ANALYZE THE 2N4427 N-P-N TYPE BIPOLAR TRANSISTOR BY PERFORMING THE FOLLOWING SEQUENCE WHEN DESIGNING A SINGLE-STAGE AMPLIFIER CIRCUIT

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Annotation. In this paper, the design of a single-stage amplifier circuit of a 2N4427 n-p-n type bipolar transistor is analyzed by performing the following sequence.

Keywords: bipolar transistors, capacitor, resistor,oscilloscope,vsine

Transistors are used in electronics to amplify, generate, and switch electrical oscillations. The transistor is a key element of microelectronic devices. Depending on their structure and method of operation, transistors are divided into bipolar and unipolar transistors. The operation of bipolar transistors is based on the p-n junction, while the operation of a unipolar transistor is based on the electric field control of the conductivity of a semiconductor with the same conductivity. The bipolar transistor was proposed in 1949 by U.B. Shockley. A bipolar transistor is a three-electrode semiconductor device consisting of two interacting p-n junctions that amplify signals by current, voltage, or power. Current in a bipolar transistor is based on the motion of two types of charge carriers - electrons and cavities. A bipolar transistor consists of three semiconductors with p-n-p and n-p-n conductivity. In bipolar transistors, the three-layer structure can be of two types. The outer layers that are the source of the charge carriers (electrons and cavities) are called the emitter (E). The layer that receives the charge carriers from the emitter is called the collector (K). The middle layer is called the base (B). The emitter is a semiconductor triode designed to inject non-core charge carriers into the base. The electron-hole transition between the emitter and the base is called the emitter transition [1-3]. When using an n-p-n type transistor, a positive voltage U_P^+ is used to power the circuit. To determine the basic parameters of the amplifying phase, it is first necessary to analyze its mode at constant current.

$U_Э^0$, U_K^0, $U_Б^0$ where the main parameters are the emitter, collector and base voltages, as well as currents, respectively $I_Э^0$, I_K^0, $I_Б^0$, are constant sizes [4].

The given transistor values are as follows:

$U_{KE} = 5V$
$I_K = 100mA$
$\beta = 10$

We calculate the supply voltage U_P as follows

$U_P = U_{KE} * 2 = 5V * 2 = 10V$ $U_P = 10V$ bo'ladi

The resistor voltage in the collector is equal to $\frac{3}{4}$of the U_{RK} collector emitter voltage U_{KE}

$U_{RK} = \frac{3}{4} U_{KE} = \frac{3}{4} * 5V = 3.75V$ $U_{RK} = 3.75V$

Strict control in the emitter:

$U_E = \frac{U_{KE}}{4} = \frac{5V}{4} = 1.25V$ $U_E = 1.25V$

$I_K^0 = \frac{I_K}{2} = \frac{100mA}{2} = 50mA$ $I_K^0 = 50mA$

I calculated the resistance R_K in the collector as follows.

$R_K = \frac{U_{RK}}{I_K^0} = \frac{3.75V}{50mA} = 0.075k\Omega$

$I_E \approx I_K$

The resistance in the emitter R_E was calculated as follows:

$R_E = \frac{U_E}{I_K^0} = \frac{1.25V}{50mA} = 0.025k\Omega$

The total base voltage is equal to the sum of the voltage at the U_B emitter U_E and the base emitter voltage U_{BE} Since $U_{BE} \approx 0.7V$, U_B is equal to

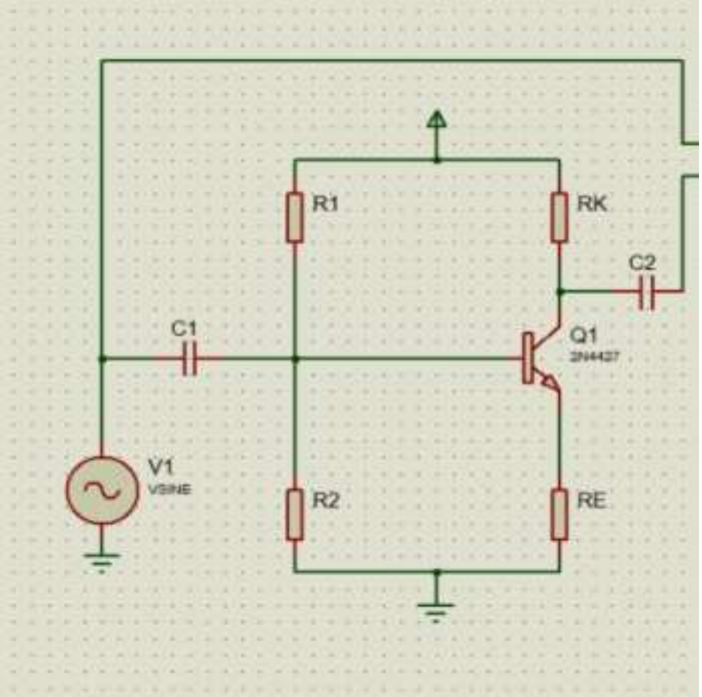
$$U_B = U_E + U_{BE}$$
$$U_B = 1.25V + 0.7V = 1.95V$$

The U_{R1} voltage across resistor R_1 is calculated as follows.

$$U_{R1} = U_P - U_{BE}$$
$$U_{R1} = 10V - 1.95V = 8.05V$$

The relationship between the currents flowing in the circuit:

$I_E = I_B + I_K$ $I_K >>> I_B$ $I_E \approx I_K$



to calculate the cascade in the above scheme, it is calculated using the values given using the following formulas.

$$\beta = \frac{I_K^0}{I_B} => I_B = \frac{I_K^0}{\beta}$$

$$I_B = \frac{50mA}{10} = 5mA$$

The current I_{R1} in the resistor R_1 is equal to ten times the current I_B in the base[3]

$I_{R1} = I_B * 10 = 5mA * 10 = 50mA$ $I_{R1} = 50mA$

The current I_{R2} is equal to 0.9 of the current I_{R1}

$I_{R2} = I_{R1} * 0.9 = 50mA * 0.9 = 45mA$ $I_{R2} = 45mA$

The resistances in the circuit are calculated as follows.

$$R_1 = \frac{U_{R1}}{I_{R1}} = \frac{8.05V}{50mA} = 0.161k\Omega$$

$$R_2 = \frac{U_B}{I_{R2}} = \frac{1.95V}{45mA} = 0.043k\Omega$$

$R_1 \| R_2$ Since, $R_{1,2}$ is calculated as follows:

$$R_{1,2} = \frac{R_1 * R_2}{R_1 + R_2} = \frac{0.161k\Omega * 0.161k\Omega}{0.161k\Omega + 0.161k\Omega} = 0.034k\Omega$$

The resistance r_e in the emitter is equal to:

$$r_e = \frac{26mV}{I_E^0} \qquad I_E^0 = I_K^0 + I_B^0$$

$$I_E^0 = 50mA + 5mA = 55mA$$

$$r_e = \frac{26mV}{55mA} = 0.473\Omega$$

$$R_B = \beta(r_E + R_E) = 10(0.473\Omega * 25\Omega) = 254.73\Omega$$

Input resistance R_{kir} was calculated using the following formula.

$$R_{kir} = \frac{R_{1.2} * R_B}{R_{1.2} + R_B} = \frac{34\Omega * 254.73\Omega}{34\Omega + 254.73\Omega} = 29.996\Omega$$

The output resistance R_{chiq} is calculated as follows:

$K_P = \frac{R_{chiq}}{R_{kir}}$ formula, $R_{chiq} = K_p * R_{kir}$

$R_{chiq} = K_p * R_{kir} =-3.6 * 29.996 =|107.98|\ \Omega$

We find the voltage coefficient for voltage, for current, and for power.

$$K_U = -\frac{R_K}{R_E + r_E} = -\frac{75\Omega}{25\Omega + 0.473\Omega} = -2.9 \approx -3$$

$$K_I = \beta\frac{R_{1.2}}{R_{1.2} + R_B} = 10\frac{34\Omega}{34\Omega + 254.73\Omega} = 1.2$$

$$K_P = K_I * K_U = 1.2 * (-3) = -3.6$$

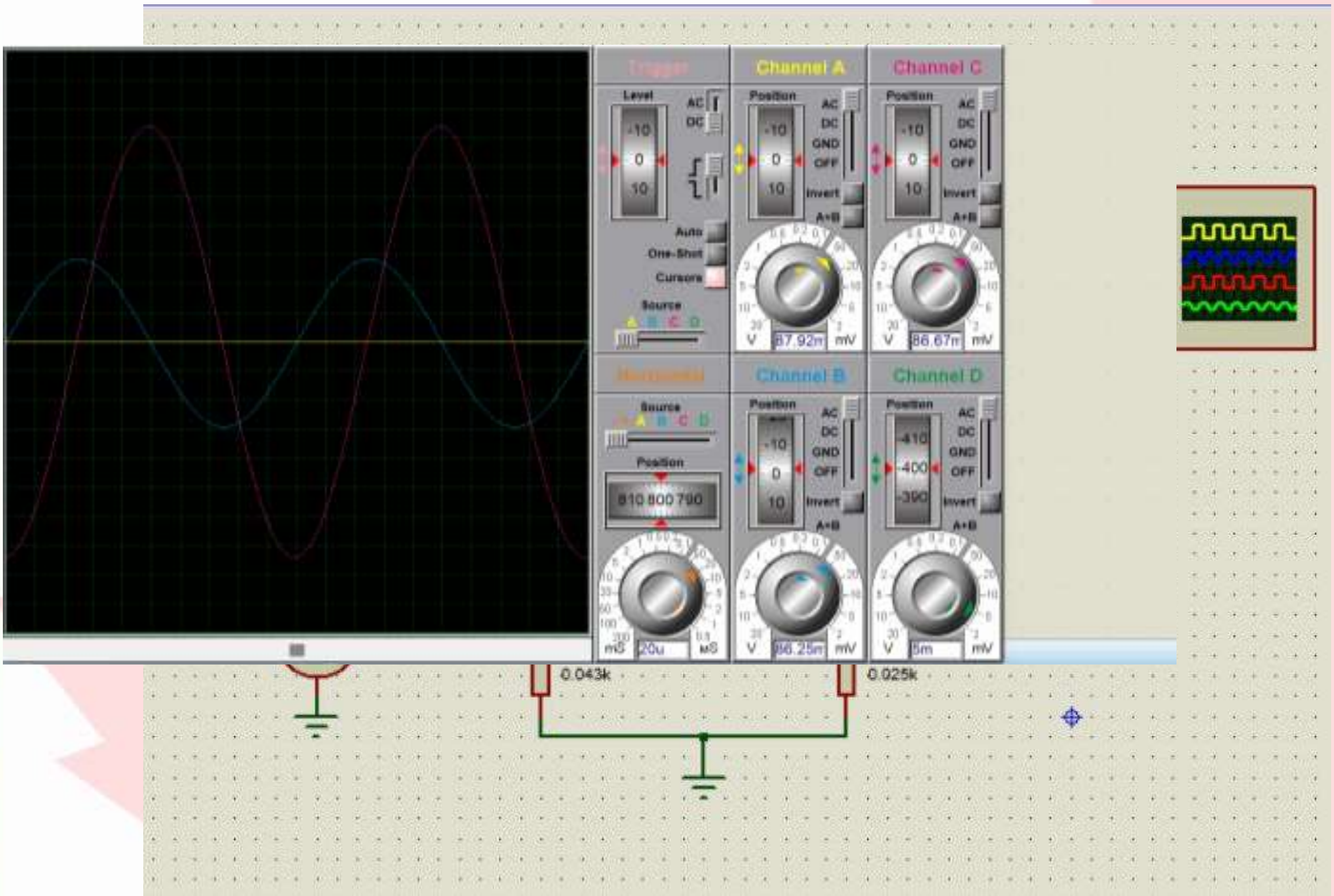
Calculate the capacitance of the capacitor in the circuit using the following formulas:

$$C_1 = \frac{1}{2\pi ƒ R_{kir}} = \frac{1}{2 * 3.14 * 3 * 10^3 Gs * 0.030 * 10^3} = 1.8\mu F$$

$$C_2 = \frac{1}{2\pi ƒ(R_{Chiq} + R_H)} = \frac{1}{2 * 3.14 * 3 * 10^3 Gs * (107.98\Omega + 50000\Omega)} == 10.5nF$$

The diagram based on the values of the resistors and auxiliary elements connected to a given transistor is shown in the following figure [6].

Below we can see the graph of the signal generated during the operation of the transistor



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