PRACTICAL EDUCATIONAL METHODS IN TEACHING THE TOPIC ON AMPLIFIERS

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Abstract. *The article gives recommendations on methods of analysis of the operation of the amplifier cascade using analytical and graphical methods to explain the operation of electronic amplifiers, using the coordinate axis summarizing the output, input, dynamic characteristics and transition characteristics of the amplifier.*

Keywords: *electronic amplifier, workflow, transistor amplifiers, signal dynamic characteristics, input signal, output signal, amplifier cascade, effective lesson, circuit, drawing, graph, chain, element.*

In recent years, in our country the systematic work is being carried out on increasing the quality and effectiveness of the education system, forming modern knowledge and skills in kindergarten trainees, pupils and students, ensuring close cooperation and integration between educational systems and the field of science and integrity and continuity of education.

At the same time, the current state of the national education system requires the implementation of consistent measures to modernize it based on the requirements of the time, to educate young people to be highly educated, physically and spiritually healthy people, to strengthen the authority of the leaders and pedagogues of educational institutions, to create the necessary conditions for their effective operation.

This renewal process, which is being carried out in our society, aims not only at the present, but also at the future of our country, at the great goal of taking its place among the developed countries of the world. To achieve this goal, highly qualified personnel is very necessary. The training of personnel that meets global requirements depends to a large extent on the skills of the pedagogue, the material and technical base, and the organization of the lesson.

In the 21st century, which is called the age of information and high technologies, electronic amplifiers are used in many other fields, such as microcircuits, microelectronics, computer equipment, radioelectronic devices, control and automation of technological processes, robotics, and space exploration.

Analytical and graphic methods are used to explain the working process of electronic amplifiers to students, and the causes of various non-linear distortions that occur in the operation of the amplifier can be shown graphically based on the graphical method. For example, the operation process of the circuit of amplifiers assembled on transistors, the operating mode of the transistor in the normal state can be determined by the graph in Fig. 1., here (that is, the creation of minimal distortions when amplifying signals) is the operating section between the points a^1 b^1, and the point n^1 is expressed in the form of the operating point.

To analyze the operation of the amplifier cascade, it is possible to summarize the output, input, dynamic characteristics and transition characteristics of the transistor, making them the same scale on the coordinate axis, as shown in Fig. 1. In this case, the transition characteristic is calculated analytically rather than experimentally. Figure 1 shows that the input characteristic of the transistor is rotated by 90^0, and the dependence of the input characteristic, the transition

characteristic, and then the output characteristic on the influence of the input signal is expressed. That is, in the set of graphs n^{l}, n and n'' represent the operating points of the transistor, and the interval between the points a', b', a, b, a'', b'' represents the operating section. The interdependence of the change of the base current, the change of the collector current, i.e., the output of the amplifier under the influence of the U_{input} applied to the input of the amplifier, the graphic expression of U_{output} and the input and output signal is clearly shown.

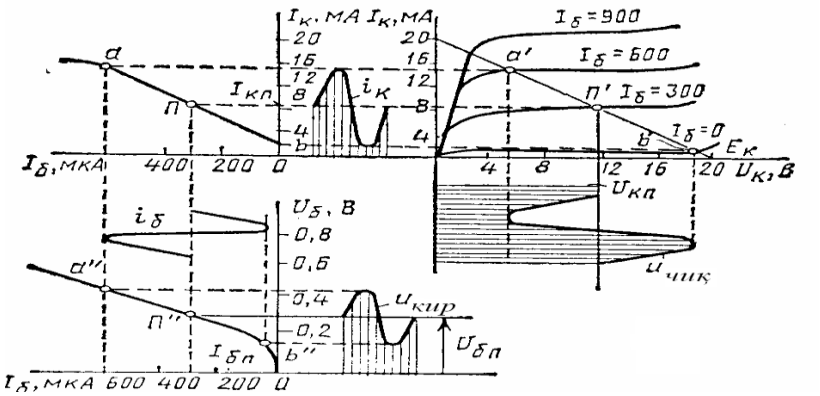

Figure 1

At the output of the amplifier, the value of the amplitude of U_{output} depends on the value of the resistor R_k, and the value of R_k is chosen to be several kOhm.

It can be seen in Figures 1 that when the input signal U_{input} is given, constant I_{bp} and variable i_b components are formed in the base circuit. As a result of their influence, the constant I_{kp} and variable I_k currents are formed in the collector circuit. The change in I_k can be seen through the dynamic line as the voltage changes in R_k with the collector voltage. This drop of potentials consists of two components, constant and variable. The variable component represents the output signal of the amplifier and its value is equal to the value of the output signal and its phase is opposite to the input signal. The value of the output voltage U_{output} is expressed by the following formula: $u_{output} = - R_k i_k$

For the input signal, the equality $u_{input}=R_{kir}i_{kir}$ is suitable. The value of the output signal is several tens, hundreds of times greater than the input signal supplied to the U_{output} amplifier. Because $i_k >> i_b$ and $R_k >> R_{kir}$ are greater and $i_b \approx i_{kir}$. If the input voltage U_{input}, the base current i_b and the collector current i_k lie in the linear part (operating section) of the dynamic characteristic, the appearance of the output signal of the amplifier will be the same as the appearance of the input signal. For example, if the input signal is sinusoidal, the output signal of the amplifier will also be sinusoidal, only the phase will be shifted by 1800.

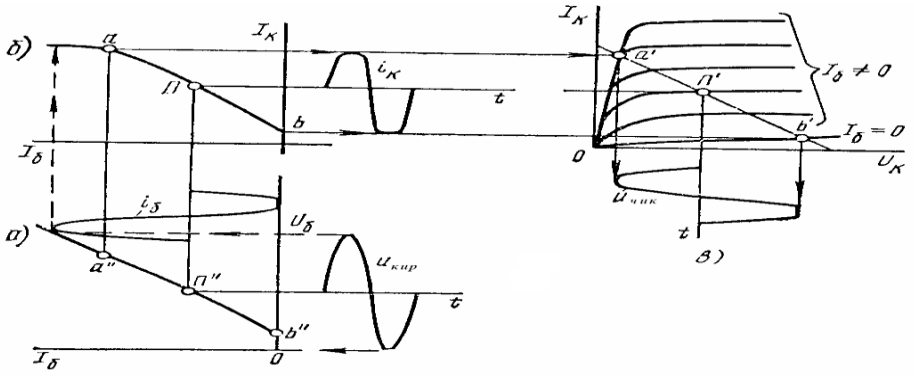

Figure 2

If the amplitude value of the input signal is large and leaves the operating range (outside the operating range, the input and transition characteristics are not linear), the shape of the collector current i_k will be distorted (see Fig. 2).

This causes the shape of the output signal to change. This phenomenon is called output signal distortion. Amplitude characteristic of the amplifier $U_{output}=f(U_{input})$ is used to determine the threshold amplitude of the distortion input voltage (the maximum value at which distortion does not occur).

In practice, the value of the input resistance of the amplifier cascade ranges from several hundred Oms to several kOms. The output resistance is usually greater than the input resistance. Often, the input signal source has a large resistance, and the load resistance is relatively small. Because the connection resistances of the amplifiers differ sharply from each other, connecting the input and output of the amplifier to the signal source and the output load leads to considerable difficulties. That is, the value of the input signal and the value of the signal transmitted to the load cause some absorption. To eliminate this drawback, it is necessary to equalize the source resistance of the input signal with the input resistance of the amplifier, and the output resistance of the amplifier with the resistance of the consumer.

Based on the didactic tasks, taking into account the specialties of the students and the characteristics of the educational materials, the methods of conducting classes on the basics of electrical engineering were selected effectively. At the same time, it is taken into account that the practical use of certain educational methods is combined with the introduction of principles and methods specific to the special didactic purpose that help to form the creative qualities of specialists.

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