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RESEARCH OF THE OPERATION PRINCIPLE OF OF THE MULTIPLEXER AND DEMULTIPLEXER USING MODERN PEDAGOGICAL TRAINING TECHNOLOGIES

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Abstract

This article presents a methodological technology for studying digital logic devices. Recommendations on the technology of teaching digital logic devices using rational, best methodological methods and teaching techniques are given. The proposed topic is "Multiplexer and demultiplexer". Studying methods used: modular studying, developmental studying, demonstration (frontal), step-by-step studying, problem-based studying. The process of implementing learning technology explained by the plan prepared for the lesson (mostly the basics of electronics in Kazakhstan are not included into the educational basis of the school and are only taught in higher educational institutions, therefore, the basic learning range, conventionally referred to in the lesson plan, seminars or lectures.

Keywords: digital logic devices, methodical technology, modular studying, multiplexer, demultiplexer.

Аннотация

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ИССЛЕДОВАНИЕ ПРИНЦИПА РАБОТЫ МУЛЬТИПЛЕКСОРА И ДЕМУЛЬТИПЛЕКСОРА С ИСПОЛЬЗОВАНИЕМ СОВРЕМЕННЫХ ПЕДАГОГИЧЕСКИХ ТЕХНОЛОГИЙ ОБУЧЕНИЯ

В данной статье представлены педагогические технологии обучения цифровым логическим устройствам. Даны рекомендации по технологии обучения цифровым логическим устройствам с использованием рациональных, лучших методических методов и приемов обучения. Предлагаемая тема «Мультиплексор и демультиплексор». Используемые методы обучения: модульное обучение, развивающее обучение, демонстрационное (фронтальное), поэтапное обучение, проблемное обучение. Процесс реализации технологии обучения объясняется планом, подготовленным к уроку (в основном основы радиоэлектроники в Казахстане не входят в учебный базис школы, а преподаются только в высших учебных заведениях, поэтому основной спектр обучения, условно именуемый в плане уроком, - семинары или лекции.

Ключевые слова: цифровые логические устройства, методическая технология, модульное обучение, мультиплексор, демультиплексор.

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ҚАЗІРГІ ЗАМАНҒЫ ПЕДАГОГИКАЛЫҚ ОҚЫТУ ТЕХНОЛОГИЯЛАРЫН ҚОЛДАНА ОТЫРЫП, МУЛЬТИПЛЕКСОР МЕН ДЕМУЛЬТИПЛЕКСОРДЫҢ ЖҰМЫС ПРИНЦИПІН ЗЕРТТЕУ

Бұл мақалада сандық логикалық құрылғыларды оқытудың әдістемелік технологиясы көрсетілген. Оқытудың ұтымды, үздік әдістемелік (методикалық) әдіс-тәсілдерін пайдаланып сандық логикалық құрылғыларды оқытудың технологиясы жайлы маңылуматтар берілген. Ұсынылатын тақырып «Мультиплексор мен демультиплексор». Қолданылған оқыту әдіс-тәсілдер: модульдік оқыту, дамыта оқыту, демонстрациялық (фронтальды), кезеңдік оқыту, проблемдік жағдай тұғызып оқыту. Оқыту технологиясының жүзеге асу процесін сабаққа (негізінде радиоэлектроника негіздері Қазақстанда мектептің оқыту базисіне кірмейді, тек жоғарғы оқу орындарында оқытылады, сол себепті жоспарда шартты түрде сабақ деп аталғанынымен негізгі оқыту спектрі семинарлар немесе лекция) дайындалған жоспар арқылы түсіндірілген.

Түйін сөздер: сандық логикалық құрылғылар, әдістемелік технологиясы, модульдік оқыту, мультиплексор, демультиплексор.

Introduction. Video conferencing is one of the most promising areas of use of multiplexers. This type of communication, which is a simultaneous two-way transmission, processing, transformation and presentation of interactive data over a distance in real time. To implement video conferencing and depending on its type are used to group terminals and the individual terminals of the video conference.

The individual terminal uses real-time video communication directly from the workplace. As an individual terminal, it can used both a specialized terminal and various multifunctional devices, such as a personal computer, laptop, mobile phone and others.

Group terminals are used for organizing videoconferencing lectures. When organizing group-type videoconferencing lectures, the picture can be displayed on one common screen. At the same time, each participant's seat is equipped with a group terminal with a microphone and a video camera. Thus, such a system has one common output and many individual inputs, which is provided by the multiplexer.

1. Learning technology.

Theme: « Multiplexer and demultiplexer» [1-3].

Purpose of the lesson: Introduce students to numerical logic devices, their types and principles of their functioning. Including to acquaint students with types, features, principles of operation of the multiplexer and demultiplexer, features of their application

Knowledge (Education): Train students to learn the specifics of digital logic devices and use these digital logic devices, work with them. Introduce students to the basic principles of electronic circuits necessary for future activities, and teach them how to design the simplest electronic structures [4].

Developing: Increase interest in the subject. Develop skills to apply the acquired knowledge in practice, thinking, memory.

Educational: educate accuracy, diligence.

Lesson type: combined lesson. Explanation of the new topic.

Lesson type: nontraditional.

Tools: computer, slides, flowcharts created on a computer.

Plan of the lesson:

1. The organizational stage – 1 min.
2. Repeat of the completed material - 5 min.
3. Explanation of the new topic - 15 min.
4. Demonstration experiments - 10 min.
5. Consolidation of knowledge in the classroom.
6. Submission of homework.
7. Evaluation.

I The organizational stage.

Greetings, students. Sit down, please. Who's absent in today's class?

II Repeat of the completed lesson.

In the section repetition of the past lesson, you must repeat the material of the past lesson.

III Explanation of the new topic.

In this section, we will begin to get acquainted with the basics of the topic under study, that is, the topic "multiplexer and demultiplexer". The main methods used in explaining the lesson are modular, developmental teaching methods and problem situations. The overall learning process is a manifestation of a *step-by-step learning method*.

Modular training technology provides independent training in terms of the content of education, the rate of assimilation of knowledge, the ability to work independently, methods and techniques of training. The training module consists mainly of three structured parts: introductory, conversational and final [3].

In the introductory part, the teacher introduces students to the general structure of the training module, its goals and objectives. Then the teacher briefly (for 10-20 minutes) interprets the training material designed for the entire time of this training module, based on known samples of drawings, tables, etc. The student explains the lesson in his methodology using flowcharts.

2. Introductory part (modular training).

Digital logical devices-are classified into two groups *combinational* and *sequential* logical devices (fig.1) [5, 6].

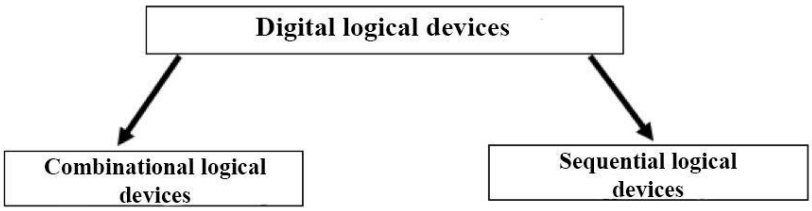

Figure 1. Classification of digital logical devices

Learning on the topic: Digital combination devices.

Combinational device refers to a logical unit, in which the output signal at any given time is determined by the input signal at this time (Fig.2).

There are many types of combinational digital devices: binary codes converters, digital comparators, switches, and binary numbers multipliers, switches, digital signals and other devices are available in the form of microchips and are represented in a truth table of operation or with a detailed description of the timing diagram.

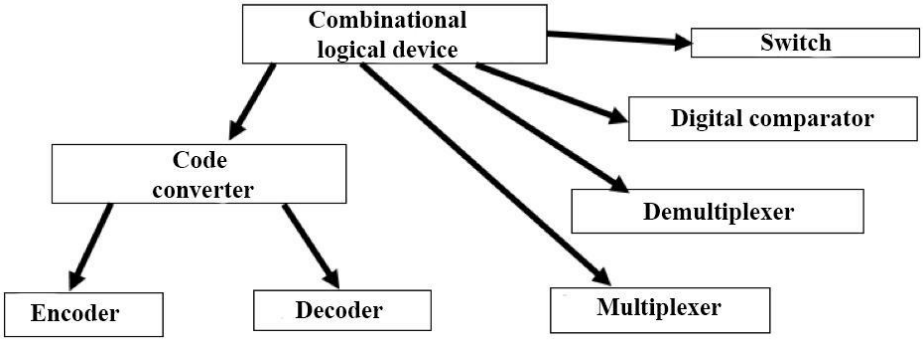

Figure 2. Classification of combinational logic devices

Multiplexer – a multi-stage circuit with one output that switches one of the information inputs to the output. The input of the multiplexer is information $x_1 \dots x_n$ and control (address) $A_k \dots A_k$. The normal number of information inputs is $n = 2^k$, k is the number of address inputs. The code received at the address input determines which of the information inputs should be connected to the output.

The operation of a two-bit multiplexer is shown in the truth table. The operation of the multiplexer is described by the logical equation:

$$F = (\underline{A_1}\underline{A_2})x_1 + (A_1\underline{A_2})x_2 + (\underline{A_1}A_2)x_3 + (A_1A_2)x_4.$$

To create a multiplexer in accordance with the equation there are required 3AND-4OR logic gates and two inverters. The block diagram is shown in Figure 3, the conditional graphic image of the multiplexer is shown in Figure 4.

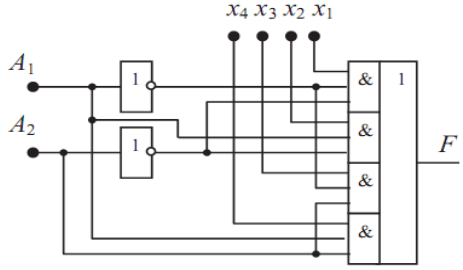

Figure 3. Block diagram of the multiplexer

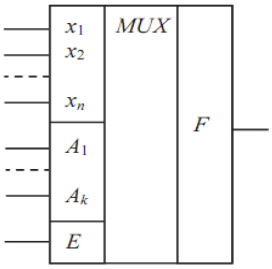

Figure 4. Conditional graphic designation of the multiplexer

Integrated structure multiplexers have one or two permitted *(E)* inputs, except for the address and information inputs. These inputs allow for multiplexer expansion.

Demultiplexer – a circuit that performs the inverse function of the multiplexer, namely one information input, *n* – information outputs F_1 ... F_n [7].

The full demultiplexer has an output of $n = 2^k$, (the state table 1→4 of the demultiplexer is shown below). According to the table, the equation describing the operation of the demultiplexer will look like this:

$$F_1 = x_1 \cdot (\overline{A}_1 \overline{A}_2),$$
$$F_2 = x_1 \cdot (A_1 \overline{A}_2),$$
$$F_3 = x_1 \cdot (\overline{A}_1 A_2),$$
$$F_4 = x_1 \cdot (A_1 A_2).$$

A_2	A_1	F_1	F_2	F_3	F_4
0	0	x_1			
0	1		x_1		
1	0			x_1	
1	1				x_1

To build in accordance with it, two inverters and 4AND elements for three inputs are required. A conditional graphic image of the demultiplesor is shown in Figure 5.

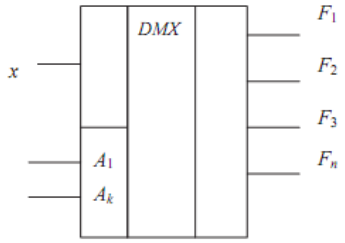

Figure 5. Conditional graphic representation of demultiplexor

A series of multiplexers and demultiplexers formed by bipolar transistors commute only digital signals, i.e. *0* or *1*.

In a series of field-effect transistors, a two-position key is created.

IV The demonstration experiments. Conducting the practice.

In the conversational part (modular study), the cognitive process is based on the interaction of students, mainly by dividing the group into subgroups of 2-6 people. Students choose their own tasks of a particular level. It is not necessary to perform tasks in stages from simple to complex. The student is free to choose a task based on their capabilities [3]. There is another feature of the *conversational part* of the training module. According to the study, the widespread use of active and playful forms of learning allows students to repeatedly return and work on educational material from 13 to 24 times.

This article also uses the developmental learning method and the demonstration (front-end) method of demonstrating the experience. As already mentioned, we divide students into groups, distribute them to the places where they sit, so as not to waste time. That is, in this section, together with students, we perform an experiment on the topic. We practice with students using the electronic program Electronics Workbench. In the process of performing the experiment, in parallel with teaching students to draw a diagram, we analyze the tools used in the diagram. Using the *technology of developing study.*

Table 1

G	*B*	*A*	*Q*
0	*0*	*0*	
0	*0*	*1*	
0	*1*	*0*	
0	*1*	*1*	
1	*0*	*0*	
1	*0*	*1*	
1	*1*	*0*	
1	*1*	*1*	

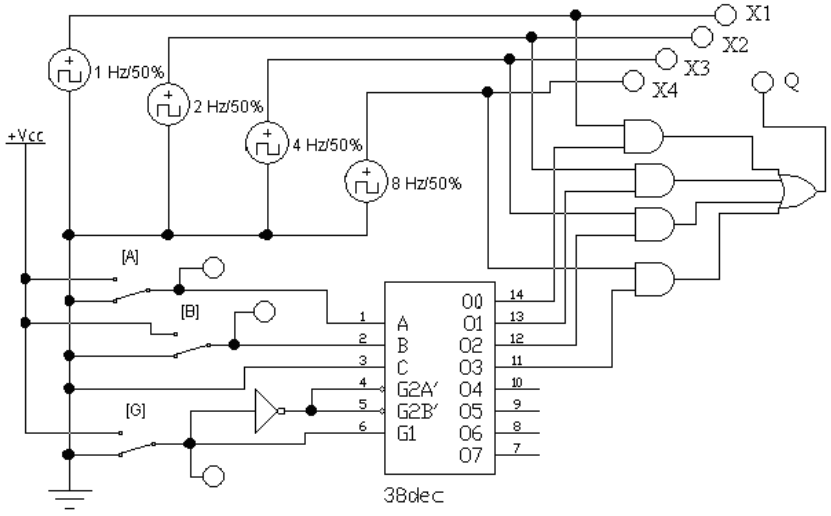

Figure 6. The multiplexer circuit

Build a diagram of the multiplexer according to Figure 6, and study its operation. The used 38dec decoder in the circuit with a three-bit address is used as a decoder with a two-bit address, for which the C-input is grounded. The study is carried out by comparing the input (address) information signals (*A, B, C*) and output (*Q*) signals of the multiplexer, *O1 ÷ O7* - inputs. Display of measurement results as a Table 1. *38dec* chip selection path: *Digital → GenGeneric 3-to-8 Dec → Accept*. In this regard, a group analysis of the decoder and encoder (developing learning technology) is carried out. Each group is asked questions about the decoder and encoder.

Questions:

1. What is an encoder?
2. What are the principles of its operation?
3. What is a decoder?
4. What are the principles of its functioning?

Such questions should be answered by a group.

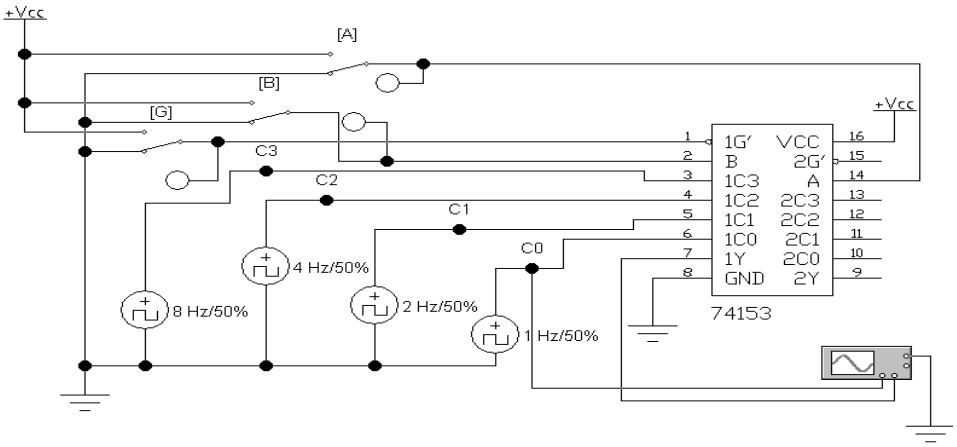

Figure 7. Scheme of research of the multiplexer work 74153

Study of the operation of the multiplexer 74153 according to Figure 7

Designations of the chip 74153 outputs:

1C0÷1C3 – outputs;

GND – general;

VCC – supply voltage + 5 B;

*1*G' – permission input (active level-low);

1Y – direct output;

A, B – address inputs.

The order of execution of the laboratory work:

1. Sequential connection of channel *A* input to points *C0, C1, C2, C3* of the circuit
2. Signal transmission at inputs G, A and B according to Table 1.

The path of the chip selection circuits 74153: *Digital ICs → 741xx Seris → 74153 (Dual 4-to-1 data Sel / MUX) → Accept.*

3. Explain the resulting waveform (Figure 8).

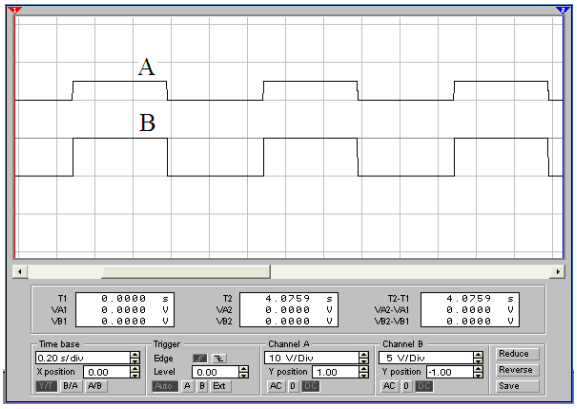

Figure 8. Waveforms of the information channel signal C0 (A) and the output signal (B)

After these practices, students are asked questions about the technology of learning in a problem situation.

Questions:

1. In order to solve what problems is a digital multiplexer used?
2. Where are demultiplexers used?
3. How many outputs can decoders have?
4. On which logic elements are the multiplexer and demultiplexer assembled?

V pinning lesson.

The final part of the training part (*modular study*) is the control part (i.e., consolidation and evaluation). If in the conversational part, students are encouraged to help each other, teach each other, use various scientific sources, then in the final part, the student must demonstrate their knowledge, skills and abilities in the conversational part without assistance. Fixing the lesson consists of two stages. At the first stage, students ' knowledge is differentiated through reflection. The analysis of students ' ideas about the new lesson is carried out. (Reflection-gives information about how much the teacher was able to explain the new lesson to students). The second stage is carried out by setting questions of consolidation. That is, questions are directly asked on a new topic and students ' knowledge is differentiated [3].

Reflection: In the form of reflection, reflexive questions are given.

Reflexive questions:

1. What did you understand in today's lesson?
2. What new concepts have we learned?
3. What new values do you anticipate?
4. What interesting details would you like to know?

Questions for fixation:

1. What are digital combination devices?
2. What are theexisting types of them?
3. What is a multiplexer?
4. What are the principles of the multiplexer?
5. Give examples of how the multiplexer works.
6. What is a demultiplexer?
7. What are the principles of operation of the demultiplexer?
8. Give examples of the operation of the demultiplexer.

VI Homework: Repeat the topic and analyze the experience gained.

VII estimation.

As one of the new assessment methods that meet modern requirements, we propose the following assessment method. The assessment is based on four main criteria (as shown in the Table 2). The first criterion is the assessment of homework, i.e. an analysis of how well you have mastered the topic you have passed, and it is determined and evaluated at what level the homework has been completed. The second criterion is the assessment of student behavior. The third criterion is a criterion for evaluating the activity of students in the classroom, their active participation in the classroom. The fourth criterion, it is designed to evaluate the thinking of students, that is, with the help of this criterion, you can check the logical thinking of students. The level of thinking can be determined as follows - using the elements of learning with the creation of the problem situation using this method students answer a given problematic situation, for example, a question based on that, you can define the logic of the student and assess in the process of consolidating classes. The peculiarity of this assessment is that each criterion is evaluated through a 5-point system, that is, through each criterion, the student receives points. When setting the final grade, the sum of these points is taken into account and the student is given the final grade of the lesson [3].

Table 2

№	*Name*	*For homework (5-points)*	*Discipline(5-points)*	*Activity (5- points)*	*Thinking (5- points)*	*Final grade*
1						
2						
3						

1) Assessment of the student who scored 1-4 points – 2 (0-49);
2) Assessment of the student who scored 5-11 points – 3 (50-69);
3) Assessment of the student who scored 12-15 points – 4 (70-89);
4) Assessment of the student who scored 16-20 points – 5 (90-100).

Conclusion. The advantage of modular training is the individualization of the learning process, the activation of cognitive activity, creative development and self-expression of the individual.

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