либо стирается; subsequent read interval последующий интервал считывания; instruction-execution rate скорость выполнения команды; maximum data transfer rate максимальная скорость передачи данных; the overlap operation перекрывающиеся операции; clock pulses тактовые импульсы; semiconductor memory полупроводниковая память; nondestructive operation операция без разрушения информации; in consecutive order в последовательном порядке; incremented by one count с приращением на единицу; each time каждый раз; program counter (PC) счетчик команд; the entry point точка ввода, входная точка.

Text C

CORE MEMORY CYCLE

I. a) Read the Text. b) Find the part of it describing a timing sequence of simple instructions.

Typically, a core memory cycle is divided into two approximately equal intervals: a read operation and a write operation (see Fig. 3.11*a*). The read interval represents the operation time required by the memory to decode the address, switch the cores, and sense the outputs before the data are presented to the CPU. This interval is defined as the access time. As the information stored in memory at that address is read from the cores, it is either destroyed or cleared. To restore the data, the information must then be written back into the cores immediately following the read interval. With a cycle time in the range of 1 to several microseconds, nearly all control operations required by the instruction can be completed during the write interval and subsequent read interval. This implies that the memory access rather than the control operations is the limiting factor in the instruction

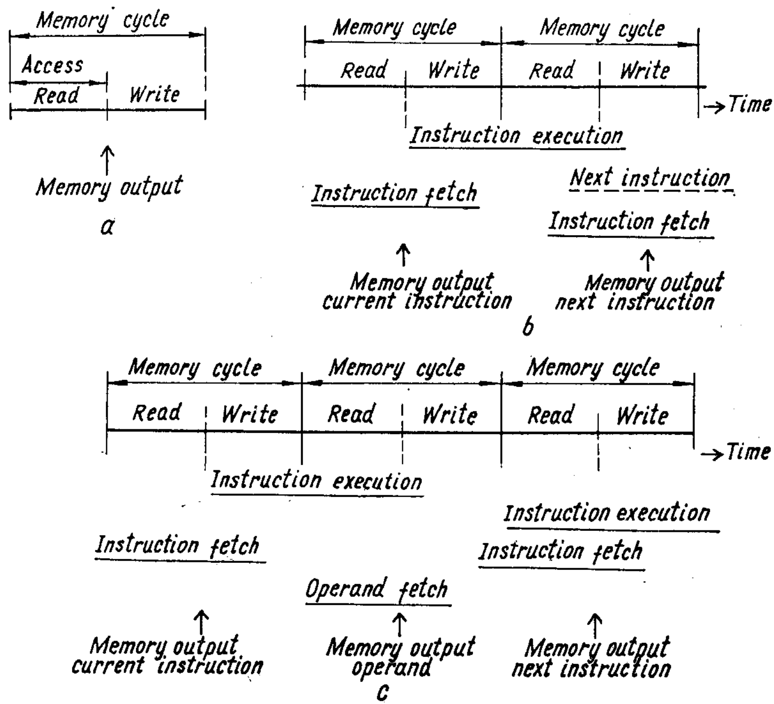


Fig. 3.11. The memory fetch operation:
a memory cycle; *b* instruction cycle; *c* instruction cycle with operand fetch.

execution rate of a processor. However, this is not true for more complicated instruction, such as multiplication or division. These instructions require many cycles of repeated operations without any memory access.

By organizing the basic cycle to coincide with the memory cycle, the maximum data transfer rate between main storage and the processor may be realized. Fig. 3.11*b* shows a timing sequence of simple instructions that can be fully implemented during the write and read intervals. The overlap operations of instruction fetch and execution keep the memory access rate at the 100 per cent level. Fig. 3.11*c* shows an instruction requiring an operand fetch. In both cases, the memory access and the instruction execution are completely synchronized to use the memory at its fastest possible rate.

A program sequence is normally executed in consecutive order with the program address incremented by one count each time an instruction is fetched from memory. At times, it is necessary to branch from the regular program sequence and jump to a new one. The address of the next instruction found in the program counter (PC) will be changed to correspond to the entry point of the new program sequence. Fig. 3.12*a* and 3.12*b*, respectively, show the hardware and the timing chart of a sequential instruction fetch. The PC is automatically incre-

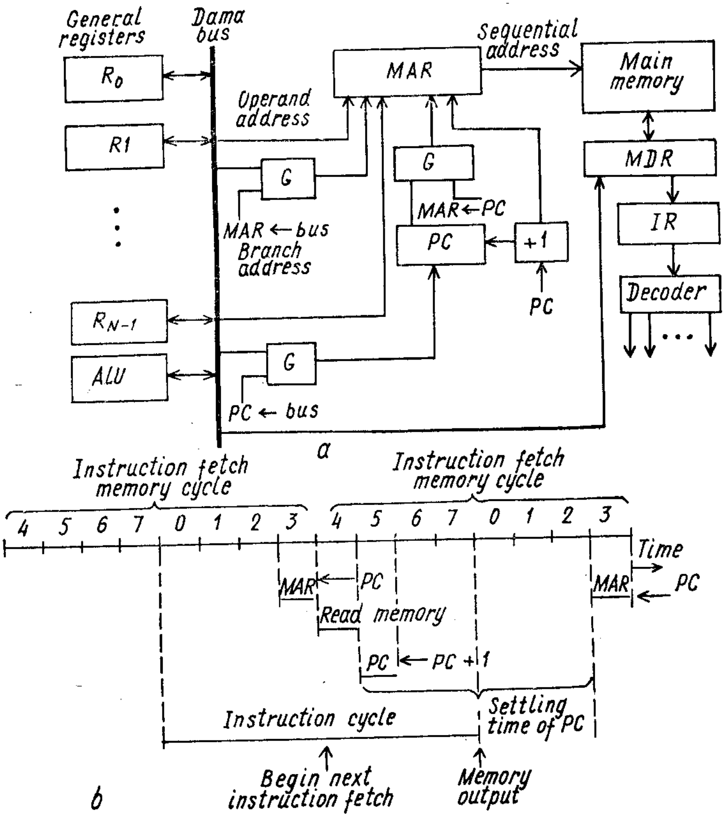


Fig. 3.12. Memory addressing:
a functional diagram; *b* timing sequence of simple sequential addressing.

mented by one count after its content is transferred to the memory address register (MAR). A serial counter rather than a high speed parallel binary counter can be used in the implementation of the PC, since the count does not have to be settled until the next PC-to MAR transfer.

ASSIGNMENTS

I. a) Skim through the Text C and divide it into logical parts. b) Choose the key sentences from the text and translate them.

II. Find the part of the Text C containing information about the maximum data transfer rate between main storage and the processor. Discuss it.

III. Answer the following questions embracing the contents of the Text C.

1. What does instruction sequencing provide? 2. How many intervals is a core memory cycle divided into? 3. What does the read inter-

val represent? 4. How is this interval defined? 5. What happens to the information stored in the memory when it is read? 6. What is necessary to restore the data? 7. What is the limiting factor in the instruction executive rate of a processor? 8. How may the maximum data transfer rate between main storage and the processor be realized? 9. What does Fig. 3.12*b* show? 10. What figure shows an instruction requiring an operand fetch?

IV. Ask additional questions on the contents of the Text. C.

V. Discuss the problem of core memory cycle.

VI. Examine Fig. 3.12 and comment on:

1. Functional diagram.
2. Timing sequence of simple sequential addressing.

VII. Prepare a dialogue on your own situation.

VIII. Speak on the text according to your own plan.

IX. Express your opinion of the text from the viewpoint of your speciality.

X. Make a short summary of the text.

XI. Translate the Text C to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

saturate	относиться
subsequent	требовать
refer	общая точка
certain features	насыщать
require	повышать(ся)
rise	обычно
common point	сопротивление нагрузки
typically	последующий
load resistor	определенные черты

II. Find the following word-combinations in the Text D and translate the sentences with them.

Subsequent forms of logic circuits; forward base current; direct-coupled transistor logic; transistor logic circuit; a succeeding stage; DCTL configuration; latter transistor; collector-current cutoff; fan-out transistor; supply voltage; base-input resistor.

Text D

DIRECT-COUPLED TRANSISTOR LOGIC

I. a) Read the following text and say about transistor logic. b) Review the text.

In one of the early forms of transistor logic circuit, the collector of an inverter transistor was connected directly to the base of a succe-

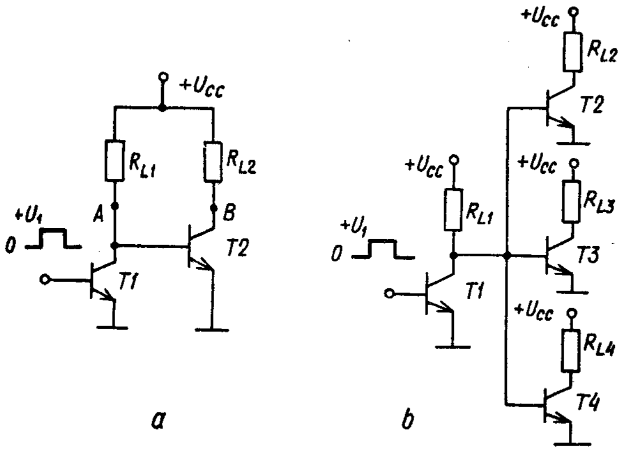


Fig. 3.13. Logic circuits of DCTL-type:
a a simple two-transistor circuit with one input; *b* fan-out loading of a DCTL inverter.

eding stage. This form of transistor logic is referred to as "direct-coupled transistor logic" (DCTL). Although the DCTL configuration is not widely used today, it is discussed here in order to illustrate certain features of subsequent forms of logic circuits.

Fig. 3.13 shows a DCTL circuit. Consider, for the moment, that the base of transistor T_2 is not connected to the collector of transistor T_1 and also that this latter transistor is at collector-current cutoff; collector voltage of T_1 is close to the U_{CC} level. If the base of T_2 is now connected to the collector of T_1 current will flow through R_{L1} into the base of T_2 and the voltage at point A will fall to the $U_{BE(ON)}$ level of T_2. Forward base current to T_2 saturates this device, and the voltage at point B is close to ground potential. When T_1 is driven to saturation, the voltage at point A becomes equal to the $U_{CE(sat)}$ level of T_1. If this voltage is less than that required to turn on T_2, the voltage at point B will rise to nearly the level of U_{CC}.

The bases of two or more transistors can be driven from a common point, as shown in Fig. 3.13. Each of these fan-out transistors can be connected, at their collectors, to bases of other transistors.

Only one supply voltage is normally used for DCTL circuitry. This voltage is typically 1.5 to 5 volts. In the circuit of Fig. 3.13 R_{L1} serves as a load resistor for T_1 and is also the base-input resistor to T_2, T_3 and T_4.

ASSIGNMENTS

I. Answer the following questions embracing the contents of the text.

1. Where was the collector of an inverter transistor connected directly to the base of a succeeding stage? 2. What is referred to as "direct-coupled transistor logic"? 3. Is the DCTL configuration widely

used today? 4. What does Fig. 3.13 show? 5. When will current flow through R_{L1} into the base of T_2? 6. When does the voltage at point A become equal to the $U_{CE(sat)}$ level of T_1? 7. Where can the bases of two or more transistors be driven from? 8. What can each of these fan-out transistors be connected to? 9. What voltage is normally used for DCTL circuitry?

II. Express your opinion of DCTL.

III. Discuss the problem of transistor logic.

IV. Examine Fig. 3.13 and comment on:

1. A simple two-transistor circuit with one input.
2. Fan-out loading of a DCTL inverter.

V. Make a short summary of the Text D.

VI. Translate the following sentences into English without using the dictionary.

1. Универсальный центральный процессор делится на 4 функциональных блока. 2. Устройство управления является основой системы для интерпретирования и выполнения хранимых команд, выбранных из основной памяти. 3. Работа с выборкой команд делает возможным выполнять команды непрерывным потоком. 4. Команды должны выполняться непрерывным потоком. 5. Количество выборов операндов зависит от семейства (набора) команд. 6. Требуются различные сигналы управления, чтобы скоординировать работу в различные моменты времени.

VII. Look through the latest magazines and find additional material on transistor logic for summary and discussion.

III. GRAMMAR EXERCISES

I. Translate these sentences. Pay attention to the modal verbs with the Passive Infinitive.

1. A general purpose CPU may be considered as being devided into four functional units. 2. Control operations may be classified into four basic categories. 3. To restore the data, the information must then be written back into the cores immediately following the read interval. 4. With a cycle time in the range of 1 to several microseconds, nearly all control operations required by the instruction can be completed during the write interval and subsequent read interval. 5. Fig. 3.11*b* shows a timing sequence of simple instructions that can be fully implemented during the write and read intervals.

II. Find the Infinitives in the following sentences. Define their functions and translate the sentences.

1. Three techniques are used to implement the control section in hardware. 2. Logic gates are minimized to reduce the hardware cost. 3. The instruction fetch operation allows a continuous flow of instructions to be executed. 4. A data fetch is required to obtain the prescribed data from memory. 5. To implement an instruction various control signals are required to coordinate the activities occurring at different times. 6. A serial counter rather than a high speed parallel binary counter can be used in the implementation of the PC, since

the count does not have to be settled until the next PC-to MAR transfer.

III. Define the function of the Participles in the following sentenses and translate them.

1. The logic structures generated by random logic and the PLA's are equivalent. 2. These operations dictate the necessary control signals required to implement the control functions defined by the instruction set of a computing machine. 3. As the information stored in memory at that address is read from the cores, it is either destroyed, or cleared. 4. Fig. 3.11*c* shows an instruction requiring an operand fetch. 5. In one of the early forms of transistor logic circuit, the collector of an inverter transistor was connected directly to the base of a succeeding stage.

IV. Translate the following sentences paying attention to the verbs in the Passive Voice.

1. Control signals are scattered throughout the entire machine in an apparently random manner. 2. A core memory cycle is divided into two approximately equal intervals. 3. The memory access and the instruction execution are completely synchronized to use the memory at its fastest possible rate. 4. The address of the new instruction found in the program counter (PC) will be changed to correspond to the entry point of the new program sequence. 5. The PC is automatically incremented by one counter after its content is transferred to the memory address register (MAR).

V. Put questions to the words in bold type.

1. This **permits different instructions** with identical operations **to share the same hardware.** 2. **The number of operand fetches** depends **on the instruction set.** 3. The read interval **is defined as the access time.** 4. These instructions **require** many cycle of **repeated operations without any memory access.** 5. **It** is necessary to branch **from the regular program sequence** and jump to a new one.

Chapter IV. RADIO ELECTRIC CIRCUITS AND MEASURING TECHNIQUE

Lesson 1. NEGATIVE FEEDBACK

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. Make sure that you know these words. b) Say what Russian words help you to guess their meanings.

Signal, negative, correct, graph, figure, original, fundamental, experiment, mechanical, engineering, examination, polarity, specify, effective, voltage, basic, denominator, stable, component, electronics, resistor, sine, form, amplitude.

II. a) Listen, repeat and memorize the following words and word-combinations. b) Check if you know their meanings.

negative feedback отрицательная обратная связь; index finger указательный палец; open-loop gain коэффициент усиления при разомкнутом контуре обратной связи; *A* closed-loop gain коэффициент усиления при замкнутом контуре обратной связи; β feedback fraction коэффициент (передачи цепи) обратной связи; internal stray capacitance внутренняя паразитная емкость; excessive variation излишнее изменение; frequency response частотная характеристика; deficiency недостаток; frequency distortion частотное искажение; plot v. изображать, наносить данные на график; flatten v. сглаживать; ruler up понижение; overall loss общая потеря; touch at the tips касаться кончиками; to control the speed of rotating machinery управлять скоростью вращения машины; be accurately predictable быть точно предсказуемым; make clear the effect выяснить влияние; feedback loop incorporating an attenuator which feeds a fixed fraction цепь (петля) обратной связи, содержащая аттенюатор, который передает определенную часть; enormous fall in gain at high frequencies большое падение коэффициента усиления на высоких частотах.

III. a) Analyse the constituents the following words consist of. b) Translate these words into Russian.

Amplifier, largely, capacitance, excessive, variation, distortion, feedback, greater, equation, independent, capacitor, probably, governor, rotating, calculation, simply, input, output, rearranging, equation, closed-loop, immediately, situation, exactly, subtracting, adding, independent, precisely.

IV. Repeat these formulas after the speaker and learn their reading.

$A = \frac{U_{out}}{U_{in}}$ *A* is equal to *U* sub out divided by *U* sub in.

$e = U_{in} + \beta U_{out}$ *e* is equal to *U* sub in plus β multiplied by *U* sub out.

$U_{out} = A_0 (U_{in} + \beta U_{out})$ *U* sub out is equal to *A* sub 0 round bracket open *U* sub in plus β multiplied by *U* sub out round bracket closed.

$\beta A_0 \gg 1$ β multiplied by A_0 larger than one.

$A \approx \frac{A_0}{\beta A_0}$ *A* approximately equal to *A* sub 0 divided by β multiplied by *A* sub 0.

Text A

FREQUENCY RESPONSE

I. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

No amplifier gives the same gain at all frequencies. The gain of any amplifier begins to fall at high frequencies largely as a result of its internal stray capacitance. When an amplifier exhibits excessive variation of gain with signal frequency, it is said to have a poor frequency response. This deficiency is sometimes referred to as frequency distortion, but must not be confused with non-linear distortion. Negative feedback can correct a poor frequency response as long as the

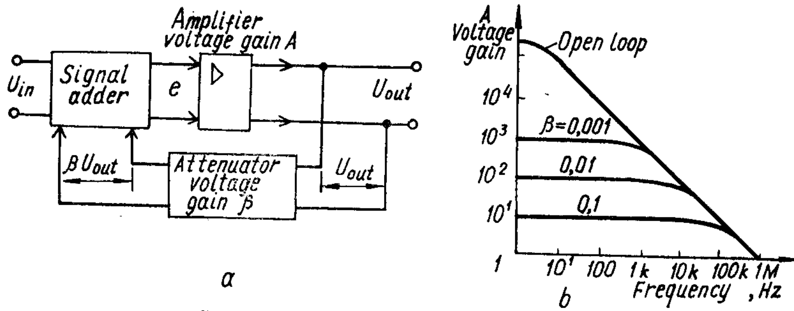


Fig. 4.1. An amplifier with feedback:
a functional diagram; *b* frequency response with different feedback factors.

open-loop gain remains greater than the closed-loop gain. Fig. 4.1*b* shows the graphs of the gain of an amplifier plotted against frequency. The top line shows the open-loop gain; the enormous fall in gain at high frequencies is in fact deliberately introduces by an internal capacitor for stability reasons. The lower curve illustrate the way that negative feedback flattens the frequency response but at the expense of gain; frequency responses are plotted for closed-loop gains of 1000, 100 and 10 and are so level that they can be drawn with a ruler up to the region where the closed-loop gain approaches the open-loop figure.

Although the overall loss of gain with negative feedback may appear serious, it is in fact easy to connect two negative feed-back amplifier in cascade (i. e. one after the other) and thus return to a gain figure similar to the original open-loop gain but with a much improved frequency response.

2. Average Reading

Text B

EQUATION FOR AN AMPLIFIER WITH FEEDBACK

I. a) Listen to the text. b) Read it (time limit is 5 min.). c) Find the part of it dealing with a block diagram of an amplifier of voltage gain A_0 with a feedback loop. Translate it.

The concept of negative feedback is fundamental to life. A simple experiment will illustrate this point: close your eyes and then bring your index fingers together so that they touch at the tips. You will probably miss.

Examples of negative feedback can also be found in the field of mechanical engineering. One of the clearest examples is the governor which is used to control the speed of rotating machinery.

An examination of a basic feedback circuit together with one or two simple calculations will make clear the effect of negative feedback. Fig. 4.1*a* is a block diagram of an amplifier of voltage gain A_0 with a feedback loop incorporating an attenuator which feeds a fixed fraction, β, of the output back to the input. In this case, we shall keep the polarity of amplifier gain and feedback positive, the feedback signal added to the input signal.

In Fig. 4.1*a* we can specify the effective voltage gain, A, of the amplifier with feedback. This is given simply by the ratio of the output voltage to input voltage, $A = \frac{U_{out}}{U_{in}}$. Now we shall consider the signal e at the input of the basic amplifier of gain A_0: $e = U_{in} + \beta U_{out}$, also, we know $U_{out} = A_0 e$, therefore $U_{out} = A_0(U_{in} + \beta U_{out})$. Rearranging, $U_{out}(1 - \beta A_0) = A_0 U_{in}$, hence

$$A = \frac{U_{out}}{U_{in}} = \frac{A_0}{1 - \beta A_0}. \tag{4.1}$$

Equation (4.1) is the general equation for an amplifier with feedback. The basic gain, A_0, is often referred to as the open-loop gain and the gain with feedback, A, as the closed-loop gain. The feedback is positive and it may be seen immediately that when $\beta A_0 = 1$, an interesting situation develops in that A becomes infinite. Infinite gain implies that the amplifier will give an output signal with no input, and this is exactly what happens. Positive feedback is the bases of oscillators (signal generators).

For negative feedback, we can make β negative by subtracting the feedback from the input instead of adding.

Then
$$A = \frac{A_0}{1 + \beta A_0}. \tag{4.2}$$

Now if, as is usually the case, $\beta A_0 \gg 1$ then we can neglect the 1 in the denominator and

$$A \approx \frac{A_0}{\beta A_0}, \text{ i. e. } A \approx \frac{1}{\beta}. \tag{4.3}$$

This is the most significant equation because, for the first time, we have "designed" an amplifier with a precisely determined voltage gain. As long as the open-loop gain is much larger than the closed-loop gain (e. g. a hundred times greater) then the closed-loop gain is independent of the amplifier characteristics and dependent only on β. This feedback fraction, β, usually depends upon just two resistors in a potential divider. Resistors are the most stable components in electronics; their value can be precisely specified to any desired accuracy and is unlikely to change with time. Negative feedback extends these attributes of accuracy and stability to the gain of the entire amplifier.

ASSIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about.

II. Skim through the Text B and find the part of it dealing with the general equation for an amplifier with feedback.

III. Find the part in the Text B containing information about resistors as the most stable components in electronics. Translate it.

IV. Answer the following questions embracing the contents of the Text A and the Text B.

1. What is the concept of negative feedback? 2. What experiment may illustrate the concept of negative feedback? 3. Where can examples of negative feedback be found? 4. Where can examples of closed-loop gain be found? 5. What makes clear the effect of negative feedback? 6. What is shown in Fig. 4.1*a*? 7. What feedback is the basis of oscillators?

V. Translate the following word-combinations into English and memorize their English equivalents.

Фактически; легко соединить; одним из ярких примеров; в общем случае; обычно зависит от; это расширяет понятие.

VI. Prepare a dialogue on an amplifier with the feedback (Fig. 4.1*a*)

VII. Examine Fig. 4.1*b* and comment on frequence response with different feedback factors.

VIII. Speak on negative feedback of an amplifier.

IX. Retell the Text B according to your own plan.

X. Make a short written summary of the Text A and the Text B.

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these words and word-combinations.

Occur встречаться; virtually фактически, в сущности; well worth trading можно легко обменять; version вариант; drop падать; excursion отклонение, уход; unwanted addition нежелательное дополнение; in order to maintain для того, чтобы поддержать; boost v. повышать; in return в свою очередь.

II. Find these word-combinations in the Text C and translate the sentences containing them.

Perfect magnified replica совершенная (идеальная) усиленная копия; clipping distortion искажение за счет ограничения; pointless exercise бессмысленное упражнение; boost v. усиливать.

Text C

NON-LINEAR DISTORTION

I. a) Read the text. b) Speak on the variaties of distortion.

Distortion occurs when an amplifier does not present a perfect magnified replica of the input wave form but changes its shape in some way because of a non-linear transfer characteristic. Fig. 4.2 shows a pure sine wave together with two versions of the same waveform after it has been subjected to different forms of non-linear distortion. These varieties of distortion arise because the gain of the amplifier is in some way dependent upon the instantaneous signal amplitude. In Fig. 4.2*b* the amplifier gain is dropping at large positive or negative signal excursion ("clipping distortion"), whilst in Fig. 4.2*c* it is when the signal is very low in amplitude, near the zero crossing, that the gain falls.

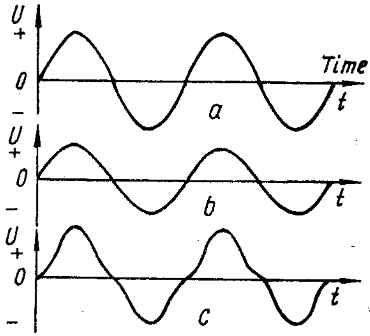


Fig. 4.2. The waveforms in amplifier circuits:
a pure sine wave; *b* clipping distortion; *c* crossover distortion.

Non-linear distortion can be seen as an unwanted addition by the amplifier to the original signal. When negative feedback is applied to an amplifier, distortion is reduced by the factor $(1 + A_0)$ but, in return, the input signal must be increased by the factor $(1 + A_0)$ in order to maintain the output signal.

The use of a second amplifier to boost the input by the factor $(1 + A_0)$ need not significantly contribute to the total distortion since only small signals are being handled at that stage of the processing. Voltage gain is cheap and well worth trading for low distortion. It is difficult to design a power amplifier with less than 1 % total harmonic distortion under open-loop conditions, but with negative feedback figures lower than 0.1 % are common in high-quality audio amplifiers.

ASSIGNMENTS

I. Divide the text into logical parts. Entitle each part.

II. Find the part in the text containing information about non-linear distortion. Translate it.

III. Answer the following questions embracing the contents of the Text C.

1. When does distortion occur? 2. What does Fig. 4.2 show? 3. Why do these varieties of distortion arise? 4. Is the amplifier gain in Fig. 4.2*b* dropping at large positive or negative signal excursion? 5. How can non-linear distortion be seen? 6. Is it difficult to design a power amplifier with less than 1 % total harmonic distortion?

IV. Ask additional questions on the Text C.

V. Combine your answers into a short summary of the text.

VI. Speak on:

1. Non-linear distortion.
2. Voltage gain.

VII. Examine Fig. 4.2 and comment on:

1. Pure sine wave.
2. Clipping distortion.
3. Crossover distortion.

VIII. Find the sentences in the Text C with the verbs in the Continuous and Perfect Tense. Translate them.

IX. Translate the Text C to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

impedance	удобный метод
impedance matching	неизбежно
at first sight	сводится
assess v.	полное сопротивление, импеданс
resolve v.	на этом этапе
convenient method	уместно отметить
in the way	в последовательной цепи (по пути)
invariably	удобное представление
it is relevant to point out	подтверждать
confirm	согласование сопротивлений
at this stage	на первый взгляд
convenient representation	представить в виде

II. Pick out all technical terms from the Text D and translate sentences with them.

III. Translate the following word-combinations from the text.

Any electrical device; just like any other impedance; at first sight; however complicated; in the majority of circuits; in such cases; it is important to note.

Text D

INPUT AND OUTPUT IMPEDANCES

I. Read the text and say about the input impedance of a circuit such as a bipolar transistor amplifier.

Any electrical device which requires a signal for its operation has an input impedance. Just like any other impedance (or resistance in d. c. circuit), the input impedance of a device is a measure of the current drawn by the input with a certain voltage across it.

The input impedance of a circuit such as a bipolar transistor amplifier might seem to be more complicated. At first sight, the presence of capacitors, resistors and semiconductor junction in a circuit makes the input impedance difficult to assess. However, any input circuit, however complicated, may be resolved into the simple impedance shown in Fig. 4.3*a*. If U_{in} is the a. c. input signal voltage and I_{in} the a. c. current drawn by the input, then input impedance

$$Z_{in} = \frac{U_{in}}{I_{in}}. \qquad (4.4)$$

In the majority of circuits, the input impedance is resistive over most of the frequency range, there being negligible phase difference between input voltage and input current. In such cases, the input appears as the circuit of Fig. 4.3b and Ohm's law applies, the complex algebra

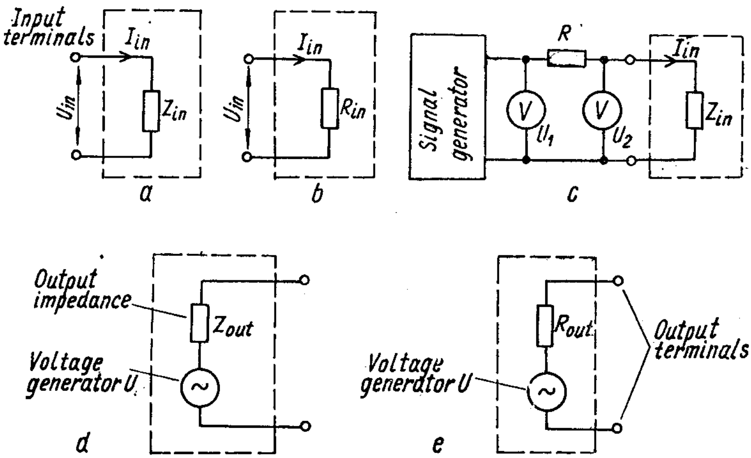


Fig. 4.3. Input and output impedances:
a a pair of input terminals with input impedances Z_{in}; *b* a device with a resistive input impedance; *c* a circuit for input impedance measurement; *d* Thevenin's equivalent circuit, applicable to any pair of output terminals; *e* an equivalent circuit applicable to devices with resistive output impedance.

and vector diagrams of reactive circuits being unnecessary. It is important to note, however, that a resistive input impedance does not necessarily mean that a d. c. signal can be used to measure the input resistance; there may be reactive components in the way (e. g. a coupling capacitor) which, whilst insignificant at moderate a. c. frequencies will prevent d. c. measurement from being made on the input. The most convenient method for input impedance measurement is shown in the circuit of Fig. 4.3*c*.

All output circuits, both a. c. and d. c. invariably have a certain output impedance associated with a voltage generator. That this simple description applies to even the most complicated circuits is confirmed by Thevenin's theorem, which states: any network of impedance and generators having two output terminals may be replaced by the series combinations of one impedance and one generator. Here, a "generator" is assumed to be an ideal voltage-producing device which continue to produce a constant voltage even when current is drawn from it. Thevenin's description of an output circuit is shown in Fig. 4.3*d*, Z_{out} being the output impedance and *U* the open-circuit output voltage.

ASSIGNMENTS

I. Answer the following questions embracing the contents of the Text D.

1. What device has an input impedance? 2. What is shown in Fig. 4.3*a*? 3. What is the input impedance in the majority of circuits? 4. What makes the input impedance difficult to assess? 5. What is the input impedance? 6. What means a resistive input impedance? 7. What is the output impedance? 8. What does Thevenin's theorem state?

9. Where is Thevenin's description of an output circuit shown?
10. What does the equivalent circuit represent in Fig. 4.3*e*?

II. Discuss the problem of input and output impedances.

III. Prepare a dialogue on:

1. A device with a resistive input impedance.
2. An equivalent circuit applicable to most devices: resistive output impedance.

IV. Examine Fig. 4.3 and comment on:

1. A pair of input terminals with input impedances Z_{in}.
2. A device with a resistive input impedance.
3. A circuit for input impedance measurement.

V. Speak on:

1. Input impedance.
2. Thevenin's equivalent circuit, applicable to any pair of output terminals.

VI. Express your opinion of negative feedback.

VII. Look through the latest magazines, find additional material on he topic and discuss it with your fellow-students.

III. GRAMMAR EXERCISES

I. Analyse the structure of the following sentences. Translate them.

1. Negative feedback can correct a poor frequency as long as the open-loop gain remains greater than the closed-loop gain. 2. The lower curves illustrate the way that negative feedback flattens the frequency response but at the expense of gain; frequency responses are plotted for closed loop gains of 1000, 100 and 10 and are so leveled that they can be drawn with a ruler up to the region where the closed-loop gain approaches the open-loop figure. 3. Infinite gain implies that the amplifier will give an output signal with no input, and this is exactly what happens. 4. Distortion occurs when an amplifier does not present a perfect magnified replica of the input wave form but changes its shape in some way because of a non-linear transfer characteristics.

II. Define the function of the Infinitive in these sentences and translate them.

1. The input impedance of a circuit such as a bipolar transistor amplifier might seem to be more complicated. 2. When an amplifier exhibits excessive variation of gain with signal frequency, it is said to have a poor frequency response. 3. One of the clearest example is the governor which is used to control the speed of rotating machinery. 4. Here, a "generator" is assumed to be an ideal voltage-producing device which continue to produce a constant voltage even when current is drawn from it.

III. Check if you know the Participle Complexes and translate the sentences with them.

1. In the majority of circuits, the input impedance is resistive over most of the frequency range, there being negligible phase difference between input voltage and the input current. 2. In such cases, the input appears as the circuit of Fig. 4.3 and Ohm's law applies, the

complex algebra and vector diagrams of reactive circuits being unnecessary. 3. In this case we shall keep the polarity of amplifier gain and feedback positive, the feedback signal being added to the input signal.

Lesson 2. THE EMITTER FOLLOWER AND THE DIRECT-COUPLED AMPLIFIER

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Make sure that you know these words. Say what Russian words help you to guess their meanings. b) Repeat these words after the speaker.

Transform, problem, emitter, signal, maximum, voltage, base, normally, potential, balanced, collector, paradox, identical, differential, voltmeter.

II. Check if you know the meanings of these words and word-combinations.

Emitter follower эмиттерный повторитель; straight прямо, непосредственно; feed v. питать(ся); to be fed вводиться, подаваться; supply rail шина питания; preferred value предпочтительная величина; step down the voltage понижать напряжение; as far as the signals are concerned по отношению к рассматриваемым сигналам; output signal swing capability способность выходного сигнала изменяться;

a. c. view of circuit тип схемы для переменного тока; in dotted form пунктиром; as distinct from в отличие от.

III. a) Give initial forms of the following words and define the function of suffixes. b) Translate these words.

Impedance, transformer, reducing, solution, condition, capability, assuming, reasonably, showing, slightly.

Text A

OUTPUT IMPEDANCE AND EMITTER FOLLOWER

I. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

If an output impedance is to be reduced for the purpose of optimum voltage transfer to the next circuit, then a transformer will be of little advantage, for, in reducing the output impedance, it will also step down the voltage. A much more satisfactory solution to the problem is the use of a transistor in the emitter follower (common collector) circuit. In this circuit the voltage gain is just a little less than unity. However, because the transistor gives a current gain, the emitter follower lowers the output impedance of any signal source connected to the input.

2. Average Reading

Text B

THE EMITTER FOLLOWER CIRCUIT

I. a) Listen to the text. b) Read it (time limit is 3 min.). c) Find the part of it dealing with the base bias resistor.

The emitter follower circuit is shown in Fig. 4.4*a*. The emitter follower circuit is also named "common-collector". As the name "common-collector" suggests, the transistor collector is connected straight to the supply line which, as far as the signals are concerned, is the same thing as the earth (common) rail, because power supply outputs are always designed to present a very low impedance to signals. The output load resistor, R_L is in the emitter circuit, whilst the input signal is fed in between base and earth in the usual way.

Before we consider the behaviour of a. c. signals in the emitter follower, it is appropriate to consider d. c. quiescent (no signal) conditions. We must ensure that output signal is able to swing both positively (towards supply rail) or negatively (towards earth). For maximum output swing capability the quiescent emitter voltage should be midway between earth and supply, i. e. at about 4.5V in this example.

The base bias resistor, R_B, feeds sufficient base current into the base-emitter junction to maintain the required emitter current. In this example, we have assumed a value of 200 for the d. c. current gain h_{FE}. Thus, a 1 mA emitter current requires 1/200 mA base current

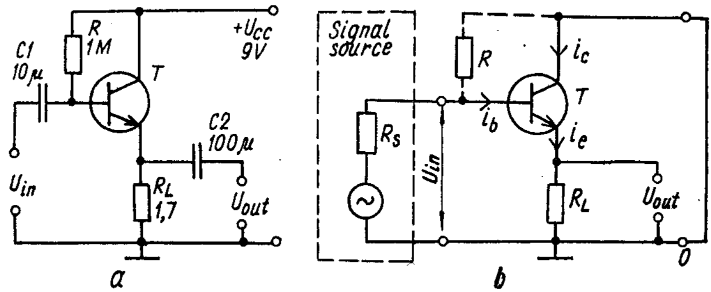


Fig. 4.4. The emitter follower:
a a simple circuit with typical parameters; *b* the circuit for a. c. signals.

(5 μ *A*) to maintain it. This current is provided by R_B whose value is calculated from Ohm's law, assuming the base voltage to be similar to the emitter voltage (4.5V). Voltage $R_B \cong (9 - 4{,}5)$ V; current in $R_B = 5 \cdot 10^{-6}$ A then,

$$R_B = \frac{9 - 4{,}5}{5 \cdot 10^{-6}} \Omega, \quad R_B = 900 \text{ k}\Omega.$$

A value of 1 mΩ is selected as a preferred value reasonably near to the calculated value.

To look at the behaviour of the a. c. signals, we shall redraw the circuit showing only these elements which are significant as far as the a. c. signals are concerned. This a. c. view of the circuit is in Fig. 4.4 *b*. Bias resistor R_B is shown in dotted form because we shall consider its effect only after we have followed the signal through the transistor. The connection between U_{CC} and earth indicates that, as far as the a. c. signal is concerned, the supply appears as a short circuit. Across the load, R_L is developed the output voltage signal U_{out}. These a. c. signal voltages and currents, are normally denoted by the lower case *u* and *i* as distinct from the upper case *U* and *I* which refer to d. c. voltage and current. We can see in Fig. 4.4 *b* that r_e and R_L constitute a potential divider for the signals, so that voltage gain A_U always turn out slightly less than unity:

$$A_U = \frac{R_L}{R_L + r_e}.$$

In this example, $R_L \cong 5$ kΩ and $r_e \cong 25$ Ω, then

$$A_U = \frac{5000}{5000 + 25} = 0.995.$$

With the voltage gain so close to unity, the emitter voltage follows the base voltage very closely indeed, this action giving its name to the circuit.

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about.

II. a) Skim through the Text B and explain how the base bias resistor, R_B, feeds sufficient base current into the base-emitter junction.

III. Answer the following questions embracing the contents of the Text A and the Text B.

1. What is the voltage gain in the circuit shown in Fig. 4.4*a*? 2. Why does the emitter follower lower the output impedance of any signal source connected to the input? 3. Where is the output load resistor R_L? 4. What is the function of the base bias resistor? 5. What base current does a 1 mA emitter current require to maintain it? 6. How is the bias resistor chosen in Fig. 4.4*a*? 7. What does the connection between U_{CC} and earth indicate?

IV. Discuss the information obtained from the Text A and the Text B.

V. Be ready to discuss the information received at your lectures on speciality.

VI. Prepare a dialogue on a. c. signals in the emitter follower.

VII. Speak on the emitter follower as seen by a. c. signal.

VIII. Make short summaries of the Text A and the Text B.

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these words.

Shift v. сдвигать, смещать; midway на полпути, посередине; interpose v. вставлять, входить между чем-л.; restrict ограничивать; earth земля; quiescent находящийся в покое, неподвижный; by means of посредством; with respect to по отношению к; further дальнейший; exhibit v. представлять.

II. Find the following word-combinations in the Text C and translate the sentences with them.

Coupling capacitor конденсатор связи; supply rail шина питания; permissible circuit voltage возможное (допускаемое) в цепи (схеме) напряжение; balanced power supply балансный источник питания; offset null control управление нулем сдвига; level-shifting arrangement устройство сдвига уровня.

III. Analyse the structure of these words and translate them.

Coupling, permissible, midway, two-transistor, complementary, consisting, slightly, divider, variable, zero-set, voltmeter, pointer.

IV. Find the English equivalents of the following word-combinations in the Text C.

В особенности; это, конечно, означает, что; в случае чего-л., посредством (с помощью); таким образом; с внешней стороны;

мы знаем, что; этот парадокс разрешается; оптимальное рабочее условие получается, когда; более чем.

Text C

DIRECT-COUPLED AMPLIFIER

I. a) Read the text. b) Find the part of it describing the optimum working condition obtained when T_2 quiescent collector potential is at earth (0V).

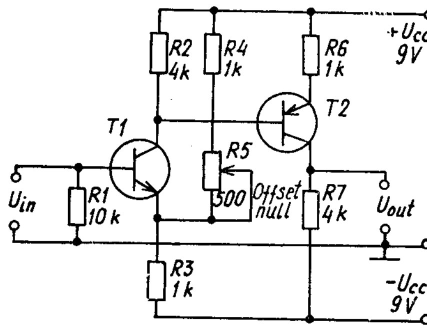


Fig 4.5. A simple d. c. amplifier.

The design of an amplifier without coupling capacitors restricts the range of permissible circuit voltages. In particular, it is very desirable that, when there is no signal, both the input and the output should be at earth potential. This, of cause, means that the quiescent d. c. output voltage can no longer be set midway between earth (0V) and supply rail (U_{CC}). The solution in the case of the d. c. amplifier is to use two balanced power supplies, one positive and one negative.

A simple two-transistor d. c. amplifier is shown in Fig. 4.5. It uses balanced power supplies and complementary (n-p-n and p-n-p) transistors. By means of the potential divider, consisting of R_4 and R_5 with R_3, the emitter of T_1 is held at a potential just a slightly negative of earth (—0,6 V). Thus T_1 is correctly biased if its base is tied to earth via the input resistor R_1.

On the output side, we know that the collector of an n-p-n transistor must be positive with respect to the base and yet in this d. c. amplifier, we require the collector to be at earth potential if zero input is to give zero output. This paradox is resolved by T_2, a p-n-p transistor, which is interposed to shift the quiescent output voltage back to zero and at the same time to perform further amplification. T_2 is simply a fully-stabilized amplifier stage working between supplies of +9 V and —9 V, with its base potential held, not by a potential divider, but by T_1 collector. The optimum working condition is obtained when T_2 quiescent collector potential is at earth (0V), giving zero output voltage for zero input to T_1. If zero does not result in zero d. c. output, the amplifier is said to exhibit an offset voltage; the purpose of variable resistor R_5, "the offset null control" is to adjust for zero output with zero input, rather as a voltmeter zero-set screw is adjusted to bring the pointer to scale zero with no applied signal.

ASSIGNMENTS

I. Skim through the Text C and give the main idea of it.

II. a) Divide the text into logical parts. b) Choose the key sentences, analyse and translate them.

III. Comment on the author's attitude to direct-coupled amplifier.

IV. Answer the following questions embracing the contents of the Text C.

1. What does the design of an amplifier without coupling capacitors restrict? 2. What is the solution of a problem in the case of d. c. amplifier? 3. What is shown in Fig. 4.5? 4. What does it use? 5. What is T_2?

V. Ask additional questions on the Text C.

VI. Combine your answers into a short summary of the text.

VII. Prepare a dialogue on a simple two-transistor amplifier.

VIII. Speak on d. c. amplifier.

IX. Translate the Text C to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

in assessing	гарантировать, обеспечивать
split v.	синфазный вход (вход общего сигнала)
common-mode input	точная копия
common-mode gain	разделять
ensure v.	оценивая, при оценке
exact replica	усиление (коэффициент усиления) синфазной составляющей

II. Use the following word-combinations when reading the Text D.

Now we shall consider сейчас мы рассмотрим; here we can no longer assume здесь мы не можем больше допустить; as we did in Fig. 4.6 как мы допускали, рассматривая рис. 4.6; as this would imply that как это подразумевалось бы (значило бы), что; for the purpose of calculating с целью расчета; it is reasonable to assume that целесообразно предположить, что; thus we see that таким образом, мы видим, что; note that заметьте, что; hence следовательно; we have seen that мы увидели, что.

III. a) Give the initial forms of the following words and translate them. b) State the function of suffixes.

Assessing, differential, assuming, corresponding, negligible, calculating, comparison.

Text D

VOLTAGE GAIN IN THE D. C. AMPLIFIER

I. Read the text and speak on voltage gain.

In assessing the voltage gain of the differential amplifier we shall consider two input conditions. First of all, in Fig. 4.6, input (1) and

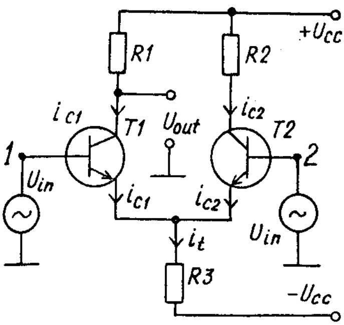


Fig. 4.6. The differential amplifier with common mode inputs.

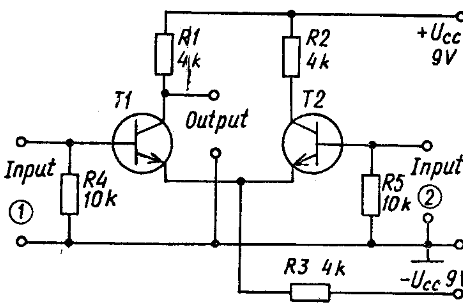


Fig. 4.7. The basic differential amplifier.

input (2) are both connected to the same signal U_{in}. Emitter follower action will ensure that an exact replica of the input signal appears across the tail resistor R_3. The total signal current in R_3 (i_t) will be given by

$$i_t = \frac{U_{in}}{R_3}.$$

Again, assuming the transistors to be identical, this current will be split equally between both devices so that signal collector current of T_1 = signal collector current of T_2, i. e. $i_t = i_{c1} + i_{c2}$ (assuming $i_c \cong i_e$) and since

$i_{c1} = i_{c2}$, $i_t = 2i_{c1}$. Now, $U_{out} = -i_{c1}R_1 \cong -\frac{U_{in} \cdot R_1}{2R_3}$ therefore voltage gain $= \frac{U_{out}}{U_{in}} = -\frac{R_1}{2R_3}$.

In the case of Fig. 4.6 $R_1 = R_3$ and, when both inputs are driven together with the same signal, the overall voltage gain is one half. This type of input is called a common-mode input and the corresponding gain the common-mode gain. The higher the value of the tail resistor R_3 compared with the collector load R_1, the lower the common-mode gain.

Now we shall consider the amplifier with a differential input, i. e. with a different signal on input (1) from that on input (2) Fig. 4.7. Here we can no longer assume that the emitters are connected together with negligible resistance as we did in Fig. 4.6, as this would imply that the output could not be different. For the purpose of calculating the differential voltage gain we shall consider the signal current flowing in r_e for each transistor. It is reasonable to assume that R_3 is much larger in value than r_e so that any common mode signal current (i_t) flowing in R_3 can be neglected in comparison with i_{e1} and i_{e2}. Then,

$$U_{out} = \frac{-g_m R_1 (U_{in(1)} - U_{in(2)})}{2}.$$

Thus we see that the differential amplifier responds to the difference in potential between its input. Note that if $U_{in(1)}$ is more positive than $U_{in(2)}$ the output is negative and if $U_{in(2)}$ is more positive than $U_{in(1)}$ the output is positive. Hence, input (1) is called the inverting input and input (2) the non-inverting input. The differential voltage gain A_{VD} is given by

$$A_{VD} = \frac{U_{out}}{U_{in(1)} - U_{in(2)}} \cong - \frac{g_m R_1}{2}, \; g_m \text{ in } mA/V, \; R_1 \text{ in k}\Omega.$$

We have seen that the differential amplifier exhibits a very low gain when both inputs carry the same signal (common-mode) but responds with a high gain to a potential difference between input (differential mode).

ASSIGNMENTS

I. Answer the following questions embracing the contents of the Text D.

1. Where are input (1) and input (2) connected to in Fig. 4.6? 2. What will emitter follower action ensure? 3. What will the current be, assuming the transistors to be identical? 4. When is the overall voltage gain one half?

II. Prepare a dialogue on the topic of the lesson.

III. Make up a plan of the Text D and speak on the text according to your plan.

IV. Examine Figs. 4.6, 4.7 and comment on:

1. The differential amplifier with common mode inputs.
2. The basic differential amplifier.

V. Look through the latest magazines and find additional material on the topic. Discuss it with your fellow-students.

III. GRAMMAR EXERCISES

I. Define the function of the Infinitive in the following sentences and translate them.

1. This limitation may seem to present a problem: we have so far assumed that the output signal should sit at $U_{CC}/2$ in order to allow both positive and negative swings in the signal. 2. If zero input does not result in zero d. c. output, the amplifier is said to exhibit an offset voltage; the purpose of variable resistor R_5, the "offset null control" is to adjust to zero output with zero input, rather as a voltmeter zero-set screw is adjusted to bring the pointer to scale zero with no applied signal.

II. Pay attention to the verbs in Subjunctive Mood while translating the sentences.

1. It is very desirable that, when there is no signal, both the input and the output should be at earth potential. 2. Here we can no longer assume that the emitters are connected together with negligible resistance as we did in Fig. 4.6, as this would imply that the input could not be different.

III. Define the function of -ing-forms in the following sentences and translate them.

1. The design of an amplifier without coupling capacitors restricts the range of permissible circuit voltages. 2. By means of potential divider, consisting of R_4 and R_5 with R_3, the emitter of T_1 is held at a potential just a slightly negative of earth. 3. T_2 is simply a fully-stabilized amplifier stage working between supplies at +9 V and —9 V.

Lesson 3. THE OPERATIONAL AMPLIFIER

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Listen and repeat after the speaker. b) Practise the pronunciation of the following.

[s] facts, gets, inclusive, famous, numerous, continuous; [ʒ] division, provision, corrosion; measure, explosure, enclosure; but: expension, extension, pressure [ʃ]; [aı] design, resign, sign; [i:] field, piece, yield; [ju:] few, dew, new; [u:] grew, screw, blew.

II. a) Make sure that you know these words. Say what Russian words help you to guess their meanings. b) Repeat these words after the speaker.

Construction, electronic system, integrated, revolution, silicon, proportion, construct, analogue, impedance, typically, bipolar, isolated, fact, megohm, configuration, parallel.

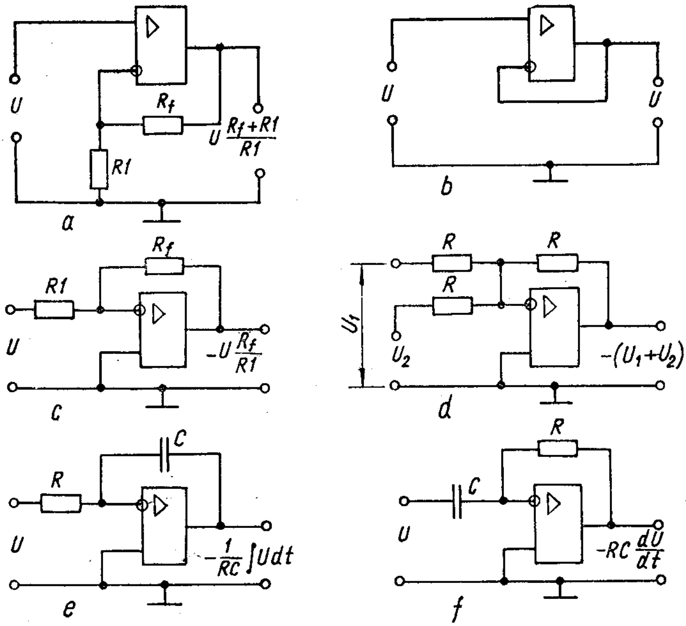


Fig. 4.8. Operational amplifier applications:
a the non-inverting amplifier; *b* the voltage follower; *c* the inverting amplifier; *d* the adder; *e* an integrator; *f* a differentiator.

III. a) Listen, repeat and memorize the following words and word-combinations. b) Check if you know the meaning of these words.

Operational amplifier операционный усилитель; elaborate тщательно разработанный; offset voltage напряжение сдвига; inherent свойственный, присущий; appropriate interconnection соответствующее взаимосоединение; "building bricks" «строительные кирпичи», основные элементы, simplifying assumptions упрощающие предположения; high-gain voltage amplifier усилитель напряжения с большим усилением; infinite open-loop voltage gain, A_{vol} коэффициент усиления по напряжению при разомкнутой петле A_{vol}, design consideration конструктивное соображение.

IV. a) Make up sentences using the following word-combinations from the Text A and the Text B. b) Learn them.

A considerable proportion of present-day circuit design значительная часть конструкций современных схем; the latter may be seen as последние можно рассматривать как; which can easily be used которые можно легко использовать для; all the circuits of Fig. 4.8 make use of все схемы рис. 4.8 используют; the term "operational" is generally used nowadays to describe термин «операционный» вообще используется сегодня для описания; the name is derived from the use of such amplifiers название происходит от использования таких усилителей; typically *зд.* обычно; the first design consideration therefore is that первое конструктивное соображение, следовательно, заключается в том, чтобы; the difference between the two input bias currents is known as разница между двумя токами смещения на входе известна как; yet another factor to be considered is that, irrespective of еще одним фактором, который рассматривается, является то, что несмотря на ... .

Text A

BUILDING BRICKS IN ELECTRONIC SYSTEMS

I. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

In the design and construction of complicated electronic system, integrated circuits (IC) have cause a major revolution. The chip of silicon in an IC is typically only 3 mm square, but twenty transistors, eleven resistors and a capacitor are included in that area.

A considerable proportion of present-day circuit design is achieved by the appropriate interconnection of ICs. The latter may be seen as "building bricks" which can easily be used to construct elaborate electronic system. Fig. 4.8 includes many circuits of this basic building bricks.

2. Average Reading

Text B

SIMPLIFYING ASSUMPTIONS

I. a) Listen to the text. b) Read it (time limit is 3 min.). c) Find the part of it dealing with the characteristics of an op amp. Translate it.

All the circuits of Fig. 4.8 make use of an operational amplifier (op amp.). The term "operational" is generally used nowadays to describe a high-gain voltage amplifier, particularly one in an IC or modular form. The name is derived from the use of such amplifiers in analogue computing operations. The characteristics of an op amp are such that the following simplifying assumptions can be made in most practical circuits: infinite open-loop voltage gain, A_{vol} (typically 2.10^5); infinite input impedance (typically 2 $M\Omega$); zero output impedance (typically 75Ω). Most IC amplifiers use bipolar transistors. The input terminals in fact connect to transistor bases which must be able to draw a small bias current if the amplifier is to function (d.c. coupling prevents the input terminals from being isolated with coupling capacitors). Input bias current typically is about 100 μA. The first design consideration therefore is that each input of any IC amplifier must have some sort of d. c. parth to earth.

The internal circuitry may be slightly unbalanced so that the two bias current are not equal (Fig. 4.9*a*).

The difference between the two input bias current is known as the input offset current and typically amounts to 20 μA.

Yet another factor to be considered is that, irrespective of external voltage at the input, the IC itself has a small inherent input offset voltage, about 1 mV.

ASSIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about.

II. a) Skim through the Text B and find the part of it dealing with the most IC amplifiers using bipolar transistors. b) Discuss the information.

III. Find the part of the text containing information about input bias current. b) Express your opinion of it.

IV. Answer the following questions embracing the contents of the Text A.

1. Have integrated circuit caused a major revolution in the design and construction of complicated electronic system? 2. What is the chip of silicon in an IC? 3. What is a considerable proportion of present-day circuit design achieved by? 4. What figure includes many circuits of the basic building bricks?

V. Ask additional questions on both texts.

VI. Summarize your answers into a sh a summary of these texts.

VII. Prepare a dialogue on simplifying ssumption.

VIII. Speak on the operational amplifier.

IX. Examine Fig. 4.8 and comment on:

1. The non-inverting and inverting amplifiers.
2. The voltage follower and the adder.
3. An integrator and a differentiator.

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these word-combinations.

Significant attenuation значительное ослабление; thanks to благодаря; unit-gain non-inverting amplifier неинвертирующий усилитель с единичным усилением.

II. Find these word-combinations in the Text C and translate the sentences containing them.

This latter requirement arises from the fact that это последнее требование возникает вследствие того, что; if the signal source cutput resistance is comparable with R_x, если выходное сопротивление источника сигнала сравнимо с R_x; it may be thought at first that вначале можно подумать, что; it will be noted будет отмечено; the answer is that ответ заключается в том, что.

III. a) State the function of each suffix in the following words. b) Translate these words.

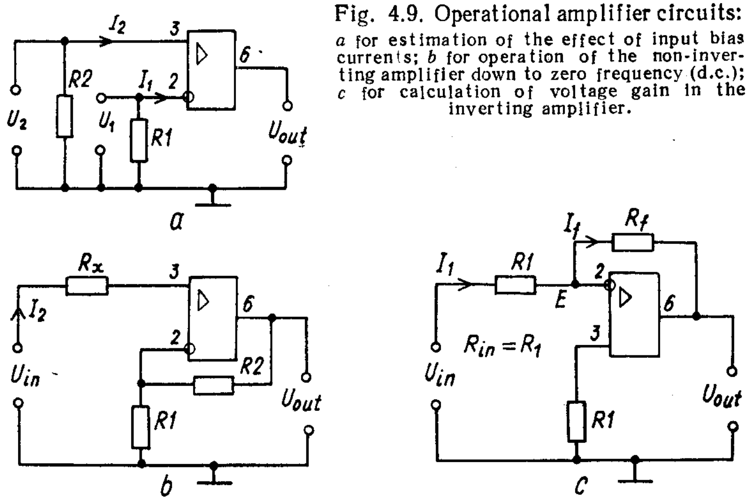


Fig. 4.9. Operational amplifier circuits:
a for estimation of the effect of input bias currents; *b* for operation of the non-inverting amplifier down to zero frequency (d.c.); *c* for calculation of voltage gain in the inverting amplifier.

Feeding, inverting, operation, connection, resistance, requirement, comparable, significant, fortunately.

Text C

THE NON-INVERTING AMPLIFIER

1. a) Read the text. b) Find the part of it describing the value of signal source output resistance, comparable with R_x. Translate it.

The feedback signal is affectively subtracted from the input signal by feeding the latter into the non-inverting input of the op amp and the feedback into the inverting input. Fig. 4.9*b* shows a non-inverting amplifier designed for operation down to zero frequency (d. c.) and with the input arranged for connection to a signal source of low output resistance. This latter requirement arises from the fact the amplifier must draw its input bias current from the signal source and must therefore see a d. c. path to earth. Resistor R_x is in circuit simply to ensure that both inputs see the same resistance to earth. If the signal source output resistance is comparable with R_x, its value should be subtracted from R_x. It may be thought at first that R_x, being in series with the signal, will cause significant attenuation; fortunately this is not the case because the amplifier itself thanks to the negative feedback, has an input impedance of at least 50 $M\ \Omega$. There will thus be a negligible signal loss across the 10 $k\ \Omega$ or so of R_x.

It will be noted in Fig.4.9*b* that circuit may be used to give unity voltage gain though the practical use of this may be questioned. The answer is that the unity-gain non-inverting amplifier is used to provide an impedance match like the emitter follower. The input impedance may be many hundreds of megohms at low frequencies and the output impedance less than 1 Ω.

I. a) Divide the text into logical parts. b) Entitle each part.

II. Look through the Text C and find the part of it dealing with the amplifier having a voltage gain approaching infinity.

III. Examine Fig. 4.9 and comment on:

1. Op. am. circuit for estimation of the effect of input bias currents.

2. Op. am. circuit for operation of the non-inverting amplifier down to zero frequency (d. c.).

IV. Answer the questions embracing the contents of the Text C.

1. What is called a virtual earth in Fig. 4.9*c*? 2. What makes the inverting amplifier very flexible in use? 3. What is the difference between the inverting amplifier and non-inverting one? 4. What does Fig. 4.9*b* show? 5. What does the latter requirement arise from? 6. What is resistor R_x in circuit simply to ensure? 7. What will R_x cause?

V. Ask additional questions on the Text C.

VI. Summarize your answers into a short summary of the text.

VII. Make up a plan of the Text C and speak on the topic.

VIII. State the tense-forms of the verbs in the Text C and translate them.

Subtract, show, arise, draw, see, think, cause, note, use.

IX. Translate the Text C to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

op amp = operational amplifier	фактически, в сущности
instead of	гибкий
approaching infinity	операционный усилитель
negligible	приближаясь к бесконечности
virtually	вместо
flexible	незначительный

II. Give the initial forms of the following words from the Text D and translate them.

Perfectly, inverting, configuration, simplifying, approaching, virtually, accepting, immediately, considering.

Text D

THE INVERTING AMPLIFIER

I. Read the text and speak on inverting amplifier.

It is perfectly feasible to feed the input signal into the inverting input of an op amp along with the negative feedback. This, as might be expected, produces an inverting amplifier, the output signal being 180° out of phase with the input. The circuit configuration, which is shown in Fig. 4.9*c* is known as shunt feedback because the negative feedback, instead of being in series with the input signal,is in parallel with it and feeds into the same input. To calculate the effect of shunt feedback, we use the three simplifying assumption about an op amp: open-loop gain $A_{vol} = \infty$, input impedance $Z_{in} = \infty$, output impedance $Z_{out} = 0$.

In Fig. 4.9*c* the point *E*, where R_f and R_1 join the inverting input, is called a virtual earth. This is so because, if the amplifier has a voltage gain approaching infinity, there must be a negligible potential difference between the two inputs. Thus, as far as the signal is concerned, the inverting input looks virtually the same as the non-inverting input, which is earthed.

Accepting that point *E* is a virtual earth means that the full input voltage U_{in} appears across input resistor R_1. Thus we see immediately why the input resistance R_{in} is quoted in Fig. 4.9 *c* as being equal to $R_1 : R_1$ is the only resistance which stands between the input terminal and the virtual earth. Signal current in R_1 is therefore given by $i_1 = \frac{U_{in}}{R_1}$. Now, considering feedback R_f, which is connected between the virtual earth and U_{out}, and taking signal current i_f in the direction shown:

$$i_f = \frac{-U_{out}}{R_f}.$$

If the op amp input impedance is infinite, no signal current is drawn by the inverting input, so it follows that $i_f = i_1$, i. e. $\frac{-U_{out}}{R_f} = \frac{U_{in}}{R_1}$ therefore $A_{vol} = \frac{U_{out}}{U_{in}} = -\frac{R_f}{R_1}$.

The way that the gain is dependent upon the simple ratio of two resistors makes the inverting amplifier very flexible in use.

ASSIGNMENTS

I. Answer the following questions embracing the contents of the Text D.

1. What is known as shunt feedback? 2. What do we use to calculate the effect of shunt feedback? 3. What is called a virtual earth? 4. When can be a negligible potential difference between the two inputs? 5. What formula is given for signal current in R_1?

II. Prepare a dialogue on your own situation describing a virtual earth.

III. Make up a plan of the Text D and retell it according to your plan.

IV. Make a short written summary of the Text D.

V. a) Look through the latest magazines and find additional information on the topic of the lesson. b) Discuss the problem of amplifier with your fellow-students.

III. GRAMMAR EXERCISES

I. Define the form and function of the verbs in the Passive Voice and translate the sentences with them.

1. The latter may be seen as "building bricks" which can be used to construct elaborate electronic system. 2. The term "operational" is generally used nowadays to describe a high-gain voltage amplifier. 3. It may be thought at first that R_x, being in series with the signal, will cause significant attenuation. 4. It will be noted in Fig. 4.9*b* that circuit may be used to give unity voltage gain though the practical use of this may be questioned.

II. Define the function of ing-form in these sentences and translate them.

1. D. c. coupling prevents the input terminals from being isolated with coupling capacitors. 2. It may be thought at first that R_x, being in series with the signal, will cause significant attenuation. 3. In Fig. 4.9*c* the point E, where R_f and R_1 join the inverting input, is called a virtual earth. 4. The inverting input looks virtually the same as the non-inverting input, which is earthed.

III. Translate the following sentences paying attention to the Infinitive.

1. Yet another factor to be considered is that, irrespective of external voltage at the inputs, the IC itself has a small inherent input offset voltage. 2. Resistor R_x is in circuit simply to ensure that both inputs see the same resistance to earth.

IV. a) Analyse the following sentences paying attention to the tense of the verbs. b) Translate them.

1. This, as might be expected, produces an inverting amplifier, the output signal being 180° out of phase with the input. 2. The circuit configuration, which is shown in Fig. 4.9*c* is known as shunt feedback because the negative feedback, instead of being in series with the input signal, is in parallel with it and feeds into the same input. 3. If the signal source output resistance is comparable with R_x, its value should be subtracted from R_x.

Lesson 4. LOGARITHMIC AMPLIFIER AND OSCILLATOR

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Make sure that you know these words. Say what Russian words help you to guess their meanings. b) Repeat these words after the speaker.

Logarithmic, instrumentation, meter, decade, parameter, accustical, decibel, phenomenon, physics, result, characteristic, basic, normal, temperature, limitation, potentiometer, factor.

II. a) Listen, repeat and memorize the following words and word-combinations from the Text A and the Text B. b) Check if you know their meanings.

Display v. отображать; roughly [rʌfli] грубо; prior to до; conveniently удобно; decay разложение, спад, понижение; reverse leakage current обратный ток утечки; swing раскачка (максимальное отклонение); fine control R_3 резистор R_3 для точной подстройки; offset potentiometer потенциометр сдвига; snag препятствие; logging transistor регистрирующий транзистор; base-emitter p. d. (potential difference) разность потенциалов между базой и эмиттером; single meter scale одна измерительная шкала; sound pressure levels уровни звукового давления; threshold of hearing порог слышимости; basic feature основная особенность.

III. Find attributes in these word-combinations and say what parts of speech they are expressed by. b) Translate them.

Logarithmic amplifiers; each major scale division; one decade of the parameter measured; in accustical measurement work; sound pressure level; some sound level meters; a single linear scale; input-output characteristic; low input voltage; the basic log amplifier circuit; the main logging transistor.

Text A

LOGARITHMIC AMPLIFIER

I. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

Logarithmic amplifier have applications in instrumentation where a wide range of signal amplitude must be displayed on a single meter scale; each major scale division can then represent one decade of the parameter measured.

In accustical measurement work, sound pressure levels are usually expressed in decibels relative to a reference level of $2 \cdot 10^{-5}$ N/m^2, which corresponds roughly with the threshold of hearing. A logarithmic amplifier connected prior to the read-out device can give readings directly in decibels. Some sound level meters cover the range 70 dB to 120 dB on a single linear scale. There are many such phenomena in physics which have an exponential decay with time. Such results can conveniently be displayed as a straight line decay via a logarithmic amplifier.

2. Average Reading

Text B

THE BASIC CIRCUIT

I. a) Listen to the text. b) Read it (time limit is 3 min.). c) Find the part of it dealing with an input-output characteristics for a basic log amplifier. Translate it.

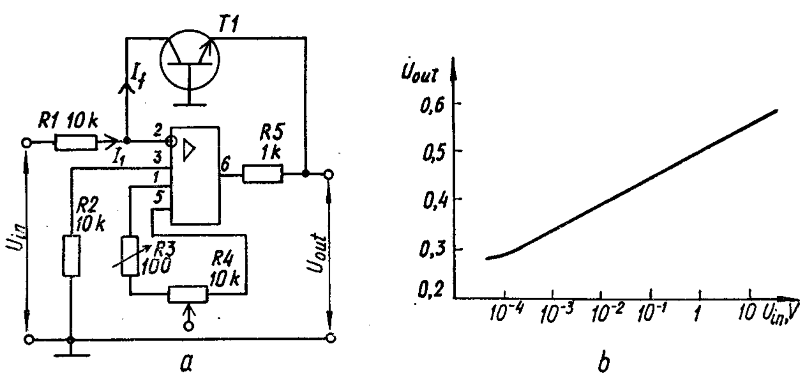


Fig 4.10. Logarithmic amplifier:
a the basic circuit; *b* a typical input-output characteristics.

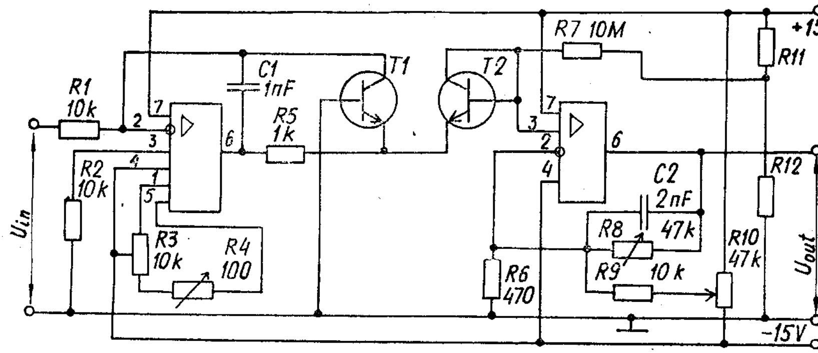


Fig. 4.11. The temperature-compensated logarithmic amplifier circuit.

The basic circuit of a logarithmic amplifier is given in Fig. 4.10*a*. Fig. 4.10*b* shows an input-output characteristic for a basic log amplifier, and it is clear that the output voltage swing is relatively small, changing by only about 0.3 V for four decades of input signal range. At low input voltages, the setting of the offset control R_3 become critical. To assist adjustment, the fine control R_4 is connected in series with the normal 10 kΩ offset potentiometer. The offset control are adjusted for zero amplifier output with the input shorted to earth.

In addition to the limited output voltage range, there is another snag associated with the basic log amplifier circuit of Fig. 4.10: it is temperature sensitive because of the kT/e factor in the transistor equation. Those two limitations may be overcome by using the more advanced circuit of Fig. 4.11. Here a second stage is added, both to increase gain and to provide temperature compensation. The latter feature is achieved by the inclusion of a second base-emitter junction T_2, in opposition to the main logging transistor T_1; T_2 experiences a negligible change in operating current over the full operating range so that it does not tend to counteract the logging of T_1. It does however encounter the same temperature changes as T_1 so that the resultant changes in its base-emitter p. d. compensate for the variations in T_1.

Potentiometer R_8 determines the scale factor (gain) and can be readily adjusted so that a 10 dB change in input gives a convenient 1 V change in output.

The remaining three preset potentiometers are offset controls.

ASSIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about.

II. a) Skim through the Text B and choose the key sentences. b) Translate the sentences.

III. Discuss the main idea of the Text A and the Text B.

IV. Answer the following questions on the Text A and the Text B.

1. What is given in Fig. 4.10*a*? 2. Why is a logarithmic amplifier used in instrumentation? 3. How are sound pressure levels expressed in accustical measurement work? 4. When can a logarithmic amplifier give readings in decibel directly? 5. What does Fig. 4.10*b* show? 6. When does the setting of the offset control R_3 become critical? 7. What are the offset controls adjusted for? 8. What does potentiometer R_8 determine? 8. What are the remaining three preset potentiometers?

V. Examine Figs. 4.10, 4.11 and comment on:

1. The basic circuit.
2. A typical input-output characteristics.
3. The temperature-compensated logarithmic amplifier circuit.

VI. Prepare a dialogue on typical input-output characteristics of simple logarithmic amplifier.

VII. Speak on:

1. Logarithmic amplifier.
2. The basic circuit.

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

1. Find the following word-combinations in the Text C and translate them with the sentences they are involved in.

One of the most useful test instruments; it is appropriate, therefore; in the case of; it is possible to arrive; this implies that; a sine-wave generator is designed so that.

Text C

POSITIVE FEEDBACK

I. a) Read the text. b) Describe the basic factor common to signal generator, i. e. positive feedback.

One of the most useful test instruments in experimental electronics is the signal generator. It is appropriate, therefore, that we should consider the methods used for signal generations.

Positive feedback is the basic factor common to signal generatcrs. We found in the discussions of negative feedback that the gain of any amplifier with feedback is given by

$$A = \frac{A_0}{1 - \beta A_0}, \qquad (4.5)$$

where A_0 is the gain without feedback and β is the fraction of the output fed back to the input. Now, with negative feedback, either β or

A_0 is negative, so that the denominator is always greater than one. In the case of positive feedback, however, it is possible to arrive at the condition $1 - \beta A_0 = 0$ (4.6) which gives an infinite value for $A = A_0/(1 - \beta A_0)$. This implies that the amplifier produces an output signal with no input, which is the condition for oscillation. An oscillator forms the heart of every signal generator. A sine-wave generator is designed so that the condition of (4.6) often called the Barkhausen criterion, is satisfied at only one frequency.

ASSIGNMENTS

I. a) Divide the text into logical parts. b) Choose the key sentences, analyse and translate them.

II. Entitle each of the paragraphs of the text using the key sentences.

III. Look through the text and find the part of it dealing with the case of positive feedback.

IV. Answer the following questions embracing the contents of the text.

1. What is one of the most useful test instruments in experimental electronics? 2. What is positive feedback? 3. When is the denominator greater than one? 4. What is the heart of every signal generator? 5. How is a sine-wave generator designed?

V. Ask additional questions and discuss the problem of feedback.

VI. Skim through the text and find the sentences containing the Participle. Translate them.

VII. Review the text in written form.

VIII. Translate the Text C to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

neglect	гасящий резистор
giving near infinite attenuation	нежелательный
unwanted	генератор с фазовым сдвигом (RC-генератор)
phase-shift oscillator	погашать, подавлять
"stopper" resistor	пренебрегать
damp out	создавая почти бесконечное ослабление

II. Translate the following word-combinations from the Text D.

A useful starting point; practical oscillator circuits; the phase-shift circuit; the voltage amplifier; a passive network; significant output; the capacitor reactance.

Text D

THE PHASE-SHIFT SINUSOIDAL OSCILLATOR

I. Read the text and speak on the application of positive feedback to a single-stage voltage amplifier.

A useful starting point in the study of practical oscillator circuits is to apply positive feedback to a single-stage voltage amplifier. This is accomplish in the phase-shift oscillator of Fig. 4.12a.

The phase-shift circuit is necessary in oscillation to be achieved, the amplifier output is 180° out of phase with its input. Hence, for positive feedback, the external circuit (R_1, C_1, R_2, C_2, R_3, C_3) must shift the phase through a further 180°.

The voltage amplifier uses a Darlington pair, so that we can neglect the transistor input impedance, which is very high. It is interesting to notice that, when 180° phase-shift is required, a passive network requires three RC stages if significant output is to be available. One *RC* stage will just manage a 90° phase-shift, but the capacitor reactance must be very high compared with the resistor, giving near infinite attenuation.

The 100 Ω resistor R_5 in Fig. 4.12*a*, is a "stopper" resistor to damp out unwanted high-frequency oscillation.

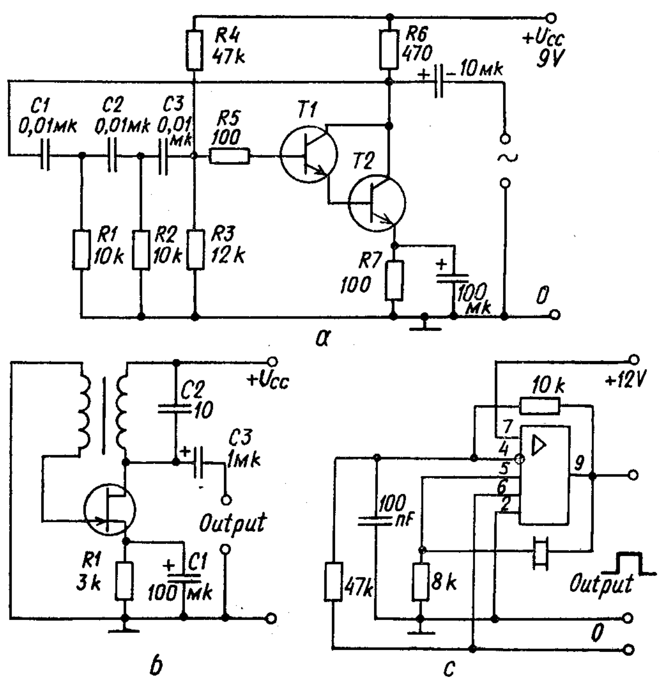


Fig. 4.12. Signal generator circuits:
a the phase-shift generator for sine-wave output; *b* simple LC generator, using FET; *c* the crystal-controlled rectangular wave output.

ASSIGNMENTS

I. Skim through the Text D and find the part of it dealing with the phase-shift circuit.

II. Answer the following questions embracing the contents of the Text D.

1. What is a useful starting point in the study of practical oscillator circuits? 2. Does the voltage amplifier use a Darlington pair? 3. When can we neglect the transistor input impedance? 4. When does a passive network require three *RC* stages? 5. What shift will one *RC* stage just manage?

III. Discuss the problem of oscillators.

IV. Examine Fig. 4.12 and comment on:

1. The phase-shift generator for sine-wave output.
2. Simple LC generator, using FET.
3. The crystal-controlled rectangular wave output.

V. Make up a plan of the Text D and speak on the topic according to your plan.

VI. Look through the latest magazines and find the material on the topic.

VII. Prepare a short information on the topic and discuss it with your fellow-students.

III. GRAMMAR EXERCISES

I. a) Analyse the following sentences and translate them. b) Pay attention to the words in bold type and define their forms.

1. It is clear that the output voltage **swing** is relatively small, **changing** by only about 0.3 V for four decades of input signal range. 2. **To assist adjustment**, the fine control R_4 is connected in series with the normal 10 kΩ offset potentiometer. 3. In addition to the limited output voltage range, there is another snag **associated** with the basic log amplifier circuit. 4. Here a second stage is added, both **to increase** gain and **to provide** temperature compensation.

II. Translate these sentences and pay attention to the modal verbs with the Passive Infinitive.

1. A wide range of signal amplitude must be displayed on a single meter scale. 2. The results can conveniently be displayed as a straight line decay via a logarithmic amplifier. 3. Those two limitations may be overcome by using the more advanced circuit of Fig. 4.11. 4. Potentiometer R_8 can be readily adjusted so that a 10 dB change in input gives a convenient 1 V change in output.

III. Change the tense-forms of the verbs in these sentences into the Past and the Future.

1. The fine control R_4 is connected in series with the normal 10 kΩ offset potentiometer. 2. The offset controls are adjusted for zero amplifier output with the input shorted to earth. 3. The latter feature is achieved by the inclusion of a second base-emitter junction T_2.

Lesson 5. INTEGRATED CIRCUITS

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Listen and repeat after the speaker. b) Practise the pronunciation of the following.

Miniaturize [ˌmɪnjətʃə'raiz], advantage [əd'vaːntɪdʒ], reliability [rɪˌlaɪə'bilɪtɪ], microminiaturization ['maɪkrɔˌmɪnjətʃərɪ'zeiʃ(ə)n], particular [pə'tɪkjulə], evaporation [ɪ'væpə'reɪʃ(ə)n], ceramic [sɪ'ræmɪk], photolithographic [ˌfouto(u)ˌlɪθə'græfɪc], essential [ɪ'senʃ(ə)l].

II. a) Make sure that you know these words. Say what Russian words help you to guess their meanings. b) Repeat these words after the speaker.

Electronics, industry, engineers, components, miniaturize, passive, elements, physical, material, technology, monolithic, integrated, process, individual, typical, naturally, factor, apparatus, temperature, basic, form, ceramic, active, combination, metallized, base, discrete, collector, emitter, start.

III. a) Listen, repeat and memorize the following words and word-combinations from the Text A and the Text B. b) Check if you know their meanings.

Integrated circuits интегральные схемы, микросхемы; continued effort непрерывная попытка, продолжающееся усилие; miniaturize делать миниатюрным; reliable надежный; trend направление, тенденция; build into встраивать, вмонтировать; eventually в итоге, в конце концов; "face of stone" поверхность камня; simultaneous fabrication одновременное изготовление; merely только, просто; chip чип (*кристалл небольшого размера*); on account of за счет чего-л.; impact влияние, воздействие; confine ограничивать; offer предлагать, давать; failure отказ, сбой в работе, провал; space probe космический зонд; soldered connections пайки, паянные соединения; actual overall cost фактическая полная стоимость; consumer потребитель; design cost стоимость разработки; literally буквально; breakdown авария, неисправность; emphasis особое значение, ударение; operating temperature рабочая температура; intimate construction *зд.* близкое размещение; total demand общая потребность; require less power to operate требовать меньше мощности для работы; in order to take full advantage для того, чтобы получить все преимущества; saving in space экономия пространства (объема).

IV. Find in the Text A and in the Text B English equivalents of the following word-combinations and translate the sentences with them.

С самого начала; миниатюризация электронного оборудования; значительно меньше; для того, чтобы получить полное преимущество; сделать возможным с помощью того же процесса, который используется; так, чтобы разрешить; электронная промышленность; жизненно важные преимущества; надежность электронного оборудования; все возрастающая сложность; может привести к полной неисправности системы; за счет трех основных факторов; по мере того, как рабочая температура увеличивается; зависит от общего требования; для определенной цепи.

V. Analyse the following words from the viewpoint of their structure. Learn them.

Development, microminiaturization, monolithic, measuring, interconnection, vitally, reliability, breakdown, furthermore, construction, manufacturing, ultimately.

Text A

MINIATURIZATION IN ELECTRONIC EQUIPMENT

I. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

Almost since the beginning of the electronics industry, scientists and engineers have concerned themselves with producing smaller components in a continued effort to miniaturize electronic equipment. In 1948, a major step forward was achieved by the invention of the transistor. Not only is the transistor considerably smaller than the thermionic valve it replaced, but also more reliable, cheaper and requires less power to operate. In order to take full advantage of the transistor, passive elements such as resistors, capacitors and inductors were greatly reduced in physical size by using new materials and improved technology.

The transistor was only a stage in the development of true microminiaturization which was made possible by the development of the monolithic integrated circuit. This is a complete circuit which is built into a single "face of stone", i. e. silicon.

The silicon monolithic integrated circuit is produced by the same processes used to fabricate individual transistors and diodes. The technology is merely extended so as to permit a complete circuit to be made within a single silicon chip, e. g. a typical integrated chip, measuring only 1.25 mm square by 0.25 mm thick, may contain up to fifty electronic components (transistors, diodes, resistors, capacitors) plus their interconnections.

2. Average Reading

Text B

RELIABILITY OF INTEGRATED CIRCUITS

I. a) Listen to the text. b) Read it (time limit is 3 min.). c) Find the part of it dealing with the three main factors of high reliability of integrated circuits. Translate it.

The impact the integrated circuit has had on the electronics industry is not confined to miniaturization. It offers two other vitally important advantages over the older discrete components circuit, these are: a) greater reliability; b) production of large number of circuits at low cost.

Naturally, reliability of electronic equipment has always been important. However, the ever increasing complexity of present day electrical equipment (in space probes, computers, etc.) where literally hundreds of thousands of circuit elements are utilized and where failure of any may cause complete breakdown of the system, means that greater emphasis is placed on reliability. Integrated circuits offer high reliability on account of three main factors:

a) absence of soldered connections between circuit components;

b) simultaneous fabrication of whole circuits by carefully controlled processes;

c) low power operation. In general, reliability of electronic apparatus decreases as the operating temperature increases. Thus, since integrated circuits are low power operated, the resulting temperature rise is small, giving high reliability. Furthermore, due to its intimate construction the effects of temperature variation are more uniform than in discrete assemblies and this contributes to greater reliability.

The reduction in manufacturing cost is achieved because many similar circuits may be fabricated simultaneously. The actual overall cost per circuit to the consumer, i. e. design cost plus manufacturing cost, does ultimately depend on the total demand for that particular circuit.

ASSIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about.

II. Skim through the Text B and find the part of it dealing with the reliability of electronic equipment. Translate it.

III. Find the part of the text containing information about the effects of temperature variation. Discuss it.

IV. Answer the following questions.

1. When did scientists invent the transistor? 2. What was the transistor invented for? 3. What are the advantages of the transistor as compared with the thermionic valve? 4. By what means were passive elements reduced in physical size? 5. How is the silicon integrated circuit produced? 6. What advantages does the integrated circuit offer over the older discrete component circuit? 7. Is the silicon monolithic integrated circuit produced by the same processes used to fabricate individual transistors and diodes? 8. Has reliability of electronic equipment always been important? 9. On account of what factors do integrated circuits offer high reliability? 10. When are the effects of temperature variation more uniform? 11. Does it contribute to greater reliability?

V. Prepare a dialogue on the main factors of high reliability of integrated circuits.

VI. Speak on the advantages of transistors and integrated circuits.

VII. Make up a plan of the Text B.

VIII. Retell the text according to your plan.

IX. Translate the question-answer units into English. Work in pairs.

1. Когда был изобретен транзистор? (Транзистор был изобретен в 1948 г.).

2. Каковы преимущества транзистора по сравнению с электровакуумной лампой? (Транзистор значительно меньше, чем электровакуумная лампа, более надежен, дешевле и требует меньше мощности для работы.)

3. Намного ли уменьшены физические размеры пассивных элементов? (Да. Пассивные элементы, такие как резисторы, конденсаторы и катушки индуктивности, значительно уменьшены в размере путем использования новых материалов и улучшенной технологии).

4. Как изготавливается кремниевая интегральная схема? (Кремниевая интегральная схема изготавливается посредством тех же процессов, которые применяются при изготовлении отдельных транзисторов и диодов.)

5. Какими преимуществами обладает интегральная схема по сравнению со схемой из старых дискретных деталей? (Она обеспечивает большую надежность и изготовление большого количества схем меньшей стоимости.)

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these words.

Approach подход; true истинный; both ... and как ..., так; simultaneously одновременно; fabricate изготавливать; directly непосредственно; separate отдельный; somewhat similar кое в чем подобна interconnected взаимосвязанный.

II. Memorize these words and word-combinations used in their specialized meaning.

Mount устанавливать; bonding связь, соединение, сваривание; common base общая основа, подложка; deposite осаждать; diffuse planar technique диффузионная планарная технология.

III. Find the following word-combinations and terms in the Text C and translate the sentences containing them.

A small single wafer небольшая отдельная «вафля», пластинка; film circuit пленочная схема; insulation substrate изолирующая основа, подложка; thin-film circuits тонко-пленочные схемы; thick-film circuits толсто-пленочные схемы; interconnection wiring pattern узор, рисунок из соединительных проводников; evaporation technique техника напыления (с помощью испарения); separate semiconductor wafer отдельная полупроводниковая пластинка (кристалл); silk-screen technique техника шелкографии; multiple-chip circuit многокристальная схема; oxidized surface оксидированная поверхность; wiring patterns проволочный узор.

IV. a) Arrange the following words of the same root according to the model. b) Do the same with other words from the Text C.

Model. metal — metallize — metallization — metallic

interconnect, deposite, evaporate, combine, approach, use, add.

Text C

CLASSIFICATION OF INTEGRATED CIRCUITS

I. a) Read the text. b) Find the part of it dealing with the thick-film methods. Translate it.

There are two basic approaches to microelectronics.

1. Monolithic Integrated Circuits. This is the true integrated circuit, in which all components both active and passive are formed simultaneously in a small single wafer of silicon by the diffused planar technique.

2. Film Circuits. Film circuits are microminiature electronic circuits fabricated by forming passive electronic components directly on the surface of an insulation substrate. There are two types: thin-film circuits and thick-film circuits.

In the thin-film technique, passive components — resistors and capacitors, and the interconnection wiring pattern — are formed, using evaporation technique, onto glass or ceramic substrates. The active components — transistors and diodes — are fabricated as separate semiconductor wafers and these wafers are then mounted directly onto prepared locations on the pattern and connected into the circuit.

The thick-film method is somewhat similar to the thin-film approach. The passive components and wiring pattern are formed using silkscreen technique on ceramic substrates. The active semiconductor devices are again added as discrete wafers.

In addition to the two basic approaches to microelectronics, there are two other methods using a combination of techniques.

1. **Multiple-chip Circuits.** Here, the passive and active components are formed in separate wafers or "chips" of semiconductor material and these are then mounted onto a common base and interconnected with very small diameter gold wire using thermocompression bonding.

2. **Hybrid Integrated Circuits.** This is a combination of monolithic and film technique, in which the active components are first formed in a single wafer of silicon with an oxidized surface, and the passive components and metallized interconnection pattern are deposited onto the silicon-oxide surface by evaporation technique.

ASSIGNMENTS

I. Divide the text into logical parts. Choose the key sentences and translate them.

II. Find the part of the text describing the two basic approaches to microelectronics. Discuss it.

III. Read the Text C attentively and answer the questions.

1. How many approaches are there to microelectronics? 2. What are they? 3. What are film circuits? 4. How are they fabricated? 5. How many types of film circuits are there? 6. What are these types of film-circuits? 7. How are passive elements formed? 8. How are the active components fabricated? 9. Is the thick-film method similar to the thin-film approach? 10. How are the passive components and wiring pattern formed? 11. What are additional basic approaches to microelectronics? 12. What are the passive components and metallized interconnection pattern deposited onto?

IV. Prepare a dialogue on your own situation.

V. Analyse the structure of the following sentences and translate them into Russian.

1. Using the standard photolithographic technique previously described, silicon oxide is removed so that the only oxide film remaining is that over the region where the transistor is to be formed. 2. Compare the structure of the transistor just considered with the structure of a discrete planar transistor shown in Fig. 4.13*a*. 3. The important steps involved in the manufacture of one widely used type of integrated

circuit transistor are the following. 4. Starting with a suitable prepared silicon wafer, a thin film of silicon oxide is thermally deposited on the working surface.

VI. Speak on:

1. Multiple-chip Circuit.
2. Hybrid Integrated Circuit.

VII. Translate the Text C to be sure you understand it well.

VIII. Make up a plan of the text.

IX. Retell the text according to your plan.

X. Review the text in written form.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

through one common working surface	как сверху, так и снизу
starting with	ранее описанный
suitably prepared	первоначально разработанная
previously described	еще одна пленка
heavy p-type impurity diffusion	через одну общую рабочую поверхность
both the top and bottom	начиная с
further film	сильно легированная область эмиттера
heavily doped emitter region	подготовленный соответствующим образом
originally developed	сильная диффузия примеси р-типа
except for	за исключением

II. Be sure that you know these words.

Etch v. вытравливать; subsequently впоследствии; final film завершающая пленка; laterally горизонтально; sandwich v. прослаивать; essential существенный; solution решение; n^+ buried layer скрытый n^+ слой; prefer v. предпочитать; eventually в конечном счете.

III. Give the initial forms of the following words and translate them.

Originally, working, widely, using, remaining, diffusion, immediately, thickness, approximately, readiness, resistivity.

Text D

TRANSISTORS FOR INTEGRATED CIRCUITS

I. Read the following text and tell about the important steps involved in the manufacture of one widely used type of integrated circuit transistor.

Although there are several different ways in which transistors for integrated circuits can be fabricated, they are all based on the planar process originally developed for discrete transistors. The name planar is used because the collector, base and emitter region are all formed through one common working surface of the wafer and the external connections all come to the same surface (planar means single surface). The planar process utilizes the various processes.

The important steps involved in the manufacture of the widely used type of integrated circuit transistor are:

Step 1: Starting with a suitably prepared silicon wafer, a thin film of silicon oxide is thermally deposited on the working surface (top face).

Step 2: Using the standard photolithographic technique silicon oxide is removed so that the only oxide film remaining is that over the region, where the transistor is to be formed.

Step 3: The wafer is subjected to heavy p-type impurity diffusion from both the top and bottom. The original n-type material is converted to p-type except for the region immediately below the silicon oxide mask. The thickness of this isolated n-type region which will eventually contain the collector, base and emitter region is approximately half the wafer thickness. A new film of silicon oxide is deposited over the entire working surface of the wafer.

Step 4: A window in the silicon oxide is created in readiness for a second diffusion process.

Step 5: P-type impurities are diffused through the windows in the oxide until the n-type silicon immediately below the window is converted to p-type of the correct resistivity to form the base of the transistor. A further film of silicon oxide is then deposited on the working surface of the wafer.

Step 6: Further windows are etched in the silicon oxide in readiness for a third diffusion process.

Step 7: N-type impurities are diffused through the windows to form the heavily doped emitter region (n^+), plus a heavily doped (n^+) region within the collector so as to provide a good contacts. A final film of silicon oxide is laid on the working surface.

Step 8: Contact holes are etched in the oxide film and aluminium is then deposited on the wafer. This aluminium film is subsequently etched to form the separate collector, base and emitter terminals.

Compare the structure of the transistor just considered with the structure of a discrete planar transistor shown in Fig. 4.13*a*. It will be seen that the essential difference is that with the discrete transistor the collector contact is made at the bottom of the structure, whereas it is at the top for the integrated circuit transistor. Because of the necessity for this top connection, the collector current must flow laterally along a narrow n-type region of relatively high resistivity. The result is a higher $U_{CE(sat)}$.

Two methods are used to overcome this high collector resistance. One approach is to use two collector contacts as suggested. Although the resistance may be reduced from say 30 Ω to 20 Ω and $U_{CE(sat)}$

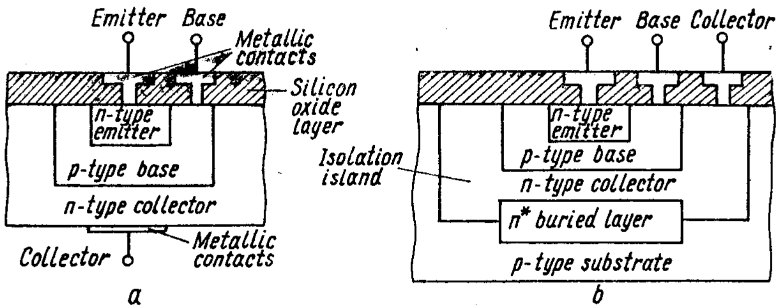


Fig. 4.13. The comparison of the structure of a discrete and integrated transistors:
a a discrete transistor; *b* an integrated transistor, utilizing buries n^+-layer.

from 0.32 V to 0.20 V by using this method, the improvement is obtained at the expense of increased transistor area. A preferred solution is to diffuse a heavily doped (low resistivity) n-type silicon layer sandwitched between the p-type substrate and the n-type collector. The resulting structure is shown in Fig. 4.13*b*, from which it may be seen that the collector current can now flow laterally through a low resistance region, resulting in considerable decrease in the collector resistance and $U_{CE(sat)}$.

ASSIGNMENTS

I. Give the main idea of the Text D.

II. Answer the following questions embracing the contents of the Text D.

1. What are different ways for transistor fabrication based on? 2. How many important steps are there in the manufacture of integrated circuit transistor? 3. What is shown in Fig. 4.13*a*? 4. What essential difference is in the structure of the discrete transistor, on the one hand, and the integrated circuit transistor, on the other? 5. What methods are used to overcome the high collector resistance? 6. What is the first approach to this problem? 7. What is the second approach to the same problem? 8. What does Fig. 4.13*b* show? 9. Why is the name *planar* used? 10. Does the planar process utilize the various processes? 11. What are the important steps involved in the manufacture of one widely used type of integrated circuit transistor? 12. Where is the comparison of the structure of a discrete and integrated transistors shown?

III. Prepare a dialogue on your own situation.

IV. Speak on:

1. The planar processes originally developed for discrete transistors.
2. The important steps involved in the manufacture of integrated circuits.
3. Compare the structure of the transistor just considered with the structure of a discrete planar transistor.

V. Make up a plan of the text.

VI. Retell the text according to your plan.

VII. Look through the latest magazines and find additional material about integrated circuits. Discuss it with your fellow-students.

III. GRAMMAR EXERCISES

I. Find the verbs in Perfect Tenses in the following sentences and translate them.

1. Scientists and engineers have concerned themselves with producing smaller components. 2. The impact the integrated circuit has had on the electronics industry is not confined to miniaturization. 3. Reliability of electronic equipment has always been important. 4. Many new devices have been invented by the scientists.

II. State the tense-forms of the verbs in the Passive Voice in the following sentences. Translate the sentences.

1. Passive elements were greatly reduced in physical size. 2. The development of true microminiaturization was made possible by the development of the monolithic integrated circuit. 3. This circuit is built into a single "face of stone", i. e. silicon. 4. Many thousands of circuit elements are utilized. 5. The reduction of manufacturing cost is achieved because many similar circuits may be fabricated simultaneously. 6. The active components — transistors and diodes — are fabricated as separate semiconductor wafers and these wafers are then mounted directly onto prepared locations on the pattern and connected into the circuit. 7. The active semiconductor devices are again added as discrete wafer.

III. Find the sentences with the verbs in the Passive Voice in the Text D.

IV. a) State the forms and functions of the Infinitive and-*ing*-forms. b) Translate the sentences.

1.Almost since the beginning of the electronics industry, scientists and engineers have concerned themselves with producing smaller and smaller components in a continued effort to miniaturize electronic equipment. 2. In order to take full advantage of the transistor, passive elements such as resistors, capacitors and inductors were greatly reduced in physical size by using new materials and improved technology. 3. The technology is merely extended so as to permit a complete circuit to be made within a single silicon chip. 4. However, the ever increasing complexity of present day electrical equipment means that greater emphasis is placed on reliability.

Lesson 6. MOS TECHNOLOGY

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

I. a) Listen and repeat after the speaker. b) Memorize the following abbreviations.

MOS — metal-oxide-semiconductor transistor;
SSI — small-scale integration;
MSI — medium-scale integration;
LSI — large-scale integration;
ULSI — ultra large-scale integration;
MOSLSI — large-scale integration of metal-oxide-semiconductor transistor;
NMOS — n-channel metal-oxide-semiconductor transistor;
CMOS — complementary metal-oxide-semiconductor transistor.

II. a) Listen, repeat and memorize the following words and word combinations. b) Check if you know their meanings.

Threefold тройной; feasible возможный, существенный; somewhat несколько; dynamic circuit techniques методы построения динамических схем; a steadily increasing fraction постоянно растущая доля (часть).

III. a) Listen and repeat after the speaker. b) Analyse the structure of the following terms. Translate them.

A single integrated circuit chip; small-scale integration; large-scale integration; equivalent gates; first commercial digital circuits; a new identifier; ultra large scale integration; two distinct classifications; standard parts; many system manufacturers; custom circuits; suitable standard parts; a specific application; small-scale digital integrated circuits; large-scale integrated digital memory and microprocessor circuits; the most important advantage; bipolar circuits; fabricated process; fewer critical defects; bipolar circuit fabrication; dynamic circuit technique; a given circuit function; internal dimensions; a great many variations of MOS technology; zero power consumption; a reverse-biased p-n junction; a typical integrated-circuit p-n junction capacitor.

Text A

SCALE OF INTEGRATION

1. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

In practice, many simple digital schemes or gates are manufactured on a single integrated circuit chip. Although there are no universally accepted definitions for levels of complexity, when between 1 and 10 gates are included on a chip, the usual term referring to this level of complexity is small-scale integration (SSI).

Medium-scale integrated circuits (MSI) are generally considered to include 10 to 100 gates on a chip, while large-scale integration (LSI) refers to complexities in the range of 100 to approximately 10,000 gates or bits of memory per chip. The term very large scale integration (VLSI) is commonly used for integrated circuit chips containing more than 10,000 equivalent gates; the first commercial digital circuits at this level of complexity became available about 1980. Ultimately it may be possible to incorporate a million or more gates on a chip; a new identifier such as ultra large scale integration (ULSI) may come into common usage.

Two distinct classifications for integrated circuits are as **standard parts** (components used by many system manufacturers) or **custom circuits** (components designed and manufactured for one customer). Custom circuits are used when suitable standard parts are not available, or to reduce costs by providing exactly the function needed for a specific application.

2. Average Reading

Text B

METAL-OXIDE-SEMICONDUCTOR (MOS) TRANSISTOR

1. a) Listen to the text. b) Read it (time limit is 3 min.). c) Find the part of it dealing with the most important advantage of MOS circuits over bipolar circuits for LSI. Translate it.

Small-scale digital integrated circuits based on complementary MOS technology have been in use for many years. MOS technology is the basis for most of the large-scale integrated (LSI) digital memory and microprocessor circuits. The most important advantage of MOS circuit over bipolar circuits for LSI is that more transistors and more circuit functions may be successfully fabricated on a single chip with MOS technology. The reason for this are threefold. First, an individual MOS transistor occupies less chip area. Second, the MOS fabrication process involves fewer steps and as a result achieves fewer critical defects per unit chip area than in bipolar circuit fabrication. This makes feasible somewhat larger chips in MOS technology. Third, dynamic circuit techniques that require fewer transistors to realize a given circuit function are practical in MOS technology but not in bipolar technology. The result of these differences is that MOSLSI circuits are significantly cheaper to manufacture than bipolar circuits of equivalent function. Consequently, MOSLSI circuits are making up a steadily increasing fraction of the total market for digital LSI.

ASSIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about.

II. Skim through the Text B and find the part of it dealing with the most important results of using MOS technology.

III. Find the part of the Text B containing information about differences in MOSLSI circuits and bipolar circuits. Discuss it.

IV. Answer the following questions.

1. What are manufactured on a single integrated circuit chip? 2. Are there any universally accepted definitions for levels of complexity? 3. What are MSI generally considered? 4. What term is commonly used for integrated circuit chips containing more than 10,000 equivalent gates? 5. When did the first commercial digital circuits at this level of complexity become available? 6. What are two distinct classifications for integrated circuits? 7. When are custom circuits used?

V. Prepare a dialogue on your own situation.

VI. Make up a plan of the Text B.

VII. Retell the text according to your plan.

II. CLASSWORK

PRE-TEXT EXERCISES

I. Be sure that you know these words.

Significant feature отличительная особенность; very sharp *зд.* очень серьезный; in contrast в противоположность; steady устойчивый; capability способность; shrink сокращать; furthermore более того; coin измышлять, создавать (новые слова); prevalent широко распространенный; wristwatch часы-браслет.

II. Find the following word-combinations in the Text C and translate the sentences containing them.

Pattern definition capability возможность четкого воспроизведения структуры; self-aligned silicon gate NMOS кремниевые приборы n-МОП с самосовмещенным затвором; complementary MOS (CMOS) technology технология К-МОП; zero power consumption нулевая потребляемая мощность; for both logic states для обоих логических состояний.

III. a) Find attributes in the following word-combinations and define the parts of speech they are expressed by. b). Translate them into Russian.

The internal dimensions of individual devices; sharp improvements; circuit speed; the most prevalent version of MOS technology; the great advantage of CMOS digital circuits; essentially zero power consumption; a typical integrated-circuit p-n junction capacitor.

Text C

ALTERNATIVE MOS PROCESSES

I. a) Read the text. b) Speak on a great many variations of MOS technology.

A significant feature of MOS circuits is that reductions in the internal dimensions of individual devices result in very sharp improvements in circuit speed. In contrast, bipolar circuit speed improves only gradually as internal dimensions are similarly reduced. With the steady improvements in pattern definition capability, the difference in performance between bipolar and MOS circuits has steadily become smaller. For LSI circuits, the speed difference has shrunk from a factor of 10 or more in 1970 to a factor of 2 or less in 1980.

A great many variations of MOS technology have been and continue to be used. Furthermore, the commercial reasons, manufacturers of components often coin their own name or acronym for what may be a process technology used by others under a different name.

The most prevalent versions of MOS technology today is self-aligned silicon-gate NMOS. Modern versions of this process employ a technique known as local oxidation to increase circuit density and performance.

Complementary MOS (CMOS) technologies provide both n-channel and p-channel devices in one chip, at the expense of some increase in fabrication complexity and chip area compared to basic NMOS. The great advantage of CMOS digital circuits is that they may be designed for essentially zero power consumption in steady-state condition for both logic states. Power is consumed only when circuits switch between logic states; average power consumption is usually much smaller than for NMOS circuits. CMOS is widely used for digital wristwatches and other battery-powered equipment, and it is coming into wider use in computers and communication equipment.

ASSIGNMENTS

I. Answer the following questions embracing the contents of the Text C.

1. What is a significant feature of MOS circuits? 2. How does bipolar circuit speed improve as internal dimensions are similar

reduced? 3. When has the difference in performance between bipolar and MOS circuits become steadily smaller? 4. From what factors has the speed difference shrunk in 1970 and 1980? 5. What is the most prevalent version of MOS technology? 6. What technique do modern versions of this process employ? 7. What does complementary MOS (CMOS) technologies provide?

II. a) Read the text again and ask additional questions embracing its contents. b) Combine your answers into a short summary of the text.

III. Find the part of the text containing information about the great advantage of CMOS digital circuits. Translate it.

IV. Pick out all technical terms from the Text C and translate them.

V. Make up a plan of the text.

VI. Speak on the topic according to your plan.

VII. Review the text in written form.

VIII. Translate the text to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

island	подбор
inevitable	точно
further defects	простота изготовления
relative permittivity	поверхностные взаимосоединения
it may be regarded	ранее рассмотренный
precisely	выход годных схем
simplicity of fabrication	конденсатор с параллельными пластинами
adjustment	неизбежный
circuit yield	сильно диффундированный
previously considered	островок
heavily diffused	она может быть рассмотрена
parallel-plate capacitor	*зд.* другие недостатки
surface interconnection	*зд.* неблагоприятно
offset	относительная проницаемость
adversely	свести на нет

II. Pick out all technical terms from the Text D and translate the sentences with them.

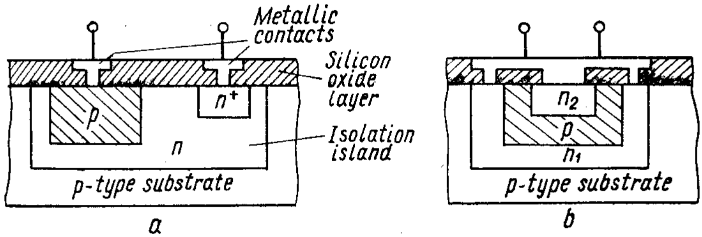


Fig. 4.14. Junction capacitors for integrated circuits:
a a typical junction capacitor; *b* a junction capacitor with increased capacitance.

III. Memorize the reading of the following formulas.

1. $C = \frac{\varepsilon_r \cdot \varepsilon_0 \cdot A}{d}$ farads — C is equal to ε sub r multiplied by ε sub 0 multiplied by A divided by d farads.
2. pF/mm^2— p multiplied by F divided (per) mm squared.

Text D

CAPACITOR FOR INTEGRATED CIRCUITS

I. Read the text and say what it is about.

Capacitor for integrated circuits fall into two categories: a) The p-n junction type. b) The thin film or MOS type.

A p-n junction capacitor uses the capacitance of a reverse-biased p-n junction. A typical integrated-circuit p-n junction capacitor is shown in Fig. 4.14*a*. It is formed in the silicon chip simultaneously with transistor fabrication. Thus the emitter base junction or the collector-base junction can be utilized, e. g. for a collector-base p-n capacitor, the p-type region may be diffused into the isolation n-type island at the same time as transistor base formation. The n^+-type contact region is formed into the island simultaneously with diffusion for transistor emitter regions.

The resulting capacitance associated with the p-n junction depends upon: a) The junction area. b) The resistivity of the two region utilized. c) The magnitude of the reverse-biased voltage. A higher value type of junction capacitor is shown in Fig. 4.14*b*. Two n-type region n_1 and n_2, sandwich a p-type region, resulting in an increase in junction area.

From Fig. 4.14 it may be noted that an unwanted capacitor is formed by the reverse-biased n-type isolation island and the p-type substrate. Further defects of junction capacitors are their voltage dependence and the inevitable leakage current associated with reverse biased p-n junctions.

The principle of the thin-film integrated circuit capacitor is that of the parallel-plate capacitor, i. e. a capacitor is formed when two

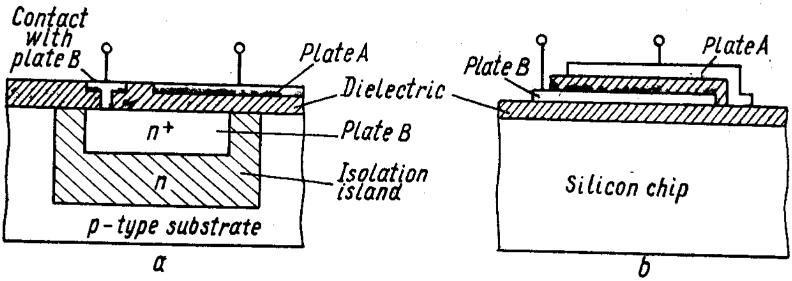


Fig. 4.15. Thin-film capacitors for integrated circuits:
a metal oxide capacitor; *b* thin-film capacitor.

conducting plates are separated by a dielectric material. The total capacitance produced, providing the area of the plates is large in reation to the distance between them, is given by

$$C = \frac{\varepsilon_r \cdot \varepsilon_0 \cdot A}{d} \text{ farads},$$

where ε_r is the relative permittivity of dielectric,
ε_0 is the permittivity of free space (8.85×10^{-12} farads/ metres),
A is the area of plates in square metres,
d is the distance between plates in metres.

There are many different forms of thin film capacitors. Fig. 4.15 shows one type which is very widely used — it is referred to as metal oxide silicon capacitor or MOS capacitor.

Plate *B* consists of a heavily diffused n^+ region that is diffused into the isolation island at the same time as transistor-emitter diffusion. The resistivity of this region is so low that it may be regarded as a conducting plate.

The dielectric layer is usually a film of silicon oxide of precisely controlled thickness. The high dielectric strength of silicon oxide makes it possible to have a very thin film, in the order of 0.05 μm which gives a capacitance of 600 pF/mm² with a safe breakdown voltage.

Plate *A* consists of a thin layer of aluminium that is deposited at the same time as metallization of the surface interconnections.

The advantages of this construction are its non-polarization and its simplicity of fabrication. The only additional processing step is adjustment of the thickness of the dielectric layer. Fig.4.15*b* shows a second type of thin-film capacitor that is fabricated entirely on top of the chip. It has an advantage over the previously considered thin-film capacitor in that it may form over previously diffused elements. Further advantages are that a wider choice of dielectric materials may be used and adjustment of the final capacitance may be obtained by abrasion of the top plate. These advantages are somewhat offset since the construction requires additional processing steps which adversely affect the cost and circuit yields.

I. Answer the following questions embracing the contents of the Text C.

1. What are the categories of capacitors for integrated circuits? 2. What capacitance does a p-n junction capacitor use? 3. Where is a typical integrated circuit p-n junction capacitor shown? 4. Is it formed in the silicon chip simultaneously with transistor fabrication? 5. What does the resulting capacitance associated with the p-n junction depend on? 6. How is an unwanted capacitor formed? 7. What are further defects of junction capacitors? 8. What is the principle of the thin-film integrated circuit capacitor? 9. By what formula is the total capacitance produced? 10. Are there many different forms of thin film capacitors? 11. What is shown in Fig. 4.15*a*? 12. What does plate B consist of? 13. What is the dielectric layer? 14. What does plate A consist of? 15. What are the advantages of this construction?

II. Examine Figs. 4.14 and 4.15. Describe them.

III. Discuss the problem of capacitors for integrated circuits using illustrations.

IV. Speak on:

1. Discrete transistor.
2. Integrated circuit transistor using buried n^+ layer.

V. Prepare a dialogue on the important steps involved in the manufacture of one widely used type of integrated circuit transistor.

VI. Look through the latest magazines and find additional information on the topic of the lesson. Discuss it with your fellow-students.

III. GRAMMAR EXERCISES

I. Find the verbs in Perfect Tenses in the following sentences and translate them.

1. Small-scale digital integrated circuits based on complementary MOS technology have been in use for many years. 2. With the steady improvements in pattern definition capability, the difference in performance between bipolar and MOS circuits has steadily become smaller. 3. For LSI circuits, the speed difference has shrunk from a factor of 10 or more in 1970 to a factor of 2 or less in 1980. 4. A great many variations of MOS technology have been and continue to be used.

II. Put as many questions as you can to different parts of the following sentences.

1. MOS technology is the basis for most of the large-scale integrated (LSI) digital memory and microprocessor circuits. 2. The individual MOS transistor occupies less chip area. 3. The MOS fabrication process involves fewer steps. 4. MOSLSI circuits are significantly cheaper to manufacture than bipolar circuits of equivalent function. 5. MOSLSI circuits are making up a steadily increasing fraction of the total market for digital LSI. 6. Reductions in the internal dimensions of individual devices result in very sharp improvements in circuit speed.

III. a) State the forms and the functions of the Participles in the following word-combinations. b) Translate them into Russian.

Integrated circuit chip; the term reffering to this level; integrated circuit chip containing more than 10 000 equivalent gates; components used by many system manufacturers; components designed and manufactured for one customer; the function needed for a specific application; small-scale digital integrated circuits based on complementary MOS technology; a given circuit function; a steadily increasing fraction; a technique known as local oxidation.

IV. Find modal verbs with the Passive Infinitive in the Text D and translate the sentences with them.

Chapter V. ELECTROAUTOMATION AND TELEMECHANICS

Lesson 1. THE LAPLACE TRANSFORM

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Make sure that you know these words. Say what Russian words help you to guess their meanings. b) Repeat these words after the speaker.

Theory, analyse, synthesize, engineering, system, electrical, general, characteristic, function, complex, integral, transformation, limit, theorem, sinusoid, component, characterize, pole, signal, diagram, form.

II. a) Listen, repeat and memorize the following words and word-combinations. b) Check if you know their meanings.

Transient переходный, неустановившийся; die down v. затухать, замирать; domain область; obey v. подчиняться; list список; height [ai] высота; solution решение; critical value критическое значение; reference table справочная таблица; steady-state condition установившееся (стационарное) состояние; complex variable комплексная переменная; steady-state solution установившееся (стационарное) решение; integral converge сходимость интеграла; single-sided односторонний; that is the case так бывает в случае, когда; for the unit step change для изменения в виде единичного скачка; linear integral transform линейное интегральное преобразование; the order of difficulty порядок трудности; evaluation of the integral оценка интеграла; transform pairs пары преобразований (взаимообратные преобразования); conventional calculus обычный расчет; single-valued однозначный; first-order time derivative первая производная во времени.

III. Memorize the reading of symbols and formulas. Repeat them after the speaker.

$f(t)$ — a function of [ti:]; $t < 0$ — [ti:] less than zero; $t > 0$ — [ti:] greater than zero;

$L[f(t)] = F(s) = \int_{0-}^{\infty} e^{-st} \cdot f(t)\,dt$ — Capital [el], square bracket opened function [ef] of [ti:] square bracket closed, equals capital [ef] of [es] equals the integral from [ou] minus to the infinity of [i:] to the minus [es ti:] power multiplied by function of [ti: di: ti:].

IV. a) Translate the following word-combinations. b) Define the attributes and say what part of speech they are expressed by.

The Laplace transform theory; engineering system; particular electrical network; more understanding; introduction of any waveshape; frequency dependent functions of a complex variable; single-sided Laplace transform; a linear integral transform; ordinary differential equation.

Text A

THE AIM OF THE TRANSFORMATION

I. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

The Laplace transform theory allows one to analyse and synthesise engineering systems and in particular electrical networks with less effort, greater accuracy and more understanding than engineers can usually develop using conventional calculus.

The Laplace transform is a general method that permits the introduction of any waveshape into a circuit and deals with transient as well as steady-state solution. The aim of the transformation is to allow one to think of the characteristics of systems and networks in the *s*-domain.

2. Average Reading

Text B

THE SINGLE-SIDED LAPLACE TRANSFORM

I. a) Listen to the text. b) Read it (time limit is 3 min.). c) Find the part of it dealing with the Laplace transform. Translate it.

The Laplace transform converts a function in the time domain $f(t)$, defines for $t > 0$, to a function in the s-domain, and is defined as

$$L[f(t)] = F(s) = \int_{0^-}^{\infty} e^{-st} f(t)\, dt, \quad (5.1)$$

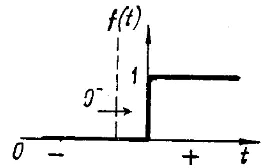


Fig. 5.1. A waveform for unit step change.

where $s = \sigma + j\omega$ is the Laplace complex variable. Normally σ is positive and sufficiently large to make the integral converge. Thus, this transformation relates time function to frequency dependent functions of a complex variable. Equation (5.1) is called the single-sided Laplace transform because the lower limit of the integral is defined as zero, in this case approached from the $t < 0$ side. This latter point is useful when dealing with functions that are discontinuous at $t = 0$. For example, for the unit step change shown in Fig. 5.1 the limit 0^- is zero, being the value of $f(t)$ at $t = 0$ approached from 0^-. To transform a time function $f(t)$ from the time domain to the s-domain using the Laplace transform, $f(t)$ must be zero $t < 0$ and single valued and defined for $t > 0$; it may or may not be defined at $t = 0$.

It is evident from Eq. (5.1) that the Laplace transform is a linear integral transform obeying the superposition theorem. The theorem can be stated as follows: if a time function $f_1(t)$ gives a Laplace transform $F_1(s)$ and a time function $f_2(t)$ gives a Laplace transform $F_2(s)$, then a time function $f_1(t) + f_2(t)$ gives $F_1(s) + F_2(s)$. The use of this transform reduces the order of difficulty of a problem because discontinuous in time, for example as shown in Fig. 5.1, are replaced by continuous function in s, while ordinary differential equations are replaced by algebraic equations. Thus having transformed the problem in the s-domain it is usually easy to write down the Laplace transform of the solution.

ASSIGNMENTS

I. a) Choose the key sentences from the text A and compare them with the title of the text. b) Say what the text is about.

II. Skim through the Text B and find the part of it dealing with the use of the Laplace transform. Translate it.

III. Find the part of the Text B containing information about an example for unit step change.

IV. Answer the following questions embracing the contents of the Text A and the Text B.

1. What does the Laplace transform theory allow? 2. What method is the Laplace transform? 3. What solutions does the Laplace transform deal with? 4. What is the aim of the transformation? 5. What function does the Laplace transform convert?

V. Ask additional questions on the Text A and the Text B.

VI. Make a short summary of the Text B.

VII. Prepare a dialogue on the theorem which a linear integral transform obeys.

VIII. Speak on the Laplace transform theory.

IX. Examine Fig. 5.1 and comment on a waveform for unit step change.

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these words and word-combinations.

Step changes ступенчатые изменения; linear second-order system линейная система второго порядка; linear differential equation линейное дифференциальное уравнение; transient term член, связанный с переходным процессом; system transfer function передаточная функция системы; characteristic equation характеристическое уравнение.

II. a) Pay attention to the attributes in these word-combinations and define the parts of speech they are expressed by. b) Translate them.

The output response of a network; a linear second-order system; a linear differential equation; knowledge of the general form of the response; the ratio of a network output; the individual transfer function.

III. Give the initial forms of the following words and translate them.

Transducer, amplifier, various, normally, equation, differential, exactly, transforming, expression, individual.

Text C

TRANSFER FUNCTION

I. a) Read the text. b) Speak on the networks connected in series.

It is often necessary to find the output response of a network or system, for example a transducer and amplifier, for various types of input, for example sinusoids or step changes. Normally the output $c(t)$ and input $r(t)$ of a linear second-order system are related by a linear differential equation of the form

$$Uc(t) + V\frac{dc(t)}{dt} + W\int c(t)\,dt = r(t), \qquad (5.2)$$

and the output $c(t)$ contains two components, a transient term and a steady-state term. It is sometimes necessary to know the output exactly, although often knowledge of the general form of the response is sufficient.

Transforming Eq. (5.2) from the time domain to the s-domain gives the expression

$$C(s) = G(s)\,R(s), \qquad (5.3)$$

It will be seen from Eq. (5.3) that the ratio of a network output $C(s)$ to its input $R(s)$ is the transfer function $G(s)$, if all initial conditions are zero.

If two or more networks are connected in series, provided the process of connection does not affect the networks, the overall transfer function is the product of the individual transfer functions.

ASSIGNMENTS

I. a) Divide the text into logical parts. b) Find the key sentences and translate them.

II. Find the part of the text containing a linear differential equation.

III. Answer the following questions on the Text C.

1. What is necessary to find the output response of a network for? 2. What are the output $c(t)$ and input $r(t)$ of a linear second-order system normally related by? 3. What components does the output $c(t)$ contain? 4. What is sometimes necessary to know and what is sufficient to know? 5. What will be seen from Eq. (5.3)? 6. What is the overall transfer function if two or more networks are connected in series?

IV. Prepare a dialogue on your own situation.

V. Speak on equations necessary to find the output response of a network or system.

VI. Translate the Text C to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English word-combinations with the Russian ones.

A pole-zero diagram	диаграмма нулей-полюсов
superimpose (on Fig.)	уходящий в бесконечность
transient response to be determined	нестабильная система
the following points regarding the poles of the transfer function	экспоненциально затухающие синусоидальные колебания
unstable system	нанести, наложить (на рис.)
going away to infinity	не затухающие колебания
complex conjugates	экспоненциальный спад
exponential decay	комплексно-сопряженные
exponentially decaying sine waves	определяемая переходная характеристика
continuous oscillation	следующие соображения, касающиеся полюсов функции передачи

II. Pick out all formulas from the Text D and write them with help of words.

III. a) Translate the following word-combinations from the Text D. b) Use them while retelling the text.

We have seen that it is fairly easy to describe; we shall now consider; the position of the poles is far more important; in this respect poles with positive real parts denote; complex poles always occur in pairs; a pole $s = -\sigma\ (\sigma > 0)$ means that.

Text D

POLE-ZERO PLOTS

I. Read the text and say about pole-zero plots.

We have seen that it is fairly easy to describe a system in the s-domain by its transfer function and to write down the characteristic equation of the system. It seems reasonable that one should be able to characterize a system in the s-plane.

We shall now consider the definitions of poles and zeros. Values of s which make a system output $C(s)$ infinite are called poles of $C(s)$. These poles are found by solution of the equations

$$\frac{1}{G(s)} = 0, \qquad (5.4); \qquad \frac{1}{R(s)} = 0. \qquad (5.5)$$

The position of the poles obtained from Eq. (5.4) on the complex s-plane gives information regarding the transient response of the system. The poles obtained from Eq. (5.5) are determined by the input signal and the initial conditions.

Values of s which makes $C(s)$ zero are called zeros of $C(s)$ and it is clear that they are obtained from the equations

$$G(s) = 0; \qquad (5.6); \qquad R(s) = 0. \qquad (5.7)$$

A pole-zero diagram of a system transfer function obtained from Eqs. (5.4) and (5.6), allows the form of the transient response to be determined. The position of the poles is far more important in this respect than that of the zeros. Onto this diagram can be superimposed the pole-zero diagram of a particular input, allowing the form of the output response to be determined.

The following points regarding the poles of the transfer function obtained from the characteristic equation are important:

1. Poles with positive real part denote an unstable system, that is a transient response going away to infinity.

2. Complex poles always occur in pairs, called complex conjugates, and the presence of poles $s = -\sigma \pm j\omega\ (\sigma > 0)$ denotes the presence of exponentially decaying sine waves in the transient response.

3. A pole $s = -\sigma\ (\sigma > 0)$ means that the transient response contains an exponential decay.

4. Poles $s = \pm j\omega$ denote continuous oscillation.

ASSIGNMENTS

I. Answer the following questions embracing the contents of the Text D.

1. Is it very easy to describe a system in the s-domain by its transfer function? 2. What are called poles of C (s)? 3. What gives information regarding the transient response of the system? 4. By what are the poles obtained from Eq. (5.5) determined? 5. What points regarding the poles of the transfer function obtained from the characteristi- equation are important?

II. Ask additional questions on the Text D.

III. Combine your answers into a short summary of the text.

IV. Discuss the problem of pole-zero plots.

V. Express your opinion of the topic.

VI. a) Look through the latest magazines and find additional material on the topic. b) Use it for short information and discussion.

III. GRAMMAR EXERCISES

I. Find the Infinitive in the following sentences and translate them.

1. The single-sided Laplace transform allows initial conditions to be introduced into the analysis in a simple direct manner. 2. Normally σ is positive and sufficiently large to make the integral converge. 3. It is easy to write down the characteristic equation of the system. 4. Onto this diagram can be superimposed the pole-zero diagram of a particular input, allowing the form of the output response to be determined.

II. Define the form and function of the Participles in these sentences and translate them.

1. Thus having transformed the problem to the s-domain it is usually easy to write down the Laplace transform of the solution. 2. Greater accuracy and more understanding than engineers can usually develop using conventional calculus. 3. This latter point is useful when dealing with functions that are discontinuous at $t = 0$. 4. For example, for the unit step change shown in Fig. 5.1 the limit 0^- is zero, being the value of $f(t)$ at $t = 0$ approached from 0^-. 5. The position of the poles obtained from Eq. (5.4) on the complex s-plane gives information regarding the transient response of the system.

III. Define the tense-forms of the verbs in the following sentences and translate them.

1. The sinusoidal waveforms are being considered. 2. Equation (5.1) is called the single-sided Laplace transform because the lower limit of the integral is defined as zero. 3. It will be seen from Eq. (5.3) that the ratio of a network output $C(s)$ to its input $R(s)$ is the transfer function $G(s)$, if all initial conditions are zero. 4. We have seen that it is easy to desribe a system in the s-domain by its transfer function. 5. It seems reasonable that one should be able to characterize a system in the s-plane.

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Make sure that you know these words. Say what Russian words help you to guess their meanings. b) Repeat these words after the speaker.

Physical, system, component, element, block, analyse, generalize, diagram, summing, produce, situation, general, summarize, information, illustrate, horisontal, stable, original, equilibrium, position, resulting, pole.

II. Check if you know the meaning of these words and word-combinations.

Close-loop gain коэффициент усиления при замкнутой цепи; wide (narrow) bandwidth широкая (узкая) полоса пропускания; low output impedance низкий выходной импеданс; noise effects шумовые эффекты; extraneous disturbances посторонние помехи; property of inversion свойство инвертирования; generalized block diagram обобщенная структурная схема (блок-схема); the gain round the loop усиление во всей цепи; a simple feedback system простая система с обратной связью; summing point суммирующая точка; noise source источник шумов; well-defined gain четко определяемый коэффициент усиления; giving accuracy заданная точность; fast response быстрое реагирование (реакция); remains fairly constant остается почти постоянной.

III. Listen to the reading of formulas from the Text B and write them with help of words.

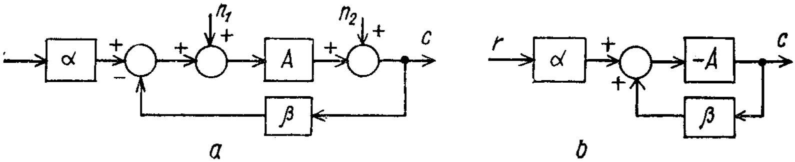


Fig. 5.2. Generalized block diagrams of simple feedback systems: *a* input and output in phase; *b* input and output in anti-phase.

Text A

THE BLOCK-DIAGRAMS

1. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

A physical system may have many components or elements and it is convenient to consider each such element as a block with its own input-output relationship, that is its own transfer function. The blocks representing the various elements of a system are connected to use their functional relationship within the system, thus producing a block diagram for the system. This may well be helpful in analyzing a measuring system, and of course *considering each element as a block* helps in design of new systems.

2. Average Reading

Text B

CLOSE-LOOP GAIN

1. a) Listen to the text. b) Read it (time limit is 3 min.). c) Find the part of it dealing with the two forms of generalized block diagram of a simple feedback system. Translate it.

The two forms of generalized block diagram of a simple feedback system are shown in Fig. 5.2. Both diagrams illustrate negative feedback, in that the gain round the loop has negative polarity. In Fig. 5.2*a*, c and r are in phase, while in Fig. 5.2*b* they are in anti-phase. A fraction α of the quantity to be measured (r) is fed in, and a fraction β of the output quantity (c) is fed back to a summing point which takes the difference and amplifies it by gain A to probuce the output quantity; α, β, and A are transfer functions while n_1, n_2 are noise sources at the input and output of the amplifier respectively. Assuming $n_1 = n_2 = 0$, the following equation expresses the situation of Fig. 5.2 *a*:

$$\alpha r - \beta c = c/A \text{ or } \frac{c}{r} = \frac{\alpha}{\beta} \cdot \frac{A\beta}{(1 + A\beta)}. \qquad (5.8)$$

The expression for Fig. 5.2*b* is similar but with a negative sign in front of it. The ratio c/r is called the closed-loop gain, while $A\beta$ is the open-loop gain and both are transfer functions. Provided $A\beta \gg 1$,

$c/r \cong \alpha/\beta$, and c/r is largely independent of A and simply determined by transfer functions α and β. We shall see that main properties of this general system can be summarized as well-defined gain (giving accuracy), wide bandwidth (giving fast response), low output impedance, reduction in noise effects and extraneous disturbances, and the property of inversion. Feedback can be employed to produce high input impedance.

ASSIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about.

II. a) Skim through the Text B and explain the close-loop gain.

III. Answer the following questions embracing the contents of the Text A and the Text B.

1. What are the blocks representing the various elements of a system connected for? 2. Where may this block diagram be helpful? 3. How is the ratio c/r called and what is A in Eq. (5.8)? 4. What do we see in Fig. 5.2 and in Eq. (5.8)?

IV. Ask additional questions on the Text A and the Text B.

V. Combine your answers into a short summary of the texts.

VI. Speak on the two forms of generalized block diagram of a simple feedback system.

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these words.

Assessment of stability оценка устойчивости; constant peak-to-peak amplitude постоянная амплитуда; slightly tipped слегка отклоненный; resulting transient response результирующая переходная характеристика; left (right) hand portion левая (правая) половина; negative real part отрицательная реальная часть; the Nyquist criterion критерий Найквиста; root-locus method метод геометрического места корней; the Bode criterion критерий Боде.

II. a) Analyse the structure of the following words. b) Translate them.

Particularly, feedback, measuring, rapidly, stability, peak-to-peak, consideration, slightly, location, *s*-plane, resulting, decreasing, disturbance, right-hand portion, requirement, assessing, root-locus method.

III. Listen to the reading of formula of Eq. (5.9) and write it with help of words.

Text C

ASSESSMENT OF STABILITY

I. a) Read the text. b) Find the part of it describing the concept of stability.

It is important to investigate the output response of a system particularly feed-back measuring system, when the input changes rapidly. This transient response characterizes the stability of the system. A system is defined as stable if its impulse response approaches zero as time approaches infinity. A system is defined as being unstable if with zero input, the output increases indefinitely. If the output of a system has continuous oscillation of constant peak-to-peak amplitude, the system is considered to be neutrally stable. Consideration of the degree of stability of a system often provides valuable information about its behaviour.

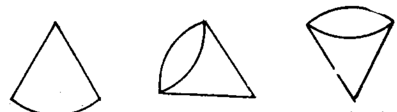


Fig. 5.3. A type of the stability of a cone.

The concept of stability can be illustrated by considering a cone placed on a horizontal (Fig. 5.3) surface. When the cone is resting on its base it is said to be stable, because if it is slightly tipped it returns to its original equilibrium position.

On the other hand, if the cone is placed on its tip and released, it falls onto its side, and so this position is said to be unstable.

It was shown that the location in the s-plane of the poles of a system indicate the resulting transient response. Poles in the left-hand portion of the s-plane result in a decreasing response for disturbance inputs, while poles in the right-hand portion result in an increasing response. Poles on the j-axis result in a neutral response to a disturbance input. Clearly it is desirable that feedback-measuring system are stable and respond satisfactorily to rapid changes in the quantity to be measured.

A necessary and sufficient condition that a system be stable is that all the poles of the system transfer function have negative real parts. Thus if a system has a transfer function

$$G(s) = \frac{C(s)}{R(s)} = \frac{b_m s^m + b_{m-1} s^{m-1} + \cdots + b_0}{a_n s^n + a_{n-1} s^{n-1} + \cdots + a_0}, \qquad (5.9)$$

the requirement for stability is that all roots of the denominator must have negative real parts. Four basic methods of assessing stability are the Hurwitz-Routh criterion, root-locus method, the Nyquist criterion and the Bode criterion.

ASSIGNMENTS

I. Skim through the Text C and speak on the main idea of it.

II. a) Divide the text into logical parts. b) Choose the key sentences and translate them.

III. Comment on the author's attitude to assessment of stability.

IV. Examine Fig. 5.3 and comment on stability of a cone.

V. Answer the following questions embracing the contents of the Text C.

1. What is necessary to investigate when the input changes rapidly? 2. What does this transient response characterize? 3. How is a system defined if its impulse response approaches zero as time approaches infinity? 4. How is the system defined if, with zero input the output increases indefinitely? 5. When is the system considered to be neutrally stable? 6. What provides valuable information about behaviour of a system? 7. What are four basic methods of assessing stability?

VI. Prepare a dialogue on a necessary and sufficient condition for the system to be stable.

VII. Translate the Text C to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English word-combinations with the Russian ones.

the rest of the system	точный исполнительный механизм
strain gauge	инверсный преобразователь
low power	тензометр, тензодатчик
inverse transducer	остальная часть системы
precision actuator	маломощный

II. Find the following word-combinations in the Text D and translate them.

A block diagram of a simple control system is shown in Fig.; shaft position is measured and compared with; the general functional diagram of a measuring system includes; a most useful application of inverse transducers is.

Text D

FEEDBACK FOR CONTROL AND MEASUREMENT

I. Read the text and say about feedback for control and measurement.

A block diagram of a simple control system is shown in Fig. 5.4*a* Here the actual quantity to be controlled (usually a non-electrical quantity), for example shaft position, is measured and compared with a demanded quantity (usually these quantities are electrical) to produce an error which is amplified to drive an actuator, for example an electric motor, producing power to drive the controlled quantity.

The general functional diagram of a measuring system includes an inverse transducer as an output device. Normally a transducer

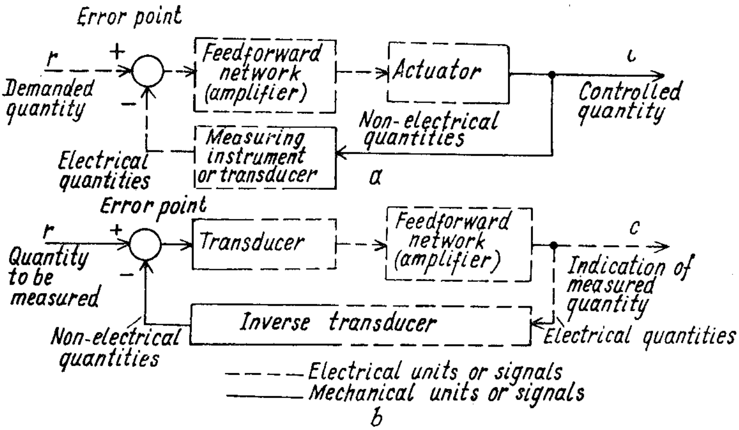


Fig. 5.4. The comparison of two systems:
a the simple control system; *b* the simple feedback measuring system.

and associated circuit has non-electrical input and an electrical output, for example a thermistor, strain gauge, and photodiode, whereas a so called "inverse transducer" has an electrical input and low-power non-electrical output.

A most useful application of inverse transducer is in feedback measuring system. A block diagram of such a system is shown in Fig. 5.4*b* for comparison with the simple control system of Fig. 5.4*a*. In the measuring system the output signal (usually electrical) is converted to a form (usually non-electrical, for example force) suitable for comparison with the quantity to be measured (for example force) . The resultant error is usually transduced into electrical form and amplified to give the output indication.

ASSIGNMENTS

I. Answer the following questions embracing the contents of the Text D.

1. What quantities are measured and compared in a simple control system? 2. What does a measuring system include? 3.What is the difference between a transducer and inverse transducer? 4.What is a most useful application of inverse transducer?

II. Ask additional questions on the Text D.

III. Combine your answers into a short summary of the text.

IV. Speak on a simple control system.

V. Prepare a dialogue on a simple feedback-measuring system.

VI. Examine Fig. 5.4 and comment on:

1. The simple control system.
2. The simple feedback measuring system.

VII. Examine Fig. 5.5 and characterize common filters.

VIII. Look through the latest magazines, find additional information and use it while discussing the topic.

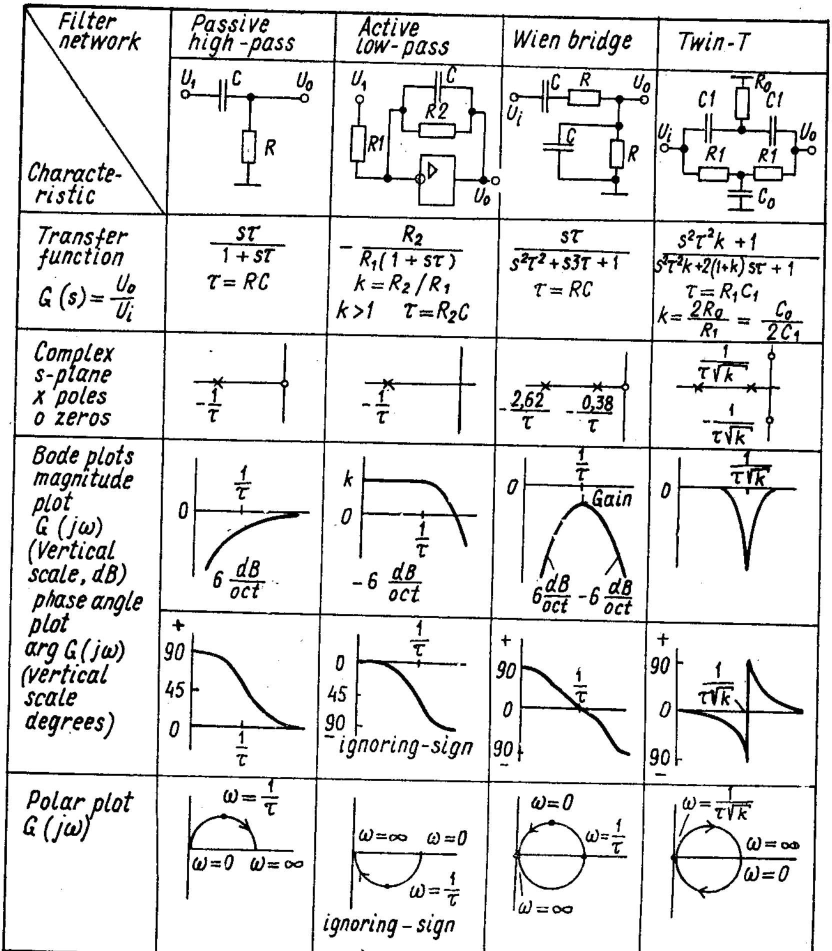


Fig. 5.5. The characteristics of common filters.

III. GRAMMAR EXERCISES

I. a) Analyse the following sentences paying attention to the Gerund and its function in the sentence. b) Translate the sentences.

1. The effect of loading at the output of the feedback system can be best understood by considering the amplifier to be a voltage amplifier with an output impedance Z. 2. This may well be helpful in analysing a measuring system. 3. The concept of stability can be illustrated by considering a cone placed on a horisontal surface.

II. Define the functions of the Infinitive in these sentences and translate them.

1. A fraction α of the quantity to be measured (r) is fed in, and a fraction β of the output quantity (c) is fed back to produce the out-

put quantity. 2. Feedback can be employed to produce high input impedance. 3. When the cone is resting on its base it is said to be stable. 4. If the output of a system has continuous oscillation of constant peak-to-peak amplitude, the system is considered to be neutrally stable.

III. Find Participle I in these sentences. Define its function. Translate the sentences.

1. The blocks representing the various elements of a system are connected to use their functional relationship within the system, thus producing a block diagram for the system. 2. Assuming $n_1 = n_2 = 0$, the following equation expresses the situation of Fig. 5.2*a*. 3. Poles in the left-hand portion of the *s*-plane result in a decreasing response for disturbance inputs, while poles in the right-hand portion result in an increasing response.

Lesson 3. MODULATION AND ENCODING METHODS

I. Independent Work.
In the Laboratory.
1. *Skimming Reading.*
Pre-text Exercises.
Text A. Modulation in Telemetry.
2. *Average Reading.*
Text B. Amplitude Modulation.
Assignments.
II. Classwork.
3. *Close Reading.*
Pre-text Exercises.
Text C. Pulse Modulation System.
Assignments.
4. *Searching Reading.*
Pre-text Exercises.
Text D. Signal Modulation.
Assignments.
III. Grammar Exercises.

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Make sure that you know these words. Say what Russian words help you to guess their meanings. b) Repeat these words after the speaker.

Process, (de)modulation, transmission, telemetry, impulse, information, radio, pulse, code, modification, original, sinusoidal, amplitude, parameter, component, proportional, resulting, interval, practical, signal.

II. Listen, repeat and memorize the following words and word-combinations. b) Check if you know the meaning of these words.

Sideband боковая полоса; transmission medium передающая среда (среда передачи); direct transmission прямая передача; land-line telemetry наземная телеметрия; radio frequency (r. f.) радиочастота; wire transmission передача по проводам; original signal первоначальный сигнал; modulated signal модулированный сигнал; amplitude modulation (AM) амплитудная модуляция; relative phase относительная фаза; message signal информационный сигнал; degree of modulation степень модуляции (индекс модуляции); to some extent до некоторой степени; in response to в ответ на; the side sinusoids боковые синусоиды; is just twice the bandwidth of the message signal itself ровно в два раза больше ширины полосы самого сигнала; convey сообщать, передавать.

III. Listen to the reading of formulas from the Text B and write them with help of words.

Text A

MODULATION IN TELEMETRY

I. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

The process of signal modulation employed depends to some extent on the transmission media to be used. Direct transmission via cable, called land-line telemetry, generally employs either current, voltage, frequency, position or impulses to convey the information. Radio frequency (r. f) telemetry employs either amplitude, frequency, or phase modulation. Such modulation may be used directly as a means of conveying information, or the modulation may be used to convey pulses, sometimes in a coded form.

2. Average Reading

Text B

AMPLITUDE MODULATION

I. a) Listen to the text. b) Read it (time limit is 3 min.). c) Find the part of it dealing with modulation and demodulation.

Modulation is the modification of a carrier waveform, which is usually sinusoidal, in response to the information to be carried. The process of recovering the original signal from the modulated signal is called demodulation. A sinusoidal carrier can be described by the equation: $U = K\sin(2\pi f_c t + \theta)$, (5.10)
where K is the amplitude, f_c the frequency and θ the relative phase of the carrier. In amplitude modulation (AM) K varies, in frequency modulation (FM) f_c varies, and in each case the varying parameter responds to the measurand.

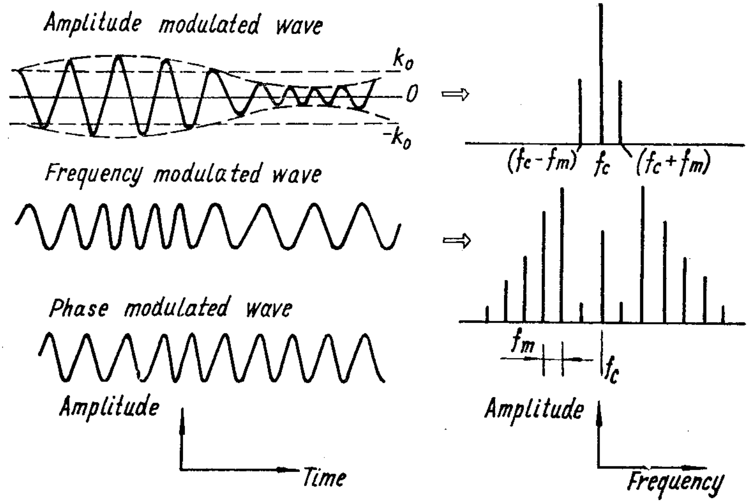


Fig. 5.6. Waveforms and spectral components for different modulation methods.

For AM, the carrier amplitude level swings about its unmodulated value, and for a sinusoidal message signal the expression for K is $K = K_0(1 + m\cos 2\pi f_m t)$, (5.11)
where K_0 is the amplitude of the carrier at frequency f_c when the amplitude of the message signal or modulation at frequency f_m is zero (Fig. 5.6). The actual amplitude of the modulation is $K_0 m$ and m indicated the degree of modulation, for .example $m = 1$ means 100 per cent modulation. If Eqs. (5.10) and (5.11) are combined, we obtain assuming $\theta = 0$:

$$U = K_0\left[\sin 2\pi f_c t + \frac{1}{2} m \sin 2\pi(f_c + f_m)t + \frac{1}{2} m \sin 2\pi(f_c - f_m)t\right].$$

Thus the waveform has three frequency components, one at f_c, one at $(f_c + f_m)$ and one at $(f_c - f_m)$, and overall bandwidth of frequencies is $(f_c + f_m) - (f_c - f_m) = 2f_m$. This modulation process has produced new «side» frequency components on each side of the carrier and transformed the frequency of the message from f_m to around f_c (Fig. 5.6). The «side» sinusoids have an amplitude proportional to that of the message signal ($K_0 m$). Any message signal can be represented as a sum of sinusoids modulates the carrier resulting in sidebands about f_c. The bandwidth of an AM signal is just twice the bandwidth of the message signal itself.

ASSIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about.

II. a) Skim through the Text B and find the part of it dealing with the actual amplitude of the modulation. b) Discuss the information about it.

III. a) Find the part of the Text B containing information about message signal represented as a sum of sinusoids. b) Express your opinion of it.

IV. Answer the following questions embracing the contents of the Text A and the Text B.

1. What does the process of signal modulation employed depend on? 2. What does radio frequency (r. f.) telemetry imploy? 3. What is modulation? 4. What is called demodulation? 5. Does the carrier amplitude level swing about its unmodulated value? 6. What is the actual amplitude of the modulation? 7. What modulation process has produced new "side" frequency components on each side of the carrier?

V. Prepare a dialogue on the modulation methods applicable to landline transmission.

VI. Examine Fig. 5.6 and comment on waveforms and spectral components for different modulation methods.

VII. Speak on the process of signal modulation.

VIII. Translate the following sentences into English.

1. Процесс модуляции сигнала зависит до некоторой степени от используемой среды передачи. 2. Модуляция — это изменение несущей, обычно синусоидальной, в соответствии с передаваемой информацией. 3. Процесс восстановления первоначального сигнала из модулированного сигнала называется демодуляцией. 4. Синусоидальная несущая может быть описана уравнением $U = K \sin (2\pi f_c t + \theta)$. 5. Боковые синусоиды имеют амплитуду, пропорциональную амплитуде информационного сигнала. 6. Ширина полосы AM сигнала ровно в 2 раза больше ширины полосы самого информационного сигнала.

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these word-combinations.

A pulse-amplitude modulation system (PAM) система амплитудно-импульсной модуляции (АИМ); pulse-duration modulation system (PDM) система широтно-импульсной модуляции (ШИМ); pulse-width modulation (PWM) широтно-импульсная модуляция (ШИМ); pulse-position modulation (PPM) фазо-импульсная модуляция (ФИМ); with the exception за исключением; variable pulse width изменяемая длительность (ширина) импульса; practical pulse-coding system практическая система кодирования импульсов; pulse-code modulation (PCM) импульсно-кодовая модуляция (ИКМ); a series of binary digits последовательность двоичных цифр; to be sampled производить выборку, стробировать; each sample value величина каждой выборки; the sampling theorem теорема о дискретном представлении; 7-digit code семиразрядный код; quantum level уровень квантования; the quantizing noise шум квантования.

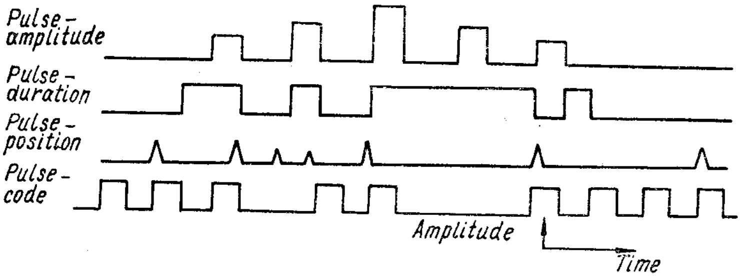


Fig. 5.7. Pulse coding methods and corresponding waveforms.

II. State the function of suffixes in these words and translate them.

Information, modulation, duration, proportion, differentiating, rectifying, transmitter, practical, coding, sending, transmission.

Text C

PULSE MODULATION SYSTEM

I. a) Read the text. b) Find the part of it describing the pulse-duration and pulse-position modulations. Translate it.

The information to be conveyed may be converted to a pulse form for land-line or r. f. telemetry. In pulse-amplitude modulation system (PAM) the carrier is modulated with pulses whose hights carry the information. In pulse-duration modulation (PDM) system, the amplitude of all pulses is constant, but the duration of the pulses varies. In PDM one edge of the pulse is fixed in time sequence and the other edge varies in proportion to the value of the information. This type of coding is also referred to as pulse-width modulation (PWM). Pulse-position modulation (PPM) is similar to PDM with the exception that a short pulse is used in place of the variable pulse width. This can be accomplished by differentiating and rectifying a PDM waveform. The same information can be sent by PPM with much less average power than PDM, since the transmitter is on a much shorter time. The narrow pulse require wider bandwidth for transmission, however.

The most efficient of the practical pulse coding system is that called pulse-code modulation (PCM). It consists of sending analogue information by transforming it into a series of binary digits, as shown in Fig. 5.7. The analogue signal is sampled at regular intervals and then each sample value is converted into a coded form, a process which introduces an error.

The PCM system often employs a 7-digit code, giving 128 quantum levels, and the signal is transmitted using FM, the least significant digit being sent first. Apart from the quantizing noise, no noise is introduced during transmission.

I. a) Divide the text into logical parts. b) Choose the key sentences, analyse and translate them.

II. Look through the Text C and find the part of it dealing with the pulse-code modulation.

III. Examine Fig. 5.7 and comment on pulse coding methods and corresponding waveforms.

IV. Answer the questions on the Text C.

1. What form may the information be converted to? 2. How is the carrier modulated in a pulse-amplitude modulation system? 3. What is constant and what varies in PDM systems? 4. How is the type of coding also referred to? 5. What modulation is similar to PDM? 6. What practical pulse coding system is more efficient? 7. What does this system consist of?

V. Prepare a dialogue on pulse-duration modulation system.

VI. Speak on pulse-amplitude modulation system.

VII. Make up a plan of the Text C and retell it.

VIII. State the tense-forms of the verbs in the Text C.

IX. Translate the Text C to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

channel bandwidth	информационный сигнал
carrier waveform	существенно исказить
signal timing	захваченные каналом
the message signal	синхронизация сигнала
relative amplitude	колебания несущей частоты
the amount of noise	изменения, изменяя
seriously degrade	ширина полосы канала
suitable	относительная амплитуда
pick up by the channel	интенсивность шума
altering	подходящий

II. Translate these word-combinations and use them while reading the Text C.

Noise may be introduced; the amount of noise may be sufficient to; there are many ways of altering a signal; it appears as shown in Fig.; the amplitude depends upon.

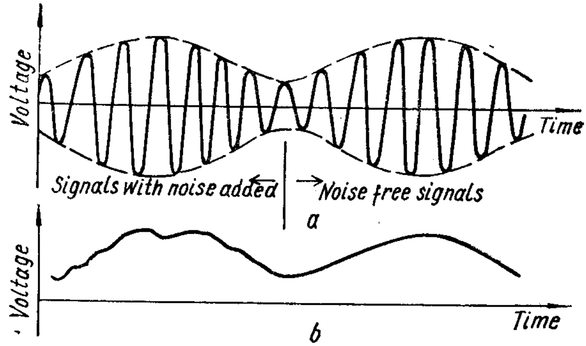


Fig. 5.8. An AM signal and noise:
a an AM signal corrupted by noise; *b* the resulting demodulated signal.

Text D

SIGNAL MODULATION

I. Read the text and say whether there are ways of altering a signal to make it suitable for transmission over a noise channel.

Noise may be unavoidable introduced on a transmission channel, whether the channel is an electrical cable, a radio frequency, optical or ultrasonic link, or by magnetic induction. The amount of noise picked up the channel may be sufficient to seriously degrade the signal being transmitted. There are many ways of altering a signal to make it suitable for transmission over a noise channel. The simplest way is to increase power of the signal at the source, but there is always a limit to the power available to do this. To transmit by radio waves it is necessary to modulate the signal.

The modulation method appropriate to a particular instrumentation system depends upon a number of things: accuracy, reliability, the channel bandwidth available, convenience, cheapness and so on. Each system will have its own problem and requirements, so it is not possible to say which is the "best" modulation method.

Modulation of the carrier waveform in response to a measurand usually involves amplitude modulation (AM) or frequency modulation (FM), and that pulse-modulation methods, in particular pulse-code modulation (PCM), are sometimes employed.

These different types of modulated signal have different properties in relation to channel noise. AM produces frequency components on each side of the carrier frequency called sidebands, such that the bandwidth of an amplitude-modulated signal is twice the bandwidth of the message signal itself. If such a modulated signal passes through a noisy channel it reaches the receiver in the form shown in Fig. 5.8*a*. After rectification and low-pass filtering, the process of demodulation, it appears as shown in Fig. 5.8*b*; the amplitude of the message signal and the degree of interference depends solely upon the relative amplitude of the two signals.

I. Answer the following questions embracing the contents of the Text D.

1. Where may noise be unavoidable introduced? 2. What is the simplest way of altering a signal to make it suitable for transmission of a noisy channel? 3. What does the modulation method appropriate to a particular instrumentation system depend on?

II. Prepare a dialogue on your own situation.

III. Make up a plan of the Text D and retell the text according to your own plan.

IV. Examine Fig. 5.8 and comment on:

1. An AM signal corrupted by noise.
2. The resulting demodulated signal.

V. a) Look through the latest magazines and find additional information on the topic. b) Discuss the problem of signal modulation.

III. GRAMMAR EXERCISES

I. Define the function of the Infinitive in these sentences and translate them.

1. Modulation is the modification of a carrier waveform, which is usually sinusoidal, in response to the information to be carried. 2. It is only essential for the receiver to be able to distinguish between a 1 and a 0. 3. Here the actual quantity to be controlled is measured. 4. The information to be conveyed may be converted to a pulse form for land-line or r. f. telemetry.

II. a) Pay attention to the *ing*-forms and define their functions. b) Translate sentences into Russian.

1. The transmitter is connected in series with its power supply and recorders / indicators, these devices being situated at the receiving end. 2. This can be accomplished by differentiating and rectifying a PDM waveform. 3. Some of the factors must be considered when choosing method to be used over a noisy channel of an instrumentation system. 4. A prerequisite of being able to control variables such as velocity, temperature and humidity. 5. In practice devices have to respond to time-varying quantities. 6. It consists of sending analogue information by transforming it into a series of binary digits.

Lesson 4. STATISTICAL MEASUREMENTS

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Make sure that you know these words. Say what Russian words help you to guess their meanings. b) Repeat these words after the speaker.

Statistical, amplitude, component, parameter, periodic, phenomenon, spectrum, constant, symbol, period, proportion, practical, totalizing, selection, sum, characteristic, correlation, situation.

II. a) Listen and repeat after the speaker, memorize the following words and word-combinations from the Text A and the Text B. b) Check if you know their meanings.

Frequency band полоса частот; sinewave синусоидный сигнал; mean value среднее значение; root-mean-square value среднеквадратичное значение; probability-density function (p.d.f.) функция плотности вероятности; power-density spectrum спектр плотности мощности (сигнала); autocorrelation function автокорреляционная функция; stationary random signal стационарный случайный сигнал; almost without exception почти без исключения; man-made искусственный; phenomenon (pl. phenomena) явление; random behaviour случайное поведение; examples ranged from примеры охватывают; aircraft noise шум самолета; in a medium limits в границах среды; the whole frequency spectrum весь частотный спектр.

Text A

PARAMETERS OF RANDOM SIGNALS

I. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

Statistical measurements are used to describe the amplitude, frequency and time behaviour of random signals. The amplitude behaviour of a random signal can be described by the mean value of the signal, the root-mean-square value of the signal or the probability-density function of the signal. Frequency behaviour, which is independent of amplitude, can be described by the power density spectrum of the signal. Time behaviour is described by the autocorrelation function of the signal, and indicates the same frequency components, but in terms of period rather than frequency. These parameters can be obtained for periodic waveforms as well as for random ones. They are different kind of averages and if these statistical properties of a random signal remain constant with time, it is called a stationary random signal.

2. Average Reading

Text B

DESCRIPTION OF RANDOM SIGNALS

I. a) Listen to the text. b) Read it (time limit is 3 min.). c) Find the part of it dealing with a random signal.

Almost without exception, all natural and man-made phenomena exhibit random behaviour to some extent. Examples range from wind motion and aircraft noise to thermal and semiconductor noise in electrical circuits. Measurements made on random signals are called statistical measurements, and their application covers the whole frequency spectrum.

A random signal cannot be described precisely in terms of voltage and frequency in the same way as a simple sinewave. Because it varies in a random manner, this requires observation of the signal's behaviour over a period of time. It is important to note that all statistical measurements are average measurements, and the longer the averaging time, the more accurate is the measurement.

ASSIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about.

II. Skim through the Text B and say what measurements are called statistical measurements.

III. Discuss the main idea of the Text A and the Text B.

IV. Answer the following questions.

1. What do all natural and man-made phenomena exhibit to some extent? 2. What are the examples of those phenomena? 3. How can

a random signal be described? 4. When are statistical measurements more accurate? 5. What is called a stationary random signal?

V. Ask additional questions and prepare a dialogue for discussion on the topic.

VI. Speak on:

1. Parameters of random signals.
2. Description of random signals.

VII. Choose the compound words from the Text A and the Text B. Analyse and translate them.

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these words.

Probability function функция вероятности; total signal весь сигнал; fluctuating флюктуирующий; standard deviation стандартное отклонение; load resistor нагрузочный резистор; averaging time время усреднения; at all possible amplitudes при всех возможных амплитудах; the curve obtained by plotting кривая, полученная при построении графика; the bell-shaped curve колоколообразная кривая; random disturbance случайное возбуждение; the horisontal amplitude scale масштаб по горизонтальной оси амплитуд.

II. Define the tense-forms of these verbs in the Text C.

Give, call, contain, refer, assume, mean, divide, obtain, add, spend, calibrate, exceed, specify.

III. Analyse these words from the viewpoint of their structure and translate them.

Mean-square, waveshape, plotting-density, bell-shaped, Gaussian-type, echo-ranging, cross-correlate, autocorrelation, cross-correlation, signal-to-noise.

Text C

MEAN, MEAN-SQUARE AND PROBABILITY FUNCTION

I. a) Read the text. b) Describe the mean-square voltage for fluctuating electrical signals.

The mean ($\bar{x}$) and mean-square ($\bar{x^2}$) values of a waveform are time averages. $\bar{x}^2$ is the mean-square value of the total signal (d. c. plus a. c.), while the mean-square value of the fluctuating component alone is given by the symbol σ^2, that is $\bar{x}^2 = (\bar{x})^2 + \sigma^2$, where $\bar{x}$ is the d. c. component or mean value. Value σ is called the standard deviation.

The a. c. power contained in a signal is proportional to σ^2. In practice for fluctuating electrical signals the mean-square voltage is often referred to as the power of the signal, and this assumes a 1Ω load resistor.

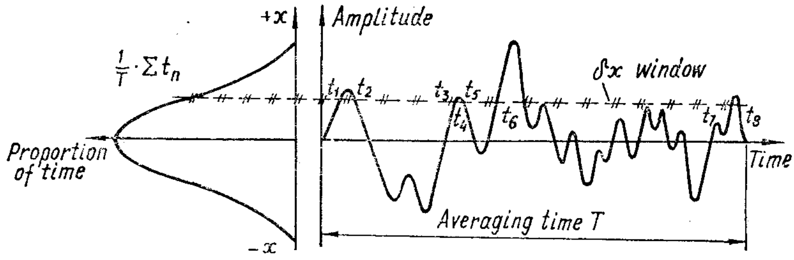


Fig. 5.9. The probability-density function of a noise-signal.

Neither the mean value nor mean-square value on its own gives any indication of waveshape. To do this, it is necessary to determine the proportion of time spent by the signal at all possible amplitudes during a finite period of time. In practical terms, this means totalizing the time spent by the signal in a selection of narrow amplitude windows, and then dividing the total for each window by the measurement or averaging time T, as shown in Fig. 5.9. The curve is obtained by plotting probability density function (p.d.f.) of the signal $p(x)$. Thus $p(x)\,\delta x$ is the probability that $x(t)$ lies between x and $x+\delta x$, and is easy to measure, being the proportion of time spent by $x(t)$ between x and $x+\delta x$. The total area under a p.d.f. is always unity, as the sum of all possible probabilities must add up to certainty. The most familiar p.d.f. is the bell-shaped Gaussian or Normal curve, shown in Fig. 5.10 *a*, which is characteristic of many naturally occuring random disturbances. The horizontal amplitude scale of the p.d.f. is calibrated in terms of σ and a Gaussian-type noise signal spends most (68 per cent) of the time between $\pm\sigma$, and hardly ever exceeds $\pm 3\sigma$, in fact it exceeds this value less than 1 per cent of the time. The Gaussian p.d.f. can be fully specified by two parameters: the mean and the standard deviation.

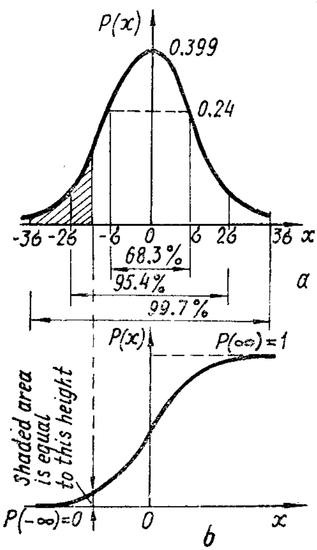


Fig. 5.10. Gaussian type noise signal:
a the probability-density function; *b* the distribution function.

ASSIGNMENTS

I. a) Divide the text into logical parts. b) Choose the key sentences, analyse and translate them.

II. Look through the text and find the part of it dealing with a. c. power contained in a signal. Translate it.

III. Answer the questions.

1. What are the mean and the mean-square values of a waveform? 2. What is necessary to determine any indication of

waveshape? 3. What does this mean in practical terms? 4. What is the most familiar p. d. f.?

IV. Ask additional questions and discuss the problem of mean, mean square and probability function.

V. Combine your answers into a short summary of the text.

VI. Examine Figs. 5.9, 5.10 and comment on:

1. The probability-density function of a noise-signal.
2. The probability-density function.
3. The distribution function.

VII. Prepare a dialogue using Figs. 5.9 and 5.10.

VIII. Review the Text C in written form.

IX. Translate the Text C to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

burried in noise	неизменяемый
echo-ranging system	отвергать, подавлять
unchanged	существенно
unwanted noise	покрыт шумами
tend v.	нежелательный шум
reject	стремиться
substantially	система измерения с помощью эхолокации

II. Translate the following word-combinations and use them when reading the text.

If a signal of known waveform is transmitted; this situation represents; the receiver output consists of; there is no correlation; cross-correlation has thus rejected.

Text D

CROSS-CORRELATION

I. Read the text and say about cross-correlation used to detect the signal.

If a signal of known waveform is transmitted into a medium and is received again unchanged in form but buried in noise, cross-correlation can be used to detect the signal. This situation represents the basic problem of all communications and echo-ranging system. The receiver output consists of two parts: the desired signal, and unwanted noise. If we cross-correlate the transmitted signal with the receiver output, then the result also has two components; one part is the autocorrelation function of the desired signal which is common to both of the waveforms being correlated, and the other part results from the cross-correlation of the desired signal with unwanted noise. Now, in general, there is no correlation between signal and noise, so the second part tends to zero, leaving only the signal in the form of its autocorrelation function. Cross-correlation has thus rejected the noise in the received signal, with the result that the signal-to-noise ratio is substantially increased.

ASSIGNMENTS

I. Answer the following questions.

1. When can cross-correlation be used to detect the signal? 2. What does this situation represent? 3. What does the receiver output consist of? 4. What form is the signal when the second part tends to zero? 5. What has rejected the noise? 6. What is the result of it?

II. Discuss the problem of cross-correlation.

III. Make up a plan of the Text D and speak on your plan.

IV. Speak on probability of distribution.

V. a) Look through the latest magazines and find new material on the topic. b) Use it when discussing the topic.

III. GRAMMAR EXERCISES

I. Analyse the following sentences, define the tense-forms of the verbs and translate them.

1. The longer the averaging time the more accurate is the measurement. 2. Amplitude statistical characteristics have already been discussed when considering measurement errors. 3. These parameters (and several others) can be obtained for periodic waveforms as well as for random ones. 4. To do this, it is necessary to determine the proportion of time spent by the signal at all possible amplitudes during a finite period of time.

II. Define the function of *-ing*-forms in these sentences and translate them.

1. In practice for fluctuating electrical signals the mean-square voltage is often reffered to as the power of the signal. 2. In practical terms, this means totalizing the time spent by the signal in a selection of narrow amplitude windows, and then dividing the total for each window by the measurement or averaging time T.

III. Put questions to the words in bold type.

1. **The a. c. power** contained in a signal is proportional to σ^2. 2. The curve **is obtained** by plotting probability density function of the signal $p(x)$. 3. The most familiar p. d. f. is **the bell-shaped Gaussian or Normal curve,** which is characteristic of many naturally occuring random disturbances. 4. There is no **correlation between signal and noise.** 5. Cross-correlation has thus rejected the noise **in the received signal.**

Lesson 5. MULTIPLEXING

INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Make sure that you know these words. Say what Russian words help you to guess their meanings. b) Repeat these words after the speaker.

Method, filtering, information, spectrum, minimize, system, multiplexing, transmission, type, analogue, synchronizing, schemetic diagram, passive, active, interest, proportional, amplitude.

II. Listen, repeat and memorize the following words and word-combinations from the Text A and the Text B. b) Check if you know their meanings.

Time-division multiplex (TDM) мультиплексная передача с временным разделением каналов; frequency-division multiplex (FDM) мультиплексная передача с частотным разделением каналов; timing согласование во времени, синхронизация, хронирование; тактирование; ring counter circuit кольцевая счетная схема; assigned subcarrier определенная поднесущая (частота); simultaneously одновременно; dynamic strain динамическая деформация; sample hold circuit схема квантования и запоминания; multiplex мультиплексная (многоканальная) передача; multiplexer мультиплексор (*устройство смешивания сигналов от разных источников в один канал*); analogue TDM system аналоговая система ВРК (временное разделение каналов); the process of sharing процесс разделения;

to be connected in turn соединены последовательно, друг за другом; other associated equipment другое, связанное с этим оборудование; in sequential order в последовательном порядке; under the control под управлением; a similar set подобный набор; transmitted data передаваемые данные.

Text A

IMPROVEMENT OF SIGNAL-TO-NOISE RATIO

I. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

Of all the methods available for separating signals from noise the most widely used is that involving filtering. If the information signal had a different spectrum from the noise, it is always possible to design a filter which attenuates the noise more than it attenuates the signal. In other words, filtering can be made to improve the signal-to-noise ratio. To minimize the effect of noise interfering with a signal, the bandwidth of the measuring system must be exactly the same as the bandwidth of the signal.

2. Average Reading

Text B

TDM- AND FDM- MULTIPLEXING

I. Listen to the text. b) Read it (time limit is 3 min.). c) Find the part of it dealing with multiplexing. Translate it.

Multiplexing is the process of sharing a single transmission channel with more than one input. There are two main types of multiplexing systems: time-division multiplex (TDM) and frequency-division multiplex (FDM).

A schemetic diagram of an analogue TDM system is given in Fig. 5.11*a*. The multiplexer of a number of switches in the transmitter such that each analogue input (U_1, U_2, ..., U_n) is connected to the transmission channel in turn. The switches are controlled by a control unit whose function is to provide the signals which select the various switches in the multiplexer and other associated equipment. Often the switches are selected in sequential order under the control of a ring counter in the control unit. A similar set of multiplexer switches is required at the receiver, and the synchronizing signal in the transmitted data is used to synchronize the receiver and transmitter switches so that data channels are isolated.

A schemetic diagram of an AM frequency division multiplex system is given in Fig. 5.11*b*. Each input modulates an assigned subcarrier at comparatively low frequencies (5—40 kHz). These subcarrier frequencies are combined in a mixer circuit, and this combination modulates a main high-frequency carrier signal. This modulated high-

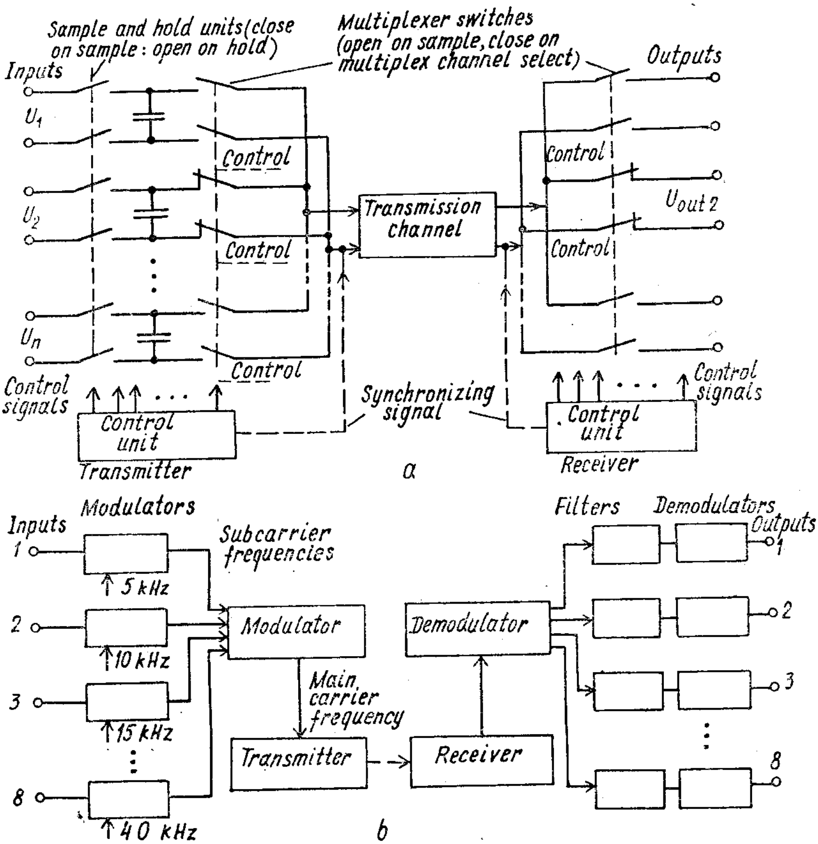


Fig. 5.11. Multiplexing:
a an analogue time-division type; *b* an AM frequency-division type.

frequency signal is transmitted to a receiver where the main high frequency signal is modulated. This reproduces the combination of subcarrier frequencies. Each of the subcarrier frequencies is separated from the other subcarrier frequencies with band-pass filters. These subcarrier frequencies are demodulated to reproduce the individual output signals. The AM-FDM system permits a number of data signals to be simultaneously sent over a common transmission channel.

ASSIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about.

II. a) Skim through the Text B and choose the key sentences. b) Translate the sentences.

III. Discuss the main idea of the Text A and the Text B.

IV. Answer the following questions.

1. What is multiplexing? 2. How many types of multiplex system do you know? 3. What is the synchronizing signal in the transmitted data used for? 4. What an AM-FDM can be used for?

V. Examine Fig. 5.11 and comment on:

1. An analogue time-division type.
2. An AM frequency-division type.

VI. Answer the following questions using Fig. 5.11. Work in pairs.

(a) 1. What does Fig. 5.11*a* show? 2. What does the multiplexer consist of? 3. What are the switches controlled by?

(b) 1. What does Fig. 5.11*b* show? 2. What does each input modulate? 3. What are these subcarrier frequencies combined in? 4. What does this combination modulate? 5. Where is the modulated high-frequency signal transmitted to? 6. What does this reproduce? 7. What is each of the subcarrier frequencies separated from the others with? 8. Why are these subcarrier frequencies demodulated? 9. What does the AM-FDM system permit?

VII. Prepare a dialogue on frequency division multiplexing system.

VIII. Speak on time-division multiplex system.

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these words.

Attenuate v. затухать, ослаблять; obscured затемненный; repetitive symmetrical waveform периодический симметричный сигнал; two-position switch двухпозиционный переключатель; lock-in amplifier синхронный усилитель; gate строб, выборка; вентиль, элемент (логический); inverted обратно преобразованный, инвертированный; averaging circuit усредняющая схема; gated signal стробирующий сигнал; coherent когерентный (согласованный); in-phase в фазе, синфазный.

II. Find the following word-combinations in the Text C and translate them. Use them while retelling the text.

It may still prove possible to improve; as shown in Fig.; two important features are readily seen; a phase difference affects the output value.

III. Define the grammar-forms of the verbs in the Text C.

Occupy, prove, measure, use, represent, show, take.

Text C

SIGNAL FILTERING

I. a) Read the text. b) Describe the passive, active and digital filter units.

If the noise interference occupies some or all of the frequency spectrum of the signal it may still prove possible to improve the

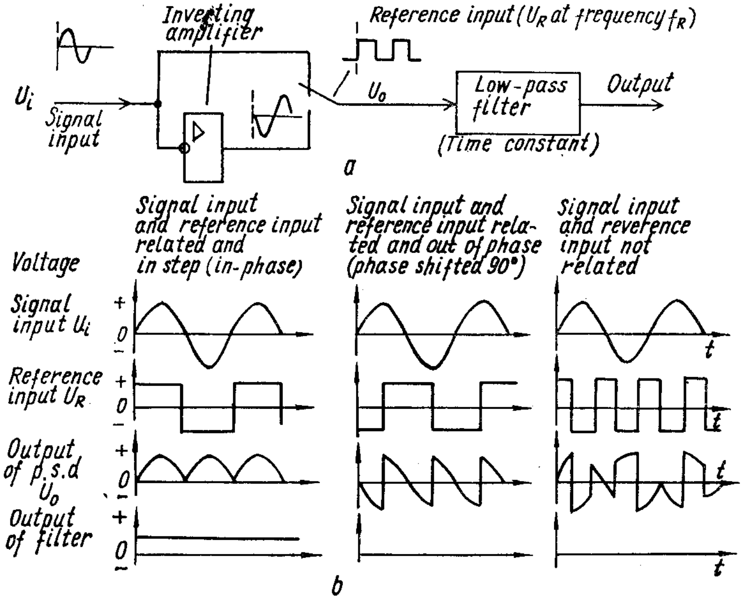


Fig. 5.12. The operation of a clock-in amplifier:
a the basic scheme; *b* the typical waveforms.

signal-to-noise ratio, if the shape of the frequency spectrum of the noise is different from that of the signal. Filter units may be passive, active or digital.

If a waveform to be measured, but obscured by high levels of noise, is a sinewave, square wave or other repetitive symmetrical waveform, then a lock-in-amplifier employing a phase-sensitive detector (p.s.d.) is used to measure the signal of interest. As shown in Fig. 5.12*a*, a p.s.d. can be simply represented by a two-position switch which alternately selects or "gates" either the signal or the inverted (opposite polarity) signal into a low-pass filter (an averaging circuit). The effect of such a p.s.d. on both synchronous and asynchronous (noise) input signals is shown in Fig. 5.12*b*. Two important features are readily seen. (1) When the a. c. signal and reference input have the same frequency and are in-phase, the lock-in output gives the average amplitude of the signal. A phase difference between signal and reference affects the output value. (2) When the signal and reference inputs are not at the same frequency, then the average value of the switch output is zero, provided a sufficiently long time is taken to establish the average.

ASSIGNMENTS

1. a) Divide the text into logical parts. b) Choose the key sentences, analyse and translate them.

II. Entitle each of the paragraphs of the text using the key sentences.

III. Look through the text and find the part of it dealing with the effect of a p.s.d. on both synchronous and asynchronous (noise) input signals.

IV. Answer the following questions embracing the contents of the Text C.

1. What can be made to improve the signal-to-noise ratio? 2. What is necessary to minimize the effect of noise interfering with a signal? 3. What kind of filter units do you know?

V. Ask additional questions on the Text C.

VI. Prepare the dialogue on the conditions under which filters can be employed.

VII. Speak on the function of the filters.

VIII. Translate the Text C to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

no longer	считать, рассматривать
without regard to	предшествующий
superposition	представлять
approximate square wave	быстрый
rapid	больше не
	суперпозиция, наложение
performance	независимо от
establish	характеристика
previous	устанавливать
consider	колебания примерно прямоугольной формы
represent	

II. Translate the following word-combinations and use them when reading the text.

It is evident, that; it is necessary to characterize; such effects are known as; a system comprises; one can define system linearity without regard to; the system may contain; a device can be represented by.

Text D

SYSTEM LINEARITY AND DISTORTION

I. Read the text and say about the amplitude of the output signal of a device having some nonlinearity.

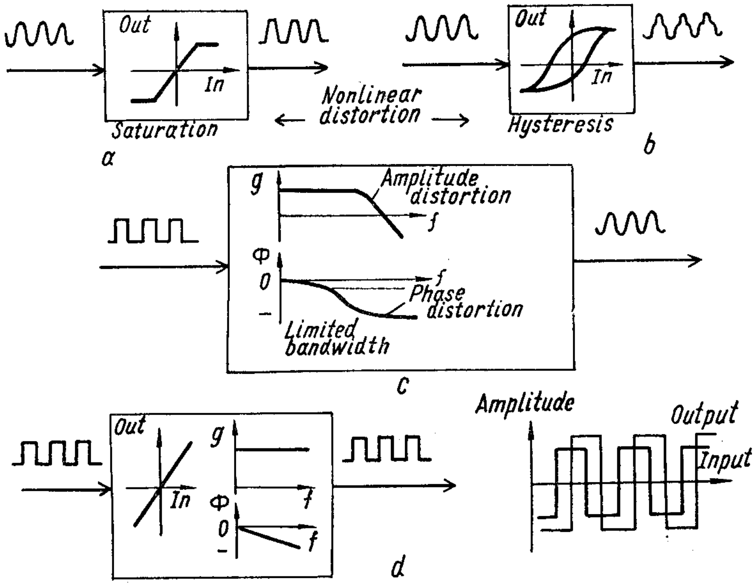


Fig. 5.13. Distortion effect:
a single-valued non-linearity; *b* doubled-valued non-linearity; *c* frequency (linear) distortion; *d* non-distortionless system.

Normally a measurand varies with time and such variation may be slow (for example temperature) or rapid (for example mechanical vibration displacement), repetitive (for example sinusoidal), non-repetitive (for example an impulse or step change) or completely random. It is evident that if the performance of a linear device or complete system to any time-varying input is to be established it is necessary to characterize the device or system.

The amplitude of the output signal of a device having some non-linearity is no longer simply proportional to the input signal amplitude (see Fig. 5.13*a*) and might be dependent on previous amplitudes (see Fig. 5.13*b*). Such effects are known as nonlinear distortion. A system comprises many devices, but one can define system linearity without regard to internal details. The system may contain nonlinear device such as A/D and D/A converters, pulse modulators, and still be considered linear, provided the overall response over the desired amplitude range obeys the principle of superposition, and that the steady-state response to a sinewave is a sinusoid which has the same frequency as the input. A device or system obeying these provisions can be represented by a linear differential equation.

A system is called distortionless if at its output and without change of shape it correctly reproduces any input waveforms. A distortionless system is one which is linear and whose frequency gain is constant and phase shift increases linearly with frequency, over the frequency range of interest (see Fig. 5.13*d*).

I. Answer the following questions embracing the contents of the Text D.

1. How does a measurand normally vary? 2. What is the amplitude of the output signal of a device having some nonlinearity depend on? 3. When may the system be considered linear? 4. What system is called distortionless?

II. Ask additional questions on the Text D and prepare a dialogue on the topic.

III. Speak on the amplitude of the output signal of a device.

IV. Examine Fig. 5.13 and comment on:

1. Single-valued non-linearity. 3. Frequency (linear) distortion.

2. Doubled-valued non-linearity. 4. Non-distortionless system.

V. Translate the following sentences into English.

1. Для обнаружения сигнала может быть использована взаимокорреляция. 2. Этот метод может применяться, если в определенную среду передается сигнал известной формы и принимается снова неизменным по форме, но скрытым в шуме. 3. Выходной сигнал приемника состоит из двух частей: полезный (желаемый) сигнал и нежелательные помехи. 4. Взаимокорреляция подавляет помехи в принятом сигнале, в результате чего отношение сигнал-помеха значительно увеличивается. 5. Это происходит таким образом: если мы проведем взаимную корреляцию переданного сигнала с выходом приемника, то в результате получим две составляющих: автокорреляционная функция полезного сигнала и взаимокорреляционная функция полезного сигнала с нежелательными помехами. 6. Вторая составляющая стремится к нулю, остается только сигнал — в виде его автокорреляционной функции.

III. GRAMMAR EXERCISES

I. a) Analyse the following sentences and define the function of the Infinitive. b) Translate them.

1. If a waveform to be measured is a sinewave a lock-in amplifier is used to measure the signal of interest. 2. To counteract any such phase shift caused in an experiment, a phase-shift facility is usually included in a lock-in system.

II. a) Translate these sentences with the verbs in the Passive Voice. b) Define the tense-forms of the verbs.

1. Two important features are readily seen. 2. A schematic diagram of an analogue TDM system is given in Fig. 5.11*a*. 3. The switches are selected in sequential order under the control of a ring counter in the control unit.

III. a) Define the functions of the words with the *-ing*-forms. b) Translate the sentences.

1. Of all the methods available for separating signals from noise the most widely used is that involving filtering. 2. In other words filtering can be made to improve the signal-to-noise ratio. 3. Multiplexing is the process of sharing a single transmission channel with more than one input.

Chapter VI. CONTROL SYSTEMS AND PROGRAMMING

Lesson 1. COMPUTERS IN COMMAND AND CONTROL SYSTEMS

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Make sure that you know these words. Say what Russian words help you to guess their meanings. b) Repeat these words after the speaker.

Command, data, computer, collect, collection, centre, process, result, organization, effective, transmission, information, exploit, basic, oriented, machine, telecommunication, concentrator, distant, automatically, communicate, analyse, copy, terminal, program, decoding, specific, synchronization, instruction, general, class, manipulation, status, structure, absolute.

II. a) Listen, repeat and memorize these words and word-combinations. b) Check if you know their meanings.

Computers in Command and Control Systems ЭВМ в автоматизированных системах управления; closed loop замкнутая петля;

simultaneously одновременно; data collection centres центры сбора данных; input inquiries входные запросы; expeditiously ускоренно, немедленно; data continuously flow up and down the line данные непрерывно перемещаются вверх и вниз (на верхние и на нижние звенья управления); can be finely defined могут быть в конце концов определены; take into account учитывать, принимать во внимание; remote equivalent of the computer-room input-output devices удаленный эквивалент устройств ввода и вывода, которые размещаются вместе с ЭВМ (в одной комнате); paper-tape readers устройство для считывания с перфоленты; punch-card readers устройство для считывания с перфокарты; non-real-time terminals терминалы, не способные работать в реальном времени; key-board панель с клавиатурой; screen display устройство отображения на экране; conversational terminals «разговаривающие» терминалы (терминалы с возможностью обмена информацией с ЭВМ); on-line or off-line непосредственно (без задержки во времени) или в буферном режиме (с задержкой во времени); punch v. перфорировать.

III. Analyse the structure of the following compound words and translate them.

Real-time, ever-growing, computer-room, paper-type, punched-card, typewriter, key-board, on-line, off-line, closed-loop.

Text A

COMPUTERS AND DATA TRANSMISSION

I. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

The Command and Control System is organized in a closed-loop where data continuously flow up and down the line. Computers are employed both in the command and in the data collection centres. Decisions for execution are sent forward and the results are continuously fed back, all processes operating in real-time. The best control of the organization resources can be effective only if the transmission of the information in both directions is fully exploited.

It is a basic requirement of a Command and Control System that the computers involved are communication orientated and can be operated on-line in a real-time environment. The adopted computers must possess the following qualifications:

(a) They should be capable of handling masses of data swiftly and efficiently and store large quantities of information.

(b) They must be able to operate a large number of input inquiries simultaneously and respond to them expeditiously.

A vast ever-growing array of machines can be attached to telecommunication lines for transmitting and receiving data.

Data transmission can be: 1. Between computer and computer. 2. Between terminal and computer. 3. Between terminal and terminal.

In any of these links there can be intermediary network devices such as concentrators and switches.

2. Average Reading

Text B

TERMINALS

I. Listen to the text. b) Read it (time limit is 3 min.). c) Find the part of it dealing with the terminals designed for human use.

A device for feeding data to or receiving data from a distant computer is called a terminal (perhaps an unfortunate choice of a word because line termination equipment in general has been called a terminal: "microwave terminal", for example, refers to the electronic equipment at the end of a microwave link).

Terminals can be devices into which data are entered by human operators or devices that collect data automatically from instruments. Terminals designed for human use may permit a fast two-way "conversation" with the computer or may be a remote equivalent of the computer-room input/output devices. The people use terminals to communicate with a computer. Paper-type readers and punched-card readers may provide input over communication lines. Printers may provide the output.

Most computers peripherals can be taken out of the computer room and attached to a communication line. They can have a typewriter added or a key-board or screen display, and then they are called conversational terminals.

The information, whether from automatic devices or from manually operated key-boards, may be transmitted immediately to the computer or may be stored in some medium for transmission at a later moment. In other words the entry of data may be on-line or off-line. Reading of instruments, for example, may be punched into paper tape, which is later transmitted to the computer.

The output may also make use of an interim medium, such as paper tape or punched card, or it may directly control the environment in question. Very often it is necessary to make a printed copy of the computer output for later analysis. In this case, part of the terminal equipment may be a typewriter or printer.

ASSIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about.

II. Skim through the Text B and say how the Comand and Control System is organized.

III. Answer the following questions embracing the contents of the Text A and the Text B.

1. Where are computers employed? 2. When can the best control of the organization resources be effective? 3. What is the basic requirement of a Command and Control System? 4. What can be attached to telecommunication lines for transmitting and receiving data?

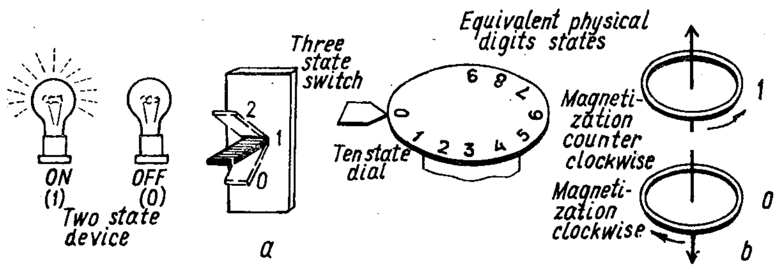


Fig. 6.1. Physical structures of the devices used to store digital information: *a* the light bulb, mechanical switch and digit wheel (dial); *b* the magnetic core.

5. What devices are terminals? 6. What may terminals designed for human use permit? 7. Why do people use terminals? 8. What may paper-tape readers and punched-card readers provide? 9. What may printers provide? 10. May the information be transmitted immediately to the computer?

IV. Prepare a dialogue on requirements of a Command and Control System.

V. Speak on common types of terminal devices.

VI. Examine Fig. 6.1 and speak on different states of various physical devices.

VII. Make a short written summary of the Text B.

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Memorize the following abbreviations from the Text C.

MPU — microprocessor unit микропроцессорный блок, микропроцессор (МП);
RAM — random-access memory ЗУ со случайным доступом (ОЗУ);
ROM — read-only memory ЗУ только со считыванием, постоянное ЗУ (ПЗУ);
I/O — input-output unit устройство ввода-вывода (УВВ).

II. Translate the following compound words and learn them.

Microprocessor; microcomputer; read/write; random-access memory; read-only memory; time-multiplexed; second- and third generation; eight- and 16-bit bidirectional lines.

Text C

MICROCOMPUTER SYSTEMS

I. a) Read the text. b) Speak on the early microprocessor devices.

The microprocessor unit (MPU) is the basic processing unit of the microcomputer system. By itself, not much is possible. So the

MPU is connected to memory and input/output. The memory unit may consist of several devices, called read/write or random-access memory (RAM) and read-only memory (ROM). Memories store necessary programs for the particular application of the microprocessor. The primary connection to external devices such as keypads, teletypes, or CRTs is accomplished through the input/output (I/O) unit. This basic interfacing unit of the microcomputer system is implemented with one or more special chips provided by the microprocessor manufacturers. The microcomputer system moves necessary information through three buses: the address bus, data bus, and control bus.

In early microprocessor device, these buses were sometimes shared in time (time-multiplexed). In all second- and third-generation microprocessors these buses are available independently. The address bus commonly is 16 bits wide. In microcomputer systems this same address bus serves to select devices by decoding particular address values for specific devices called device select addresses. The data bus is the main highway for information transfer to and from the MPU. Eight- and 16-bit bidirectional lines are now common. The control bus of a microcomputer system generates the timing, synchronization, isolation, and direction of data transfer for the memory and I/0 devices.

ASSIGNMENTS

I. a) Divide the text into logical parts. b) Find the key sentences, analyse and translate them.

II. Skim through the text and find the part of it dealing with the microprocessor devices. Translate it.

III. Compare microprocessors of different generations.

IV. Answer the following questions embracing the contents of the Text C.

1. What is the microprocessor unit? 2. To what is MPU connected? 3. What may the memory unit consist of? 4. What do memories store? 5. What buses does the microcomputer system move necessary information through? 6. What is the address bus? 7. What does the address bus serve? 8. Is the data bus the main highway for information transfer to and from MPU? 9. What does the control bus generate?

V. Describe all types of computers and their basic processing units available at your institute.

VI. Check if you know the following word-combinations. Use them when retelling the Text C.

Memory unit блок памяти, память; read/write memory запоминающее устройство (ЗУ) со считыванием и записью; keypad кнопочный переключатель; CRT (cathode-ray tube) электронно-лучевая трубка (ЭЛТ); address bus адресная шина; data bus шина данных; control bus шина управления.

VII. Pick out all verbs from the Text C and define their tense-forms.

VIII. Translate the Text C to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

personality (of a microprocessor)	способ адресации
encounter	движение данных
instruction set	код операции
data manipulation	особенности (микропроцессора)
data movement	система (семейство) команд
program status manipulation	манипулирование состоянием программы
addressing mode	команда «СЛОЖИТЬ»
ADD instruction	сталкиваться с
operation code	манипулирование (управление) данными
mnemonic	СУММА (результат сложения)
operand	мнемонический код
SUM	операнд (число, слово, участвующее в операции)

II. Memorize the following abbreviations.

OPCODE — operation code;
ADD operation — additional operation;
MPU — microprocessor unit;
PC — program counter;
BRA — branch;
JMP — jump.

Text D

PROGRAMMING MICROPROCESSORS

I. Read the text and say about programming.

Programming is your first step towards learning the personality of microprocessor. For it is here you encounter the true character of your machine, the instruction set. If we analyse instruction set, we can find four general classes in each set. These are data manipulation, data movement, program manipulation, and program status manipulation.

Data Manipulation. All instruction have a specific format that helps us to describe its structure and addressing mode. For example, the format of an ADD instruction consists of the operation code (OPCODE) and its operand R_1 and R_2. This symbolic notation of the ADD operation is a mnemonic which tells us that the two operands R_1 and R_2 are added together, placing the SUM in R_1. Other instruction formats are similarly structured.

Data Movement. It is important to understand how instructions manipulate the contents of the MPU registers, memory, and devices. In load and store instructions, data are typically transferred between the accumulator registers external to the MPU. With the transfer instruction, data between general-purpose registers internal to the MPU are being exchanged.

Program manipulation. Program manipulation instructions operate on microprocessor resources. Here we have two instructions cause a program to move to another location in memory relative to the current contents of the program counter (PC). Jump instructions cause a program to move to any location (not necessarily a location relatively addressed from the current PC). Branch instructions cause "relative" movement, whereas jump instructions cause "absolute" movement.

Program Status Manipulation. The program status manipulation instructions test and/or change conditions in the microprocessor to alter the instruction sequence. This instruction sets the interrupt (I) mask in the condition code register of the MPU. The condition code register contains the current status of the microprocessor during program execution.

ASSIGNMENTS

I. Answer the following questions embracing the contents of the Text D.

1. Is programming your first step toward learning the personality of a microprocessor? 2. When do you encounter the true character of the instruction set? 3. What general classes are there in each instruction set? 4. What does the format of an ADD instruction consist of? 5. How are data typically transferred? 6. How do program manipulation instruction operate? 7. What do the program status manipulation test?

II. Ask additional questions on the topic of the lesson.

III. Speak on:

1. Data manipulation.
2. Data movement.
3. Program manipulation.
4. Program status manipulation.

IV. Discuss the problem of programming microprocessors.

V. Express your opinion of the topic.

VI. a) Look through the latest magazines and find additional information on the topic. b) Discuss it with your fellow-students.

III. GRAMMAR EXERCISES

I. a) Define the tense-forms of the verbs in the following sentences. b) Translate them.

1. The MPU is connected to memory and input/output. 2. The microcomputer system moves necessary informations through three buses. 3. These buses were sometimes shared in time. 4. If we analyse instruction sets, we can find four general classes in each set. 5. With the transfer instruction, data between general-purpose registers internal to the MPU are being exchanged. 6. Line termination equipment has been called a terminal.

II. Translate the sentences, pay attention to the modal verbs with the Active and Passive Infinitive.

1. The computer can be operated on-line in a real-time environment. 2. The adopted computers should be capable of handling masses of data swiftly and efficiently. 3. They must also be able to operate a large number of input inquiries simultaneously. 4. Many machines can be attached to telecommunication lines for transmitting and receiving data. 5. Terminals may permit a fast two-way "conversation" with the computer or may be a remote equivalent of the computer-room input / output devices. 6. The information may be transmitted immediately to the computer or may be stored in some medium for transmission at a later moment. 7. Part of the terminal equipment may be a typewriter or printer.

III. Define the function of the Participle in these sentences and translate them.

1. Decisions for execution are sent forward and the results are continuously fed back, all processes operating in real-time. 2. It is a basic requirement of a Comand and Controle System that the computers involved are communication oriented and can be operated on-line in a real-time envirenment.

Lesson 2. TERMINALS

I. Independent Work.
In the Laboratory:
1. *Skimming Reading.*
Pre-text Exercises.
Text A. The Interaction of Human and Machine.
2. *Average Reading.*
Text B. Types of Terminals.
Assignments.

II. Classwork.
3. *Close Reading.*
Pre-text Exercises.
Text C. Remote Terminals.
Assignments.
4. *Searching Reading.*
Pre-text Exercises.
Text D. Basic Input /Output.
Assignments.

III. Grammar Exercises.

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Make sure that you know these words. Say what Russian words help you to guess their meanings. b) Repeat these words after the speaker.

Focal, system, assist, basic, agent, command, terminal, data, transmission, computerize, combination, post, process, technical, engineering, problem, technique, functional, information, detail, reaction, operator, station, manipulate, geographical, categories, sensor type, automatically, graphical, sophisticated, special, interpretation.

II. a) Listen, repeat and memorize the following words and word-combinations. b) Check if you know the meaning of these words.

Terminals and displays оконечные и отображающие устройства; reader считывающее устройство; focal points фокусные точки; Command and Control System автоматизированная система управления; command post пункт управления; remote terminals удаленные оконечные устройства; raw form сырой вид, необработанная форма; computerized system машинная система; the processed data is fed back обработанные данные выдаются; management decision управляющее решение, решение по управлению; take into consideration принимать во внимание.

III. a) Translate the following word-combinations. b) Define the attributes and say by what part of speech they are expressed.

Focal points of the Command and Control System; better control of the organization resources; interaction of human agents; a well-designed terminal; management decision; command post; processed data; output device; unskilled operator.

Text A

THE INTERACTION OF HUMAN AND MACHINE

I. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

Terminals and displays are the focal points of the Command and Control System and are provided to assist in better control of the organization resources.

In Comand and Control Systems there are two basic areas where the interaction of human agent and machine takes place: (a) remote terminals; (b) the command post. Remote terminals are the points where the data is prepared in raw form for transmission to the computerized system and where the processed data is fed out. The remote terminals may thus be either input or output devices, or a combination of both. The command post is the point where all the processed data required for management decision is displayed, and accordingly it is basically an output device.

2. Average Reading

Text B

TYPES OF TERMINALS

I. a) Listen to the text. b) Read it (time limit is 2 min.). c) Find the part of it dealing with the devices which come under the title of terminals. Translate it.

There are many devices which come under the title of terminals. They comprise those where input devices are: (a) key-boards; (b) readers; (c) switches; (d) function knobs; (e) light pens, and where the output devices are: (a) typewriters; (b) printers; (c) punches; (d) displays.

The design of the terminal is not only a technical but essentially a human engineering problem. A well-designed terminal, using all the latest techniques, answering to all the functional requirements and displaying the full information details required, may prove to be useless if the human reaction of the operator has not been taken into consideration to the fullest extent.

The terminals, whether situated at the remote stations or at the command post, must be simple and easy to manipulate. There should be no need for lengthy courses to learn how to operate these terminals; indeed, the design should be aimed at the unskilled operator.

ASSIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about.

II. Skim through the Text B and find the part of it dealing with the design of the terminal. Translate it.

III. Answer the following questions.

1. What are terminals and displays? 2. What are they provided for? 3. Where are the terminals used? 4. What two basic areas are there in Command and Control Systems? 5. What are remote terminals?

IV. Ask additional questions on the Text A and the Text B.

V. Prepare a dialogue on terminals and displays.

VI. Make a short summary of the Text B.

VII. Speak on the design of terminals.

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these words and word-combinations.

Scatter v. разбрасывать; CRT's (cathode-ray tubes) электронно-лучевые трубки; data-acquisition terminals оконечные устройства автоматического сбора данных; data-transaction terminals оконечные устройства ручного ввода данных; inquiry terminals оконечные устройства для запросов; display terminals оконечные устройства для отображения (информации); on-line real-time information непосредственная, в реальном времени информация; measurement interface equipment измерительная аппаратура сопряжения; A/D (analog-digital) converter аналого-цифровой преобразователь (АЦП); storage buffers буферные запоминающие устройства; reference clocks опорные тактовые генераторы; badge readers устройства считывания символов; remote telemetry sensors удаленные телеметрические датчики; time-sharing system система с распределением времени.

II. Translate the following word-combinations from the Text C and use them when retelling the text.

Remote terminal connect the system users; the terminals may be divided into; these terminals generally obtain; the data is collected and inserted; as with the other terminals, that is; data inquiry terminals are the most widely used; in contrast to the previous type; these terminals need not be custom.

III. Analyse the structure of these compound words and translate them.

Data-acquisition; data-transaction; on-line; real-time; A/D converter; multiplexor; demultiplexor; feedback; data-transaction; time-sharing.

Text C

REMOTE TERMINALS

I. a) Read the text. b) Speak on the centralized system by means of communication channels.

Remote terminals connect the system users scattered over a wide geographical area with the centralized system by means of communication channels. For Command and Control applications, the terminals may be divided into five major categories according to their field of application:

(a) Data-acquisition terminals. (b) Control terminals. (c) Data-transaction terminals. (d) Enquiry terminals. (e) Display terminals.

In the class of data acquisition terminals are the sensor type terminals which are "hard wired" into the process so as to collect on-line real-time information. These terminals generally obtain measurement interface equipment, A/D converters, storage buffers, reference clocks, communication multiplexors and modems.

The control terminals are complementary to the data acquisition terminals, since they are intended to automatically implement the system decisions. These terminals contain instrument interface equipment, D/A converters, storage buffers, communication demultiplexors and modems. They are used in the feedback process of the system where the operation must change its control path in real time.

In data-transaction terminals, the data is collected and inserted by human operation instead of by automatic instruments. As with the other terminals, the data-transaction terminals connected on-line to the system, that is, the data which is inserted by the human agent is transfered directly to its destination, receiving instantaneous reaction and providing the operator with a reply in "real-time".

Data inquiry terminals are the most widely used terminals particularly the time-sharing systems. In contrast to the previous type terminal discussed, these terminals need not be custom designed for a specific application but may be mass produced to cover a wide range of applications. With these inquiry terminals, the operator can insert specific request and receive the computer's reply on the same terminal.

Display terminals are primary output devices where the data is displayed for decision making in the command post. They may be divided into two main groups: personal displays and large screen displays. Personal displays are of the type of CRT key-board displays. Among them one must also include the graphic displays which are used for computer-aided designs, which allow on-line graphical conversation for sophisticated analysis of problems.

ASSIGNMENTS

I. a) Divide the text into logical parts. b) Find the key sentences, analyse and translate them.

II. Find the part of the text containing information about data inquiry terminals. Translate it.

III. Answer the following questions.

1. How do remote terminals connect the system users scattered over a wide geographical area? 2. What does the term "terminal" include? 3. What devices are display terminals? 4. What groups may displayed terminals be divided into?

IV. Prepare a dialogue on remote terminals.

V. Speak on display terminals.

VI. Make up a plan of the Text C and retell it according to your plan.

VII. Translate the Text C to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

basic input/output	сложный, замысловатый
interface	подтверждение приема (*сообщения*),

migrate	квитирование (*сообщения*)
acknowledgement (handshaking)	основы ввода/вывода
protocol	сопрягать, устройство сопряжения (интерфейс)
elaborate	перемещаться
specify	простой, ожидание
	протокол (правила обмена данными)
mark	*зд.* проба, пропуск
idle	*зд.* точно определять
space	метка, маркер, отметка; токовая посылка

Text D

BASIC INPUT/OUTPUT

I. Read the text and say about basic input/output.

In most third-generation microprocessors, microprocessors are interfaced to peripheral devices directly from the data bus of the MPU chip or through special devices or chips designed for that purpose. In future microprocessors, peripheral device functions will migrate into the microprocessor chip. In either case, this interface constitutes the input/output structure of a microprocessor. Microprocessor input/output may be single-line, multiline, parallel, or serial.

Many peripheral devices require some sort of acknowledgement or handshaking between the device and the microprocessor. This coupling phenomenon tells the microprocessor that the device either has data ready for the microprocessor or, vice versa, the microprocessor has data ready for the device. Handshake occurs when the "other" unit responds with an acknowledging signal. The specific interpretation of the control signal is called the protocol. An orderly exchange is desired. Protocols can become elaborate when the byte and message formats as well as the message sequence are to be specified. For more sophisticated interfaces, microprocessors use interface circuits. Handshaking is, then, easily handled by resources in the peripheral devices.

Many serial interfaces for a microprocessor have a typical data format. This character format requires a start bit followed by 8 information bits, and 1 or 2 stop bits which follow the 8 information bits. A "mark" or a constant binary value of 1 indicates to the device and to the MPU that the transmission is in the idle mode (no characters transmitted). Notice that the "start" bit is always a "space" or a 0. Eleven bits are required in order to transmit every character in this format. There are other versions of serial data formats, although this is very common.

I. Answer the following questions.

1. To what device are microprocessors interfaced? 2. Where will peripheral device migrate? 3. What does interface constitute? 4. When does handshake occur? 5. What is called the protocol? 6. When can protocols become elaborate?

II. Discuss the problem of basic input/output.

III. Express your opinion of the topic of the lesson.

IV. Look through the latest magazines and find additional information on the topic. Discuss it.

III. GRAMMAR EXERCISES

I. Define the form and function of the Participles in these sentences and translate them.

1. A well-designed terminals using all the latest techniques, answering to all the functional requirements and displaying the full information details required, may prove to be useless if the human reaction of the operator has not been taken into consideration to the fullest extent. 2. The command post is the point where all the processed data required for management decision is displayed, and accordingly it is basically an output device. 3. Remote terminals connect the system users scattered over a wide geographical area with the centralized system by means of communication channels.

II. Find the Infinitive in these sentences, state its function and translate.

1. The terminals, whether situated at the remote stations or at the command post, must be simple and easy to manipulate. 2. In the class of data acquisition terminals are the sensor type terminals which are "hard wired" into the process so as to collect on-line real-time information. 3. Eleven bits are required in order to transmit every character in this format.

III. Translate the following sentences paying attention to modal verbs and their equivalents.

1. Microprocessor input/output may be single-line, multiline, parallel, or serial. 2. Protocols can become elaborate when the byte and message formats as well as the message sequence are to be specified.

Lesson 3. DATA TRANSMISSION

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Make sure that you know these words. Say what Russian words help you to guess their meanings. b) Repeat these words after the speaker.

Telephone, limit, analogue, illustrate, basic elements, form, specific, communication, phase, binary, (de)modulation, popular, configuration, pulse, criterion, bit, information, voltage, individual, process, instruction, construct, extravagant, address, organization, alphabetic, Arabic.

II. a) Listen, repeat and memorize the following words and word-combinations. b) Check if you know their meanings.

Data transmission передача данных; voice traffic речевая нагрузка; analogue-type signals сигналы аналогового типа; data transmitter receiver приемо-передатчик данных; remote geographical locations отдаленные географические точки; encode закодировать; specific transmission handling особая обработка при передаче; raw form необработанная, сырая форма; modem модем (модулятор-демодулятор); translation трансляция, преобразование; voice frequency waveform колебание звуковой частоты; binary data pulses двоичные импульсы; simplex симплексный (односторонний); half-duplex полудуплексный (*режим, передача*); insert *зд.* размещаться; path тракт; public telephone network телефонная сеть общего пользования; carry data нести, передавать данные; 4-wire line circuit четырехпроводная линейная цепь; while conversely тогда как обратно; request запрос; communication procedures an answer-back процедуры (методы) связи с подтверждением приема (с квитированием).

Text A

SIGNIFICANCE OF DATA TRANSMISSION

I. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

The successful operation of a Command and Control System depends essentially on its ability to transfer data between remote geographical locations speedily and correctly.

Most of the data transmission is conducted over the traditional telephone lines, apart from a few specially designed lines with wider bandwidth. The standard telephone lines are limited by their upper frequency, since they were designed to carry only voice traffic, that is only analogue type signals. In order to transmit digital data over these lines, the data generated by the computer or by the terminals must be converted into analogue signal so that they can be transmitted in their encoded form over the ordinary telephone lines.

2. Average Reading

Text B

TYPES OF TRANSMISSION

I. a) Listen to the text. b) Read it (time limit is 4 min.). c) Find the part of it dealing with the three types of transmissions.

Fig. 6.2 *a* illustrates the basic elements required for digital data transmission. The data to be transmitted must first be encoded into a form suitable for specific transmission handling, as the transmission over a communication line produces attenuation and phase delay; it is impractical to transmit the digital pulses in their raw form over telephone lines. It is necessary to modulate the data to be transmitted over analogue telephone lines and to demodulate the signal at the

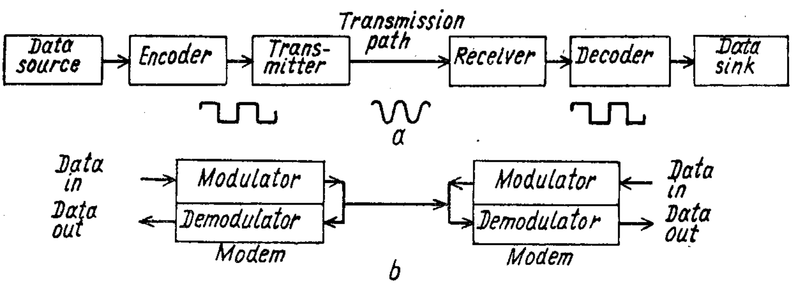


Fig. 6.2. The structure of a digital data communication system: *a* basic elements; *b* a modern system configuration.

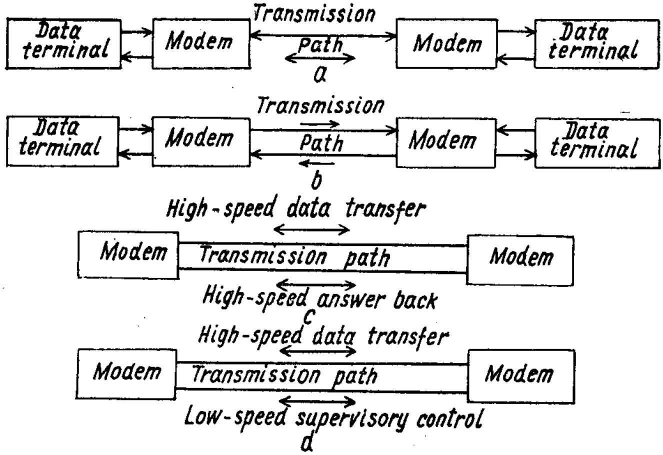


Fig. 6.3. Types of transmission:
a point-to-point half-duplex; *b* point-to-point duplex; *c* duplex transmission, operating in half-duplex mode with high-speed answer-back; *d* with low-speed supervisory control.

receiver end. Similarly as to the speech, data transmission is generally possible to both directions, although not simultaneously. The data transmitter receiver which perform the dual process of modulation and demodulation is consequently referred to by the abbreviated form of modem (see Fig. 6.2 *b*). The modem performs the operation of translation between the binary data pulses and the voice frequency waveform; hence it could also be regarded as analogue to digital and digital to analogue converters.

Without regard to the communication media, there are three types of transmission. (a) Simplex transmission, where a line carries data in one direction only, as shown in Fig. 6.3*a*. (b) Half-duplex transmission, where a line can carry data in either direction but only in one direction at a time, as shown in Fig. 6.3*b*. Here identical modems are inserted at both end of the transmission path. This is a most popular data transmission configuration, as it can be used in any public telephone network. (c) Duplex (or full duplex) transmission, where a line can carry data in both directions simultaneously, as shown in Fig. 6.3*c*. This double direction can be achieved by either transmission over two different frequency bandwidths or by a 4-wire line circuit.

Although data can flow in both directions simultaneously in a duplex configuration, it is common practice to operate it in a half-duplex mode. In these applications the digital information flows in one direction while conversely the control data flows in the other direction to indicate either an acknowledgement or a request for retransmission of the message. This mode of operation (shown in Fig. 6.3*d*) saves time when two terminals or two computers communicate. It must be appreciated that for most communication procedures an answer-back is essential.

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about.

II. Skim through the Text B and find the part of it dealing with data transmission receiver. Translate it.

III. Find the part in the Text B containing information about the mode of operation shown in Fig. 6.3*a*.

IV. Answer the following questions.

1. What does the successful operation of a Command and Control System depend on? 2. Over what lines is most of the data transmission conducted? 3. What must be done in order to transmit digital data over these lines? 4. What is necessary to do with the data to be transmitted over analogue telephone lines? 5. What is the abbreviation for the dual process of modulation and demodulation? 6. What types of transmission do you know?

V. Prepare a dialogue on data transmission.

VI. Speak on the modem system configuration.

VII. Examine Figs. 6.2, 6.3 and comment on:

1. Basic elements of a digital data communication system.
2. Point-to-point half-duplex; point-to-point duplex.
3. Duplex transmission, operating in half-duplex mode with high-speed answer-back.

VIII. Make a short written summary of the Text B.

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these words and word-combinations.

Pulse waveform code formats форматы импульсно-кодированных сигналов; return-to-zero method запись методом возврата к нулю; penaltry штраф, дополнительная плата; ternary троичный; quadric четверичный; consequitive bits последовательные биты.

II. a) Define the attributes in these word-combinations. Say what part of speech they are expressed by. b) Translate them.

Binary data transmission; the first criterion of division; half binary transmission; second criterion of division; the transmission of each bit of information; a third accepted criterion of division; respective pulse formats; the same binary information; the unit of signalling speed; the actual number of binary digit.

III. Translate the following word-combinations and use them retelling the Text C.

There are many different types of; the various coding patterns are illustrated in Fig.; the unit of signalling speed should be measured by the number of; the term bits/s refers to.

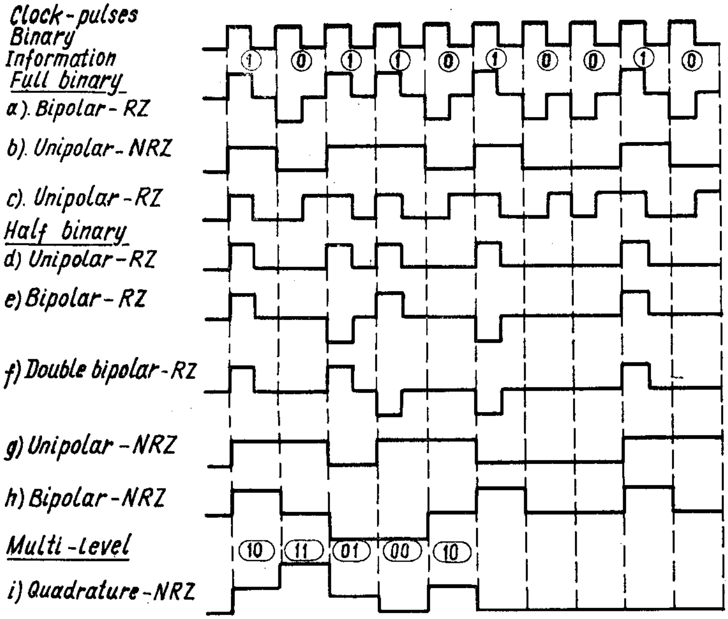


Fig. 6.4. Pulse code formats in data transmission.

IV. Pay attention to the translation of «that of» which is used instead of the noun mentioned.

1. A second criterion of division is that of relation to the zero level. 2. A third accepted criterion of division is that of direction.

Text C

PULSE CODE FORMAT

I. a) Read the text. b) Speak on different types of pulse waveform code format.

There are many different types of pulse waveform code formats which may be used in binary data transmission. All the code formats could be divided into three classes. The first criterion of division is the form of information transmission, viz. (a) Full binary transmission, where both the "0" and "1" bits are part of the formats. (b) Half binary transmission, where only the "1"'s are transmitted, having the "0"'s recognized by the absence of a pulse at the time of clock. (c) Multiple binary transmission, where ternary and quadric codes are used for each transmitted pulse. A second criterion of division is that of relation to the zero level, viz. (a) Return-to zero (RZ), where there is a return to the zero level after the transmission of each bit of information. (b) Non-return-zero (NRZ), where there is no voltage level change if consecutive bits are transmitted, although there is a level change when there is an information variation from 0 to 1 or 1 to 0.

A third accepted criterion of division is that of direction, viz. (a) Unipolar, where the pulses are in the single direction. (b) Bipolar, where the pulses are in both directions.

The various coding patterns for the respective pulse formats are illustrated in Fig. 6.4*a—i* where each pattern represents the same binary information of 1011010010.

For data transmission, the unit of signalling speed should be measured by the number of bits transmitted per second. The term "bit per second" (bits/s) refers to the actual number of binary digits that are transmitted per second.

ASSIGNMENTS

I. a) Divide the text into logical parts. b) Find the key sentences, analyse and translate them.

II. Find the part of the text containing information about the various coding patterns for the respective pulse formats illustrated in Fig.6.4. Translate it.

III. Answer the following questions embracing the contents of the Text C.

1. How many classes could all the code formats be divided? 2. What are these classes? 3. What is the first criterion of division? 4. What is the second criterion of division? 5. What is the third criterion of division?

IV. Ask additional question on the Text C and answer them. Work in pairs.

V. Prepare a dialogue on pulse code formats.

VI. Retell the Text C according to your plan.

VII. Translate the Text C to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

extravagant	связать друг с другом так, что
alphanumeric	двоичный код знака (символа)
instruction half word	двоичный разряд
variable length field	полуслово
zone part of two ...	зонная часть из двух ...
numeric part of four ...	буквенно-цифровой
binary digit	командное полуслово
treat	сохранить, сэкономить
binary character code	числовая часть из четырех ...
link in each a way that	байты, к которым обращение идет по одному адресу

converse	обращаться
conserve	*зд.* преобразовывать
half word	заглавные буквы
bytes referenced by a single address	восьмиразрядный код знака
upper case letters	знак пунктуации
punctuation mark	расточительный
eight character code	поле переменной длины

II. Translate the following word-combinations from the Text D and memorize them.

The individual storage cell provides; this basic unit is usually referred to as; computers are normally built with; although it would be possible to construct; the fundamental group of bits is called; the size of a byte is chosen so that; the individual bits of a byte are linked; alphabetic symbols are represented.

Text D

BITS, BYTES, AND WORDS

I. Read the text and say about the smallest unit of digital information.

The individual storage cell provides the smallest unit of digital information which can be stored within a computer. This basic unit is usually referred to as a binary digit or bit. Computers are normally built with a large number of bit storage cells to that programs involving extensive instruction sets and data can be stored and processed internally.

Although it would be possible to construct computer circuits to give individual addresses to each binary digit stored in the computer memory, such an arrangement would be very extravagant. For purposes such as alphanumeric data, groups of bits are normally stored together under one common address and treated by the computer as a unit of information. In some recent computers the fundamental group of bits is called a byte. The size of a byte, usually six or eight bits, is chosen so that the byte can store one alphanumeric character using the binary character code adopted for the computer. The individual bits of a byte are electrically linked in each a way that a single memory address applies to the entire byte. For such machines the byte is the basic units of addressable information.

While bytes are well adapted for character representation and storage, larger organizations of bits must be provided for storage of instructions and numbers. Such a large unit is formed by linking bytes together to form a word. The IBM 360 computer system, for example, uses four eight-bit bytes to form a word. The information stored in a word of this type can be directly referenced through the use of one address.

The various addressable groupings of information units are not restricted to bytes and words. It is found, for example, that instructions do not require as many bits as are needed for number representation. Hence, to conserve computer memory space instruction half words are often used. Likewise, although numbers are normally represented in words, for more accurate arithmetic it is possible to link two words together to form an addressable double word. The ultimate flexibility now available in large computer system uses variable length fields composed of suitably linked bytes referenced by a single address.

Alphabetic symbols and special characters are represented in computers through codes on sequences of binary digits. Normally at least six bits ($2^6 = 64$ separate patterns) are required to establish a unique code set for the 26 upper case letters, the 10 Arabic numerals, various arithmetic operators, and punctuation marks. Most large computers having a byte structure use eight character codes ($2^8 = 256$ separate patterns) to take advantage of the larger available character set.

Both the six and eight bit character representations are subdivided into two parts: a zone part of two or four bits and a numeric part of four bits.

ASSIGNMENTS

I. Answer the following questions embracing the contents of the Text D.

1. What does the individual storage cell provide? 2. How is this basic unit usually referred to? 3. What are computers normally built with?

II. Ask additional questions on the Text D and answer them. Work in pairs.

III. Prepare a dialogue on the representation of logical data.

IV. Make up a plan on the Text D and retell the text according to your plan.

V. Speak on typical organization within a computer using six or eight-bit bytes.

VI. Discuss the problem of bit information.

VII. Express your opinion of the topic of the lesson.

VIII. Look through the latest magazines and find additional information on the topic of the lesson. Discuss it.

III. GRAMMAR EXERCISES

I. a) Analyse the following sentences. Define subjects and predicates in the principle and in subordinate clauses. b) Translate these sentences.

1. The standard telephone lines are limited by their upper frequency since they were designed to carry only voice traffic that is only analogue type signals. 2. This is a most popular data transmission configuration, as it can be used in any public telephone network. 3. There are many different types of pulse waveform code formats which may be used in binary data transmission.

II. Define the form and function of the Infinitive in these sentences and translate them.

1. In order to transmit digital data over these lines the data generated by the computer or by the terminals must be converted into analogue signals so that they can be transmitted in their encoded form over the ordinary telephone lines. 2. The data to be transmitted must first be encoded into a form suitable for specific transmission handling, as the transmission over a communication line produces attenuation and phase delay; it is impractical to transmit the digital pulses in their raw form over telephone lines. 3. It is necessary to modulate the data to be transmitted over analogue telephone lines and to demodulate the signal at the receiver end.

III. Find the Participles in these sentences, state their forms and function and translate sentences with them.

1. Fig. 6.2*a* illustrates the basic elements required for digital data transmission. 2. Half binary transmission, where only the "1" 's are transmitted, having the "0"'s recognized by the absence of a pulse at the time of clock. 3. The information stored in a word of this type can be directly referenced through the use of one address.

Lesson 4. MULTIPLEXORS AND CONCENTRATORS

I. Independent Work.
In the Laboratory.
1. *Skimming Reading.*
Pre-text Exercises.
Text A. Sharing the Line Resources.
2. *Average Reading.*
Text B. Frequency-division Multiplexor.
Assignments.
II. Classwork.
3. *Close Reading.*
Pre-text Exercises.
Text C. Switching Centres.
Assignments.
4. *Searching Reading.*
Pre-text Exercises.
Text D. Microprocessors.
Assignments.
III. Grammar Exercises.

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Make sure that you know these words. Say what Russian words help you to guess their meanings. b) Repeat these words after the speaker.

Multiplexor, concentrator, transmission, reconstruction, alternative, principle, provision, centre, location, computer, configurate,

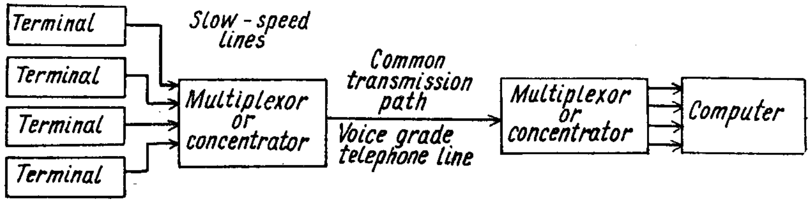


Fig. 6.5. The principle of sharing the line between a number of terminals.

microprocessor, plan, arithmetic, telephone, program, electronically, detail, musical.

II. Listen, repeat and memorize the following words and word-combinations. b) Check if you know their meanings.

Multiplexor устройство цифрового группообразования, уплотнения; мультиплексор; fixed predetermined method постоянный заранее заданный метод; overlapping перекрытие; encroaching вторжение, проникновение; carrier trunk system магистральная высокочастотная система; frequency-division multiplexor мультиплексор с частотным разделением; resource ресурс (*линии связи, машины и т. п.*); share разделять, распределять; allocation распределение, разделение, прикрепление; to smooth сглаживать; frequency slot частотный сегмент; guard band защитная полоса; voice grade line высококачественная телефонная линия; wide-band cable широкополосный кабель.

III. Give the initial forms of the following words and translate them.

Operating, sending, transmission, reconstructing, receiving, utilization, sharing, dynamically, randomly, arrangement.

Text A

SHARING THE LINE RESOURCES

I. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

The principle of sharing the same line between a number of terminals is shown in Fig. 6.5. The multiplexor or the concentrator combines several different signals operating at low speed, sending them simultaneously over the same transmission path and then reconstructing them again at the receiving end.

Communication multiplexors generally refer to the direct utilization of the transmission path by the sharing of the resources of time or frequency. In other words, the sharing is based on the static allocation of the resources by means of a fixed predertermined method. The concentrators also share the resources, but in contrast to multiplexors, they utilize the line dynamically. In this case, the line resources are shared randomly and not according to a fixed arrangement. With the concentrators better efficiency can be obtained. The function of the concentrator is to smooth the data flow in the transmission path.

2. Average Reading

Text B

FREQUENCY-DIVISION MULTIPLEXOR

I. a) Listen to the text. b) Read it (time limit is 2 min.). c) Explain the function of frequency-division multiplexor.

Frequency-division multiplexors share the frequency spectrum of the transmission path among a number of data channels. Each data channel receives a unique frequency band which is permanently allocated to the channel. If the full bandwidth F is divided into R channels, then each channel has the frequency bandwidth of F/N. However, each channel can transmit at speeds far less than the frequency slot of F/N available to it. The limitation is due to the need of guard band between adjacent channels. The guard frequency bands prevent any sideband signals from overlapping and encroaching on the adjacent channels.

The frequency-division multiplexing the transmission of the data in all the channels is in parallel form. Alternatively, each channel can transmit a bit belonging to the same character, thus transmitting the character in parallel. Frequency-division multiplexors may be used to share a one voice grade line among a number of slow-speed terminals, or alternatively may be used to share a wide-band cable among a number of voice channels.

ASSIGNMENTS

I. a) Choose the key sentences from the text A and compare them with the title of the text. b) Say what the text is about.

II. Skim through the text B and find the part of it dealing with the data channels.

III. Find the part of the Text B containing information about the limitation of channels.

IV. Answer the following questions.

1. What signals does the multiplexor or concentrator combine? 2. What do communication multiplexors generally refer to? 3. What do frequency-division multiplexor share? 4. What does each data channel receive? 5. What frequency bandwidth has each channel if the full bandwidth F is divided into R channels? 6. At what speed can each channel transmit? 7. What is the limitation due to? 8. What do the guard frequency bands prevent? 9. What is the form of the transmission of the data in all the channels in frequency-division multiplexing?

V. Prepare a dialogue on frequency-division multiplexors.

VI. Speak on multiplexors and concentrators.

VII. Examine Fig. 6.5 and comment on the principle of sharing the line between a number of terminals.

VIII. Make a short summary of the Text B.

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these words and word-combinations.

Switching centres коммутационные центры; on the principle of point to point на основе прямой связи (каждый с каждым); no provision for alternative routines без обеспечения альтернативных маршрутов; data flow поток данных; fair-sized traffic изрядная нагрузка; comprehensive terminal-to-terminal communication обширная связь между оконечными устройствами; hub центр; star network звездная сеть; "torn tape" switching centre коммутационный центр с обрывом ленты; one of the links is down одна из линий выходит из строя; non-switched некоммутируемый; to bring *sд.* вывести; to effect *sд.* приводить к; spread распространение; rout маршрутизировать, направлять.

II. a) Pay attention to the attributes in these word-combinations and define the part of speech they are expressed by. b) Translate them.

The simplest communication network; sophisticated communication network; a comprehensive terminal-to-terminal communication; large communication installation; many switching centres; local switching centres; each centre functions; other associated terminals.

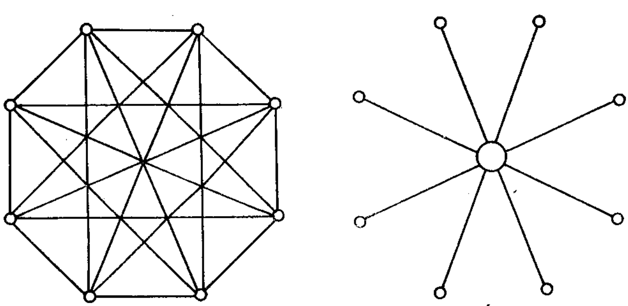
Text C

SWITCHING CENTRES

I. a) Read the text. b) Speak on the switching centres.

All the simplest communication networks are operated on the principle of point to point with no provision for alternative routines. As the network grows, the efficiency is correspondingly reduced.

In sophisticated communication networks, the data flow is not only from the terminals to a centre; there is also considerable traffic



a *b*

Fig. 6.6. The types of switched networks:
a the non-switched network; *b* the central switched network.

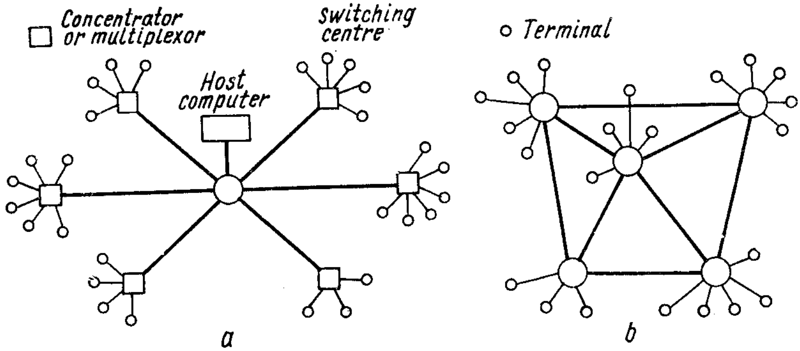


Fig. 6.7. The structure of large communication networks:
a with one switching centre; *b* with many switching centres.

between terminal and terminal. In large network there could be a multiplicity of computers distributed over wide geographical locations, where there is a fair-sized traffic between the computers. This type of communication network configuration is common in Command and Control Systems.

To achieve a comprehensive terminal-to-terminal communication in a simple network, each terminal must be connected directly to all the others. That is, all the terminals have point-to-point lines between them, as shown in Fig. 6.6*a*, which illustrates the ability of all the terminals to communicate at the same time. This network (which is known as non-switched) is obviously impractical for large networks. Therefore, the only possible course is to bring all the terminal lines to a central location, as shown in Fig. 6.6*b*. The introduction of the centre switching which exploits the whole network (and not just a single transmission path) and effects a saving in communication lines. The centre station is located at the hub of the communication network, linking all the remote stations in a configuration known as a star network (Fig. 6.7*a*).

In large communication installation, such as Command and Control Systems, there could be many switching centres in the network (as shown in Fig. 6.7*b*). The spread of computer resources over wide geographical locations requires local switching centres that can communicate with other remote centres. Each centre functions as a unique unit whose purpose is to switch and route message from any of the terminals associated with it to any other associated terminal or centre in the network.

ASSIGNMENTS

I. a) Divide the text into logical parts. b) Find the key sentences, analyse and translate them.

II. Find the part of the text containing information about terminal-to-terminal communication. Translate it.

III. Skim through the text and find the part of it dealing with the introduction of the centre switching which exploits the whole network.

IV. Answer the following questions.

1. On what principle are all the simplest communication networks operated? 2. What must be done to achieve a comprehensive terminal-to-terminal communication in a simple network? 3. What does the spread of computer resources over wide geographical locations require? 4. What is the purpose of each centre functioning as a unique unit?

V. Prepare a dialogue on your own situation.

VI. Speak on switching centres according to your own plan.

VII. Translate the Text C to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

follow	принцип управления с помощью «хранимой программы»
pocket calculator	*зд.* ручка управления
plenty	вязальные иглы
to trigger an alarm	*зд.* придерживаться, следовать
grading potatoes	поднимать тревогу
knitting	*зд.* множество
timing heart-beats	подсчет количества ударов сердца
the principle of "stored program control"	сортировка картофеля
kitchen	вязание
knob	карманный калькулятор
clockwise	по часовой стрелке
knitting needles	кухня

II. Translate the following word-combinations from the Text D. Use them retelling the text.

The plan can be anything you like; people often think of; so they can, of course; since arithmetic operations can be represented as; but there are plenty of other kinds of; that can be expressed, precisely, as; it is a truly general-purpose information-processing device; in other words, control its operation; taking the form of the program of instructions to be executed; it is no good saying; the program must be expressed in; this is why it can't recognize; to take action on the outside world; a connection must be provided between; we will have more to say about interface later.

Text D

MICROPROCESSOR

I. Read the text and say about microprocessors.

A microprocessor is a device that follows a plan. The plan can be anything you like, provided it can be specified exactly as a sequence of steps. People often think of microprocessors as performing arithmetic, like a pocket calculator. So they can, of course, since arithmetic operations can be represented as plans — think of the procedure for addition, or long division. But there are plenty of other kinds of plan. Simply counting events can be expressed as a plan. Or triggering an alarm when certain conditions are met (the conditions must be stated precisely, like "temperature greater than 80°C, rather than "dangerously hot"). Or dialling telephone digits. Or associating a list of telephone numbers with names. Or grading potatoes, knitting, timing heartbeats.

A microprocessor can do any information-processing task that can be expressed, precisely, as a plan. It is truly general-purpose information-processing device. The plan which it is to execute — which will, in other words, control its operation — is stored electronically. This is the principle of "stored program control". Without a program the microprocessor can do anything. With one, it can do anything.

The way you have to formulate a plan for a microprocessor is quite different from how you would do it for a person. A microprocessor's plan must be procedure-directed; taking the form of a program of instructions to be executed to accomplish the result. It is no good saying "go into the kitchen and turn the knob on the wall 3 degree clockwise" — which route should be taken?— what if the door is closed? — which wall? — where on the wall? The program must be expressed in miniscule steps of detail. To get a microprocessor to do something, we must ourselves know how to do it, in detail. This is why it can't recognize faces — although we can, we don't know how.

Furthermore microprocessors can only perform information-processing tasks. To take action on the outside world, or to receive signals from it, a connection must be provided between the microprocessor's representation of information (as digital electronic signals) and the real-world representation — like dots of light on a display screen, or a musical note, or a motion of knitting needles. Such a connection between information representations is called an "interface".

ASSIGNMENTS

I. Answer the following questions.

1. What device is a microprocessor? 2. What is a microprocessor like? 3. Can counting events be expressed as a plan? 4. What is the way to formulate a plan for a microprocessor? 5. Can we get a microprocessor to do anything? 6. What can microprocessor perform?

II. Ask additional questions on the Text D and answer them. Work in pairs.

III. Discuss the problem of microprocessors.

IV. Express your opinion of the problem.

V. a) Look through the latest magazines and find the information on the topic. b) Prepare a short report using the information.

III. GRAMMAR EXERCISES

I. Define the function of the *ing*-forms in these sentences and translate them.

1. The multiplexor or the concentrator combines several different signals operating at low speed sending them simultaneously over the same transmission path and then reconstructing them again at the receiving end. 2. Communication multiplexors generally refer to the direct utilization of the transmission path by the sharing of the resources of time or frequency. 3. When voice grade lines are used with frequency division multiplexors, only a total maximum speed of about 2000 bits/s can be reached. 4. The principle of sharing the same line between a number of terminals is shown in Fig. 6.5. 5. There could be many switching centres in the network.

II. State the function of the Participle in these sentences and translate them.

1. The sharing is based on the static allocation of the resources by means of a fixed predetermined method. 2. There could be a multiplicity of computers distributed over wide geographical locations. 3. The centre station is located at the hub of the communication network linking all the remote stations in a configuration known as a star network.

Lesson 5. PROGRAMMING

I. Independent Work.
In the Laboratory:
1. *Skimming Reading.*
Pre-text Exercises.
Text A. Algorithm, Flowcharts and Computers.
2. *Average Reading.*
Text B. Variables.
Assignments.

II. Classwork.
3. *Close Reading.*
Pre-text Exercises.
Text C. High-quality Program.
Assignments.
4. *Searching Reading.*
Pre-text Exercises.
Text D. Replacement of Values.
Assignments.

III. Grammar Exercises.

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Make sure that you know these words. Say what Russian words help you to guess their meanings. b) Repeat these words after the speaker.

Algorithm, instruction, class, problem, complex, geometric, adequate, basic, element, practical, formal, programmer, information, fundamental, mathematical, nature, telephone, automated, minimum, documentation, program, standard, structure.

II. a) Listen, repeat and memorize the following words and word-combinations. b) Check if you know their meanings.

Flowchart блок-схема (*в программах*); unambiguous точный, недвусмысленный; ordered set of instructions упорядоченный набор команд; lead to приводить к; problem задача; abbreviated сокращенный; not an adequately precise means не адекватно точное средство; in terms of geometric shapes в терминах геометрических форм; introduce logical ordering through spatial location and flowlines вводить логическое упорядочение с помощью пространственного размещения и линий связи (*в блок-схемах*); in the shape rectangular or rombic boxes в форме прямоугольных или ромбических четырехугольников (*в блок-схемах*); will be acceptable instruction sets for computer будут приемлемыми наборами команд для ЭВМ; formal statements of computer languages формальные предписания (высказывания, операторы) машинных языков; flowchart language язык блок-схем; flowchart actions (in the process and decision boxes) действие по блок-схеме (в четырехугольниках процессов и решений); fundamental similarity фундаментальное подобие; conversion of the algorithm to an operating computer program преобразование алгоритма в рабочую машинную программу; variables переменные; in obtaining values for different quantities в получении (числовых) значений различных величин; finding the best routine for a cross-country telephone call отыскание наилучшего маршрута для телефонного вызова через всю страну; take different values принимать различные значения; separate memory storage location отдельная ячейка ЗУ; lean (on) основываться (на), исходить (из), invent выдумывать, изобретать; HEIGHT высота; NUMBER число; to specify operation on and between задать операции над и между; the storage location we call X ячейка памяти, которую мы назвали X; a string of digits (0s or 1s) последовательность цифр (нулей или единиц); identifier идентификатор; repeatedly повторно, неоднократно; numerical числовой.

III. Translate these word-combinations and use them reading the Text A and the Text B.

For simple task; algorithm may be; to overcome this difficulty flowcharts provide; most flowcharts are developed; it is probable that some day; the value of flowcharts in preparing computer programs can be considered; in a computer, values of variables are contained in; to identify these storage location so that; by doing this we are able to; thus, we use; the content of a storage location may be interpreted as; as might be expected; finally, certain operations of mathematical logic require the use of.

Text A

ALGORITHM, FLOWCHARTS AND COMPUTERS

I. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

An algorithm must provide an unambiguous, ordered set of instructions which lead to a solution for a certain class of problems. For simple tasks, algorithms can frequently be written in an abbreviated form of a natural language such as English. However that natural language is not an adequately precise means of algorithmic expression. To overcome this difficulty, flowcharts provide us with an algorithm language through which we can express various operations in terms of geometric shapes and introduce logical ordering through spatial location and flowlines. Before introducing new elements, however, more needs to be said about the practical uses of flowcharts.

Most flowcharts are developed as an intermediate step in preparing problems for computer solution. It is probable that some day algorithms written in a simplified form of natural language will be acceptable instruction sets for computers. Until then, however, the conversion of algorithms to the formal statements of computer languages must be made by programmers and the best language for the expression of algorithms will remain the flowchart.

The value of flowcharts in preparing computer programs can be considerably increased by designing the flowchart language to treat information flow and flowchart actions (in the process and decision boxes) in a way similar to the actual operations that occur in a computer. This fundamental similarity of operation does not limit the flowchart to a particular computer language, but ensures a minimum amount of difficulty in the final conversion of the algorithm to an operating computer program.

2. Average Reading

Text B

VARIABLES

I. a) Listen to the text. b) Read it (time limit is 3 min.). c) Find the part of it dealing with values of variables.

When we use a computer we are interested in obtaining values for different quantities. These quantities are not always mathematical in nature and may involve such varied tasks as comparison of data, finding the best routine for a cross-country telephone call, or choosing the electrical voltages needed for the operation of equipment in an automated factory.

Quantities which can take different values in the course of computations are called variables. In a computer, values of variables are contained in separate memory storage locations in the computer memory. To identify these storage locations so that the data stored in them can be used in computations and other operations, we normally lean on mathematical tradition and invent variable names such as X, Y, HEIGHT, NUMBER, and so forth. By doing this we are able to specify operations on and between the different variables irrespective of the values actually stored in the memory storage locations. Operations like "Is X the same as Y?" or "Divide HEIGHT by WIDTH" express general relationships independent of the value of the quantities themselves.

When a variable is named, a link is established between the variable name and one particular storage location in the computer memory. That we use of a variable's name in a computer program is actually a reference to the contents of the associated storage location where the value of the variable is stored. A question such as "Is X greater than zero?" is equivalent to asking "Is the content of the storage location we call X greater than the value zero?"

The content of a storage location may be interpreted as a number, as alphabetic characters, or simply as a string of digits (0s or 1s), depending upon the use for which the variable is intended. Remember, the variable name is only an identifier for a particular memory storage location and that we may repeatedly change the value of variables by changing the contents of their storage locations.

There are three main classes of variables used in computers:

1. numeral variables;
2. alphanumeric variables;
3. logical variables.

As might be expected, numerical variables have their value represented by numbers. Alphanumeric variables, in contrast, have values composed of string of alphabetic characters, numerals or other symbols. Logical variables are restricted to just two values TRUE or FALSE or sometimes as YES or NO.

ASSIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about.

II. Skim through the Text B and find the part of it dealing with the use of variable's name. Translate it.

III. Answer the following questions.

1. How can algorithms be written in an abbreviated form? 2. What do flowcharts provide us with? 3. What improvements can be made for better expression of algorithm? 4. What are called variables?

5. What are values of variables contained? 6. What is the use of a variable's name in a computer program?

IV. Prepare a dialogue on your own situation.

V. Speak on the Text B according to your plan.

VI. Make a short summary of the Text B.

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these words and word-combinations.

High-quality высококачественный; lists of qualities список (перечень) качеств; minimum speed and execution минимальные скорость создания и время выполнения (*программы*); efficient use of memory and features эффективное использование памяти и ее особенностей; good documentation and debugging capability хорошая документация (*на программу*) и хорошая способность к отладке (*программы*); modular модульность; maintainability удобство эксплуатации; adaptable адаптируемость, приспособляемость; mandatory обязательный; boundary граница, ограничение; branch instruction команда (раз)ветвления, перехода; clarification прояснение, ясность; will last long after you are gone будет долго служить после того, как вы уйдете; designer разработчик (*программы*); a careful yet important collection тщательная и все же важная подборка; subroutine подпрограмма; header block заголовочный блок, заголовок; full specification полное описание; associated data structure структура соответствующих данных; from this description alone replacement code can be generated из этого описания может быть создан только код замещения; sufficient associated line comments достаточные соответствующие строчные комментарии; non-self-modifying несамомодифицирующийся; position-independent позиционно независимый; by a flowchart с помощью блок-схемы; main program главная программа; should be executable starting at the first location желательно начинать выполнение с первой ячейки; I/0 jump table таблица входных / выходных переходов; partition разделять, расчленять; common sense should prevail здравый смысл должен преобладать; to call fewer than five times вызывать (в главную программу) менее пяти раз; it may be wiser рациональнее (разумнее) будет; instead of JSR/RTS (jump to subroutine / return from subroutine) вместо операторов «переход к подпрограмме» / «выход из подпрограммы».

Text C

HIGH-QUALITY PROGRAM

I. a) Read the text. b) Speak on the qualities of a good program.

Many lists of qualities of a good program exist. Ours include: 1. Correctness. 2. Minimum cost. 2. Minimum speed and execution.

4. Efficient use of memory and features. 5. Good documentation and debugging capability. 6. Modular. 7. Maintainable. 8. Adaptable.

Correctness. Almost everyone will agree that correctness is the most important quality in a program. No one would care much about how short or how fast your program is if it does not work.

Cost versus Speed. Many factors need to be considered when minimizing cost. Execution speed may not be important. But if use of the machine is in constant demand, a fast program is more desirable.

Documentation. A well-documented program is mandatory. Program boundaries and branch instructions need full clarification. Remember that your program will last long after you are gone.

The following documentation standards have been proposed by the designers. They represent a careful yet important collection of rules.

1. Each subroutine should have an associated header block containing at least the following elements:

a. A full specification for this subroutine — including associated data structures — such that from this description alone replacement code can be generated.

b. All usage of memory resources must be defined.

2. Code internal to each subroutine should have sufficient associated line comments to help in understanding the code.

3. All code must be non-self-modifying and position-independent.

4. Each subroutine that includes a loop must be separately documented by a flow chart.

5. The main program should be executable starting at the first location and should include an I/O jump table immediately thereafter.

Modularity and Maintenance. If a program were modular, maintaining and adapting it would be easier than it were not. Modular programming partitions the program into pieces to write an independent module for each. As for the size of each module, common sense should prevail. For instance, suppose that a module consists of only two instructions and is called fewer than five times. It may be wiser to insert the two instructions directly into code instead of using JSR/RTS. It will not save space, but it will save execution time.

ASSIGNMENTS

I. a) Divide the text into logical parts. b) Find the key sentences, analyse and translate them.

II. Find the part of the text containing information about modular programming. Translate it.

III. Answer the following questions.

1. What is the most important quality in a program? 2. What documentation standards have been proposed by the designers? 3. Does modular programming partition the program?

IV. Ask additional questions and answer them. Work in pairs.

V. Prepare a dialogue on your own situation.
VI. Speak on high-quality program according to your plan.
VII. Translate the Text C to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

replacement of values	под меткой B
replacement of the existing value	замена значений
destructive operation	замена существующего значения
under the label B	после выполнения операции замены
following the replacement operation	деструктивная операция — операция с нарушением информации

Text D

REPLACEMENT OF VALUES

I. Read the text and say about replacement of values.

The most basic operation in a computer involves changing the value of a variable. This is accomplished through replacement of the existing value stored in a computer memory by another value. When the existing value is replaced by a new value, the old value is lost forever. Replacement, which is the same as the substitution of a new value, is a distructive operation.

A convenient operation symbol for replacement is ←. If we use this symbol between two variables

A ← B

we interpret this as meaning "Replace the current contents of the storage location corresponding to A by the current content of B". The previous value of A is lost, while the value stored under the label of B remains unchanged. Following the replacement operation, the value of A will be the same as the value of B.

A more general form for the replacement operation can be written as:

variable ← expression

The expression on the right hand side of the arrow may be a constant or a single variable such as:

A ← 3.14	HEIGHT ← 10
C ← B	D ← FISH

The term expression is actually more general than simple constants or single variables. The term expression means any series of data operations among constants and variables that leads to a single value which can be stored in the location identified in the replacement statement.

When a replacement operation is executed by a computer, the following steps are involved;

a. Copies of current values of variables used in expression must be fetched from their locations in the computer memory.

b. Expression must be evaluated, using the rules associated with the operation symbols appear in expression, and reduced to a single value.

c. The value which results from the evaluation of expression must be transferred to the storage location assigned to variable.

ASSIGNMENTS

I. Answer the following questions.

1. What is the most basic operation in a computer? 2. What is replacement? 3. What is a convenient operation symbol for replacement? 4. How can a more general form for the replacement operation be written? 5. What does the term expression mean?

II. Discuss the problem of programming.

III. Express your opinion of the topic of the lesson.

IV. Look through the latest magazines and find additional information on the topic to discuss at the lesson.

III. GRAMMAR EXERCISES

I. Define the tense-forms of the verbs in these sentences and translate them.

1. Algorithm can frequently be written in an abbreviated form of a natural language such as English. 2. The conversion of algorithms to the formal statements of computer languages must be made by programmers. 3. Quantities which can take different values in the course of computations are called variables.

II. Translate these sentences and define the form and function of the Infinitive, Participle or Gerund.

1. Before introducing these new elements more needs to be said about the practical uses of flowcharts. 2. The value of flowcharts in preparing computer programs can be considerably increased by designing the flowchart language to treat information flow. 3. Many factors need to be considered when minimizing cost.

КРАТКИЙ ГРАММАТИЧЕСКИЙ СПРАВОЧНИК

THE PARTS OF SPEECH
(ЧАСТИ РЕЧИ)

Часть речи	Буквенное обозначение	Функция в предложении
A Noun (Существительное)	N	Подлежащее, дополнение, именная часть сказуемого, обстоятельство, определение
A Verb (Глагол)	V	Глагольное сказуемое
An Adjective (Прилагательное)	A	Определение, именная часть сказуемого
A Pronoun (Местоимение)	Pr	Подлежащее, дополнение, определение, именная часть сказуемого
An Adverb (Наречие)	Adv	Обстоятельство
A Numeral (Числительное)	Num	Определение
A Preposition (Предлог)	Prp	Управляет падежом существительного и местоимения
A Conjunction (Союз)	Conj	Вводит придаточное предложение или часть сложносочиненного предложения
An Article (Артикль)	Art	Определитель существительного

THE VERB
(ГЛАГОЛ)

Формы глагола	Буквенное обозначение	Примеры
Неопределенная форма глагола — 1-я основная форма глагола	V_1	to work, to write

Формы глагола	Буквенное обозначение	Примеры
Неопределенная форма глагола без «to»	V	work, write
Present Indefinite (3-е лицо единственного числа)	V_s	works, writes
Past Indefinite — 2-я основная форма глагола	V_2	worked, wrote
Participle II — 3-я основная форма глагола	V_3	worked, written
Глагол в действительном залоге	V_{act}	I **have written** the letter.
Глагол в страдательном залоге	V_{pass}	The letter **has been written**.
Вспомогательный глагол	V_{aux}	**Do** you know English?
Глагол-связка	V_{is}	He **is** a student.
Модальный глагол	V_{mod}	He **can** speak English.
Participle I	V_{ing}	**working, writing**
Герундий	G	after **finishing** school...

Модальные глаголы

Модальные глаголы	Перевод	Примеры
can	*могу, умею*	Every student **can explain** the origin of X-rays.
may	*могу, имею разрешение*	You **may carry** on the experiment in the lab.
must	*должен*	You **must begin** the test.
should	*следует, должен*	You **should work** as much as possible.
would	*обычно* или не переводится	The metal **would rust** in wet air.
ought to	*следует, должен*	You **ought to remember** the names of these students.
shall	*должен* (инструкция)	Where **shall** I **switch** on this device?
will	не переводится или *обычно*	When heated the metal **will expand**.

Модальные глаголы	Перевод	Примеры
need	*нужно, надо*	You **need to devote** particular attention to this phenomenon.
dare	*смею*	He **dared test** this device without permission.

Модальные глаголы и их эквиваленты

Модальные глаголы	Эквиваленты модальных глаголов	Present	Past	Future
can *могу, умею*	**be able to** *быть в состоянии, уметь*	can am / is / are able to	could was / were able to	— shall / will be able to
may *могу, имею разрешение*	**be allowed to** *иметь разрешение*	may am / is / are allowed to	might was / were allowed to	— shall / will be allowed to
must *должен, обязан, нужно*	**have to** *приходится, должен* **be to** *должен*	must have to has to am / is / are to	— had to was / were to	— shall / will have to

Перевод модальных глаголов в сочетании с Perfect Infinitive

Модальные глаголы	Перевод с Perfect Infinitive	Примеры
must	*должно быть* *вероятно*	They **must have completed** this experiment.
can, may	*возможно*	He **can't have explained** this phenomenon. He **may have made** this experiment.
could	*мог (ли) бы*	You **could have applied** that equation.
might	*мог (ли) бы*	Professor **might have explained** this.
should	*следовало бы* *должен был бы*	They **should have calculated** the distance.
ought to	*следовало бы* *должен был бы*	You **ought to have calculated** the distance.

Active Voice
(Действительный залог)

Время	INDEFINITE V	CONTINUOUS to be + V_{ing}	PERFECT to have + V_3
PRESENT Утвер.	I V Все лица кроме — He V_s	I am V_{ing} He is V_{ing} We are V_{ing} (Множ. чис.)	I have V_3 Все лица кроме — He has V_3
Отриц.	I do not V He does not V	I am not V_{ing} He is not V_{ing} We are not V_{ing}	I have not V_3 He has not V_3
Вопрос.	Do I V? Does he V?	Am I V_{ing}? Is he V_{ing}?	Have I V_3? Has he V_3?
PAST Утверд.	I V_2 Все лица	I (he) was V_{ing} We were V_{ing}	I had V_3 Все лица
Отриц.	I did not V	I (he) was not V_{ing} We were not V_{ing}	I had not V_3
Вопрос.	Did I V?	Was I (he) V_{ing}? Were we V_{ing}?	Had I V_3?
FUTURE Утверд.	I (we) shall V You will V	I (we) shall be V_{ing} Все остальные лица You will be V_{ing}	I (we) shall have V_3 You will have V_3
Отриц.	I shall not V	I shall not be V_{ing}	I shall not have V_3
Вопрос.	Shall I V? Will you V?	Shall I be V_{ing}? Will you be V_{ing}?	Shall I have V_3? Will you have V_3?

Passive Voice

(Страдательный залог)

TO BE + V_3

Время	INDEFINITE	CONTINUOUS	PERFECT
PRESENT Утвер.	I am V_3 He is V_3 We are V_3	I am being V_3 He is being V_3 We are being V_3	I have been V_3 He has been V_3
Отриц.	I am not V_3 He is not V_3 We are not V_3	I am not being V_3 He is not being V_3 We are not being V_3	I have not been V_3 He has not been V_3
Вопрос.	**Am I V_3?**	**Am I being V_3?**	**Have I been V_3?**
PAST Утвер.	I (he) was V_3 We were V_3	I (he) was being V_3 We were being V_3	I had been V_3
Отриц.	I (he) was not V_3 We were not V_3	I (he) was not being V_3 We were not being V_3	I had not been V_3
Вопрос.	**Was I V_3?** **Were we V_3?**	**Was I being V_3?** **Were we being V_3?**	**Had I been V_3?**
FUTURE Утвер.	I (we) shall be V_3 You will be V_3	—	I (we) shall have been V_3 You will have been V_3
Отриц.	I shall not be V_3	—	I shall not have been V_3
Вопрос.	**Shall I be V_3?** **Will you be V_3?**	—	**Shall I have been V_3?** **Will you have been V_3?**

Неличные формы глагола

Виды	Название формы	Залог	Структура	Примеры
Infinitive	Indefinite	Act. Pass.	V_1 to be V_3	to write to be written
	Continuous	Act.	to be V_{ing}	to be writing
	Perfect	Act. Pass.	to have V_3 to have been V_3	to have written to have been written
	Perfect Continuous	Act.	to have been V_{ing}	to have been writing
Gerund	Indefinite	Act. Pass.	V_{ing} being V_3	writing being written
	Perfect	Act. Pass.	having V_3 having been V_3	having written having been written
Participle I	Indefinite	Act. Pass.	V_{ing} being V_3	writing being written
	Perfect	Act. Pass.	having V_3 having been V_3	having written having been written
Participle II		Pass.	V_3	written

Формы инфинитива и их перевод

Форма	Структура сочетаемости	Примеры
Indefinite Infinitive	V_1 to be V_3	I am glad **to help** you. Я рад помочь вам. I am glad **to be helped** by you. Я рад, что вы помогли мне.
Continuous Infinitive	to be V_{ing}	I am glad **to be helping** you. Я рад, что помогаю вам.
Perfect Infinitive	to have V_3 to have been V_3	I am glad **to have helped** you. Я рад, что помог вам. I am glad **to have been helped** by you. Я рад, что вы мне помогли.
Perfect Continuous Infinitive	to have been V_{ing}	I am glad **to have been helping** you. Я рад, что помогал вам.

Функции инфинитива в предложении и его перевод

Функция в предложении	Структура сочетаемости	Переводится	Примеры
Подлежащее	V_1 V_{is} ...	инфинит. существ.	**To research** this phenomenon is of paramount importance. **Исследовать** это явление очень важно.
Часть именного сказуемого	... V_{is} V_1	инфинит. сущест.	The task **is to develop** new methods. Задача — **разработать** новые методы.
Часть модального сказуемого	... V_{mod} V	инфинит.	A machine **can change** a stored number. Машина **может изменить** накопленное число.
Дополнение	$V_{сказ.}$ V_1	инфинит. существ.	He **was allowed to demonstrate** his new device. Ему **разрешили продемонстрировать** свой новый прибор.
Определение	NV_1 $V_{сказ}$	существ. с предлогом или придат. предлож.	The problem **to be solved** is very important. Проблема, **которую нужно решить, (для решения)** очень важна.
Обстоятельство цели	V_1 ... N $V_{сказ.}$ N $V_{сказ.}$ V_1 ...	обстоят. придат. предлож. с союзами «чтобы», «для того, чтобы»	**To prove** his discovery the scientist made many experiments. **Чтобы доказать** свое открытие ... The scientist made many experiments **to prove** his discovery. Ученый провел много опытов, **чтобы доказать** свое открытие.

Инфинитивный определительный оборот

Придаточные предложения, заменяемые оборотом	Оборот	Структура	Переводится	Употребление
Определительные придаточные предложения: а) The problem **which is to be solved** is very important. Задача, которую нужно решить, очень важная.	Определительный инфинитивный оборот: The problem **to be solved** is very important.	N (Pr) V_1 ...	определительным придаточным предложением с модальным сказуемым или со сказуемым в будущем времени	Заменяет определительное придаточное предложение, относящееся к любому члену предложения.
б) We must know operations **that will be performed in this unit.** Мы должны знать операции, которые будут происходить в этом блоке.	We must know operations **to be performed in this unit.**	... N (Pr) V_1		
в) He was the first **who used** our results. Он первый использовал наши результаты. (Он был первым, кто использовал . . .)	He was the first **to use** our results.	N (Pr) V_{is} Num V_1	простым или сложноподчиненным предложением	

Инфинитивный оборот «for-phrase»

Придаточные предложения, заменяемые оборотом	Оборот	Структура	Переводится	Употребление
Придаточные предложения-подлежащие: It is necessary **that he should test his device.**	For-phrase It is necessary **for him to test** his **device.**	for N (Pr) V_1	простым или сложноподчиненным предложением	После главного предложения типа: it is necessary, it is important, etc.
Необходимо, чтобы он испытал свой прибор. (Ему необходимо испытать свой прибор.)				
Обстоятельственные придаточные предложения: Professor explained the diagram once more **that we might understand it better.**	For-phrase Professor explained the diagram once more for **us to understand it better.**	for N (Pr) V_1	обстоятельственным придаточным предложением цели	Заменяет придаточное предложение цели
Профессор объяснил схему еще раз, чтобы мы лучше ее поняли.				
In order to be a good conductor a wire must be made of low resistance material.	**For a wire to be a good conductor** it must be made of low resistance material.			
Для того чтобы привод был хорошим проводником, он должен быть изготовлен из материала, обладающего низким сопротивлением.				

Инфинитивные и причастные обороты

«СЛОЖНОЕ ПОДЛЕЖАЩЕЕ»

Придаточные предложения, заменяемые оборотом	Оборот	Структура	Перевод	Употребление
Придаточные-подлежащие: а) It is said that he tests the device. Говорят, что он испытывает свой прибор.	**Инфинитивный оборот:** **He is said to test** the device.	$N (Pr) V_{pass} V_1 \ldots$	Сказуемое предложения переводится неопределенно-личным предложением типа «говорят», «сообщают» и т. п.	а) Заменяет предложения типа: it is said, it is informed, etc. Инфинитивный оборот констатирует факт; причастный оборот показывает процесс действия.
It was seen that the boats were approaching. Видели, как приближались лодки.	**Причастный оборот** **The boats were seen approaching.**	$N (Pr) V_{pass} V_{ing}$		
б) It appears that she is a very good specialist. Оказывается, она хороший специалист.	**Инфинитивный оборот** **She appears to be** a very good specialist.	$N (Pr) V_{act} V_1$	Инфинитив или причастие оборота переводится сказуемым придаточного предложения.	б) С глаголами: to seem, to appear казаться; to prove, to turn оказываться; to be sure, to be certain разумеется; to be likely вероятно.

Инфинитивные и причастные обороты

«СЛОЖНОЕ ДОПОЛНЕНИЕ»

Придаточные предложения, заменяемые оборотом	Оборот	Структура	Переводится	Употребление
Придаточные дополнительные предложения:	**Инфинитивный оборот:**	$\ldots N (Pr_{in})^{*}$ $V (V_1) \ldots$	придаточным дополнительным предложением	Заменяет дополнительное придаточное предложение после глаголов:
а) I want **that he would carry this experiment.**	I want **him to carry this experiment.**			а) выражающих желание — инфинитив с частицей «to»;
Я хочу, чтобы он провел этот эксперимент.				
б) We suppose **that his article has been published.**	We suppose **his article (to) have been published.**			б) требующих винит. падежа — инфинитив с частицей «to» и без нее;
Мы полагаем, что его статья уже опубликована.				
в) I heard **that he entered the Institute.**	I heard **him** enter **the Institute.**			в) выражающих физическое восприятие — инфинитив без частицы «to».
Я слышал, что он поступает в институт.				
	Причастный оборот:	$\ldots N (Pr_{in})\ V_{ing}$		Инфинитивный оборот констатирует факт; причастный оборот показывает процесс действия.
I heard **how he was answering.**	I heard **him answering.**			
Я слышал, как он отвечает.				

* Символ Pr_{in} обозначает «местоимение в косвенном падеже».

Формы и функции причастия в предложении и его перевод

Форма	Функция в предложении	Структура сочетаемости	Переводится	Примеры
Participle I а) V_{ing}	Определение	V_{ing} N …	причастием на -ущий, -ющий, -ащий, -ящий	The **flying** plane. **Летящий** самолет. The plane **flying** with great speed. Самолет, **летящий** с большой скоростью.
	Обстоятельство	(When, while) V_{ing}	деепричастием на -я, или придат. предлож.	(When) **making** experiments the scientist watched a new phenomenon. **Экспериментируя,** ученый **(когда ученый проводил опыты,** он) наблюдал новое явление.
б) being V_3	Определение	N being V_3	причастием на -мый или придат. предлож.	The experiments **being conducted** are based on Newton's laws. **Проводимые** опыты (Опыты, **которые проводятся)** основаны на законах Ньютона.
	Обстоятельство	being V_3 N	деепричастием с «будучи» или придат. предлож.	**Being pressed** by a force the body moves. **Если на тело давит сила,** оно движется.
Perfect Participle а) having V_3	Обстоятельство	having V_3 … N V …	деепричастием на -в	**Having tested** a new engine they put it into operation. **Испытав** новый двигатель, они запустили его в работу.
б) having been V_3	Обстоятельство	having been V_3 N V …	деепричастием с «будучи» или придат. предлож.	**Having been** carefully **tested** the device was put into operation. **После того как прибор** тщательно **проверили,** его запустили в работу.
Participle II V_3	Обстоятельство	Conj. V_3 N …	деепричастием или придат. предлож.	**Though conducted** carefully the test did not give the expected results. **Несмотря на то, что испытание было** тщательно **проведено,** оно не дало желаемых результатов.
	Определение	N V_3	причастием на -ный, -тый или придат. предлож.	The method **used** was developed in our Institute. **Использованный** метод разработан в нашем институте. An external force **applied** to the body sets it in motion. Внешняя сила, **приложенная** к телу, приводит его в движение.
		V_3 N…		Any **applied** force sets the body in motion. Любая **приложенная** сила приводит тело в движение.

Независимый (самостоятельный) причастный оборот

Предложения, заменяемые оборотом	Оборот	Структура	Переводится	Употребление
Обстоятельственные придаточные предложения условия, времени и др.: **As electrical energy is released** electromotive force is developed.	**Electrical energy being released,** electromotive force is developed.	N (Pr) V_{ing}, N V ...	придаточным обстоятельственным предложением с союзами: «так как», «когда», «если», «после того как» и др.	Заменяет придаточное обстоятельственное предложение с собственным подлежащим, отличным от подлежащего главного предложения
По мере того как освобождается электрическая энергия, развивается электродвижущая сила.				
Часть сложносочиненного предложения: This field can be detected by an electroscope **and the strength is measured by an electrometer.**	This field can be detected by electroscope, **the strength being measured** by an electrometer.	N V ... , N (Pr) V_{ing}	сложносочиненным предложением с союзами: «а», «но», «и», «причем»	
Это поле может быть определено электроскопом, а сила измерена электрометром.				

Формы герундия и их перевод

Форма	Структура сочетаемости	Примеры
Indefinite Gerund	V_{ing} being V_3	I learned of his **going** to the conference. Я узнал, что он едет на конференцию. I learned of his **being sent** to the conference. Я узнал, что его посылают на конференцию.
Perfect Gerund	having V_3 having been V_3	I learned of his **having been** there. Я узнал, что он был там. I learned of his **having been sent** there. Я узнал, что его посылали туда.

Функции герундия в предложении и его перевод

Функция в предложении	Структура сочетаемости	Переводится	Примеры
Подлежащее	G ... V	инфинит. существ.	**Demonstrating** this law experimentally is rather easy. **Продемонстрировать** этот закон экспериментально довольно легко.
Часть именного сказуемого	N V_{is} G	инфинит. существ.	Our task is **experimenting**. Наша задача — **экспериментировать.**
Часть сложного глагольного сказуемого	N V G	инфинит. существ.	They began **experimenting**. Они начали **экспериментировать (эксперименты).**
Определение	N Prp G ...	существ.	There are many methods of **solving** this problem. Есть много методов **решения** этой задачи.
Прямое дополнение	N V G	существ. инфинит.	He likes **experimenting**. Он любит **экспериментировать.**

Продолжение таблицы

Функция в предложении	Структура сочетаемости	Переводится	Примеры
Предложное дополнение	... V Prp G ...	инфинит. существ. придат. предлож.	He thought of **travelling** in outer space. Он думал **летать** в космосе. Он думал о том, **чтобы летать** в космосе.
Обстоятельство	Prp G ... N V N V ... Prp G	существ. с предлогом деепричаст. оборот	On **receiving** wrong results one must repeat the experiment. **Получив (после получения)** неправильные результаты, необходимо повторить эксперимент.

Перевод герундиальных оборотов

Придаточные предложения, заменяемые оборотом	Оборот	Структура	Переводится
Придаточные-подлежащие: **That he is sent to the plant** is very important.	Герундиальный оборот: **His being sent to the plant** is very important.	N's (Pr's) G	придаточным предложением с союзом «то, что»; существительное или местоимение в притяжательном падеже вместе с герундием переводятся подлежащим и сказуемым придаточного предложения.
То, что его посылают на завод, очень важно.			
Дополнительные придаточные предложения: They informed **the plane had arrived.**	They informed **of the plane having arrived.**	Prp N G ...	придаточным дополнительным предложением
Они сообщили, что самолет уже прибыл.			

Продолжение таблицы

Придаточные предложения, заменяемые оборотом	Оборот	Структура	Переводится
Обстоятельственные придаточные предложения: **After they had introduced a new method of building** they constructed the plant in time.	**After having introduced a new method of building** they constructed the plant in time.	Prp G ...	существительным с предлогом, деепричастным оборотом, придаточным обстоятельственным предложением
После того как они ввели новый метод строительства, они смогли построить завод к сроку.			

Перевод герундия с некоторыми предлогами

Структура с предлогом	Переводится	Примеры
by G	предлогом **при, при помощи** и существительным; **посредством** и существительным; деепричастием	**By repeating** experiments one gets more data. **При повторении** экспериментов (повторяя эксперименты) получают больше данных.
in G	предлогом **при** и существительным; деепричастием	**In melting** the ice keeps the same temperature. **При таянии** (тая) лед сохраняет ту же температуру.
on G	предлогами **по, после** и существительным; деепричастием совершенного вида	**On being heated** to a sufficient temperature any body becomes a source of light. **После того как** тело **нагрето** до соответствующей температуры, оно становится источником света.
without G	отрицательной формой деепричастия;	The students understood the article **without translating** it. Студенты поняли статью, **не переводя** ее.

Согласование времен в дополнительных придаточных предложениях

Форма глагола главного предложения	Структура	Форма глагола придаточного предложения	Структура	Отношение к действию главного предложения	Переводится
Past Indefinite	V_2	Past Indefinite Past Continuous	V_2 was V_{ing} were V_{ing}	Одновременное действие	глаголом в настоящем времени
		Past Perfect	had V_3	Предшествующее действие	глаголом в прошедшем времени
		Future-in-the-Past	should V would V	Будущее действие	глаголом в будущем времени

He said that he **worked** at the Institute.
Он сказал, что **работает** в институте.
He said that he **had worked** at the Institute.
Он сказал, что **работал** в институте.
He said that he **would work** at the Institute.
Он сказал, что **будет работать** в институте.

Наклонение (Mood)

(Показывает отношение говорящего к высказываемому)

Виды наклонений	Употребление	Что выражает	Структура сочетаемости	Примеры
Изъявительное наклонение (Indicative Mood)	В простых, сложносочинённых и сложноподчинённых предложениях	Нейтральное отношение к высказываемому	N V (все виды и времена)	A digital computer is composed of 5 functional units.
Повелительное наклонение (Imperative Mood)	В простых и главных предложениях	Повеление, приказ, просьбу, побуждение к действию	V N Let Pr V V conj...	Launch the rocket! Let's take this rule! Assume that these data are correct.

Виды наклонений	Употребление	Что выражает	Структура сочетаемости	Примеры
Сослагательное наклонение (Subjunctive Mood)	В простых и главных предложениях	Предположение полуреальное (исполнимое)	should V would V	I should receive this result myself. What our work would be like?
		Предположение нереальное (не исполнимое)	should have V_3 would have V_3	I should have done it. She would have submitted the article.
	В придаточных предложениях	Возможность, цель, боязнь, необходимость, требование, предложение и т. п.	should V	Be careful lest current should not be switched on.
		Полуреальное желание, условие, уступка, сравнение.	V_2	If there were no computer to assist calculations ...
		Нереальное желание, условие и т. п.	had V_3	If it had been found at that time ...

Бессоюзные придаточные предложения

Вид придаточного предложения	Придаточное предложение с союзом	Придаточное предложение без союза
Дополнительное	He said **that** the plane would land in Moscow.	He said the plane would land in Moscow.
	Он сказал, что самолет приземлится в Москве.	
Условное	**If** the wire were moved in the opposite direction, the induced e. m. f. and current would reverse direction.	Were the wire moved in the opposite direction, the induced e.m.f. and current would reverse direction.
	Если бы провод подвинуть в противоположном направлении, то индуцируемая ЭДС и ток изменили бы свое направление.	
	If you had tested the device, the circuit would have functioned.	Had you tested the device the circuit would have functioned.
	Если бы вы проверили свой прибор, цепь работала бы.	

Вид придаточного предложения	Придаточное предложение с союзом	Придаточное предложение без союза
Определительное	The building **which** our institute occupies is big.	The building **our** institute occupies is big.
	Здание, которое занимает наш институт, большое.	
	The invention **about which he spoke** at the last lecture is very interesting.	The invention **he spoke about** at the last lecture is very interesting.
	Изобретение, о котором он говорил на прошлой лекции, очень интересное.	

СЛОВООБРАЗОВАНИЕ

НАИВОЛЕЕ УПОТРЕБИТЕЛЬНЫЕ СУФФИКСЫ СУЩЕСТВИТЕЛЬНЫХ И ГЛАГОЛОВ

Суффиксы существительных			Суффиксы глаголов		
-er (-or)	computer	ЭВМ	-ize (-ise)	magnetize	намагничивать
	sensor	датчик	-fy (-ify)	specify	определять
-ist	physicist	физик	-ly	supply	снабжать
-ion	compression	сжатие	-py	occupy	занимать
-tion	acceleration	ускорение	-en	lengthen	удлинять
	computation	вычисление	-ate	separate	отделять
-ity	productivity	производительность			
	conductivity	проводимость			
-ance	maintenance	техническое обслуживание			
	resistance	сопротивление			
-ence	difference	различие			
-ment	equipment	оборудование			
	development	развитие			
-ness	stiffness	жесткость			
-ure	failure	поломка			
-sure	pressure	давление			
-age	voltage	напряжение			
	breakage	поломка			
-ing	shielding	защита			
-ics	physics	физика			
-th	length	длина			

ОСНОВНЫЕ ПРЕФИКСЫ

а) Префиксы с отрицательным значением

un-	unequal	неравный	in-	inaccuracy	неточность
il-	illegal	нелегальный	ir-	irregular	нерегулярный
im-	immovable	неподвижный	dis-	discharge	разгружать
de-	decompose	разлагать		disconnect	разъединять
			non-	non-conductor	непроводник

б) Префиксы с различными значениями

auto-	autocall	автовызов	anti-	antifrictional	антифрикционный
bi-	bipolar	двуполярный	co-	co-existence	сосуществование
counter-	counteract	противодействовать	fore-	foresee	предвидеть
in-	include	включать	mis-	misunderstand	неправильно понять
inter-	interrelation	взаимосвязь	micro-	micro-organism	микроорганизм
mono-	monoplane	моноплан	out-	outlive	пережить
over-	overload	перегрузить	ex-	external	внешний
en-	enlarge	увеличивать		exclude	исключать
post-	post-war	послевоенный	re-	recharge	перезарядить
pre-	pre-war	довоенный	semi-	semiconductor	полупроводник
self-	selfacting	самодействующий	super-	supersonic	сверхзвуковой
sub-	subsonic	дозвуковой	ultra-	ultrasound	ультразвук
	subdivide	подразделить	under-	underground	подземный

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