FUNDAMENTALS OF ELECTRONICS

Department of Robotics and Mechatronics

Faculty of Mechanical Engineering and Robotics

AGH University of Science and Technology

Common Emitter Amplifier

LAB 9
LAB 10

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FUNDAMENTALS OF ELECTRONICS

CONDITIONS FOR PASSING THE LABORATORY

- ***laboratory report: max 10p;***
- ***send the report to: ggora@agh.edu.pl***
- ***teams: two-person;***
- ***deadline: one week***.

EXERCISE 1 – Input characteristic of the bipolar transistor *[2p]*

Find the input characteristic (relation $i_B = f(u_{CE})$) of the NPN bipolar transistor.

PROCEDURE

1. Make the connections according to the assembly schematic fig. 1. Use two multimeters as ammeter and voltmeter. The circuit should be powered with 12V DC.
2. Make several measurements of the base current and base-emitter voltage in order to draw the input characteristics of the transistor. The base current can be changed by the VR4 potentiometer.

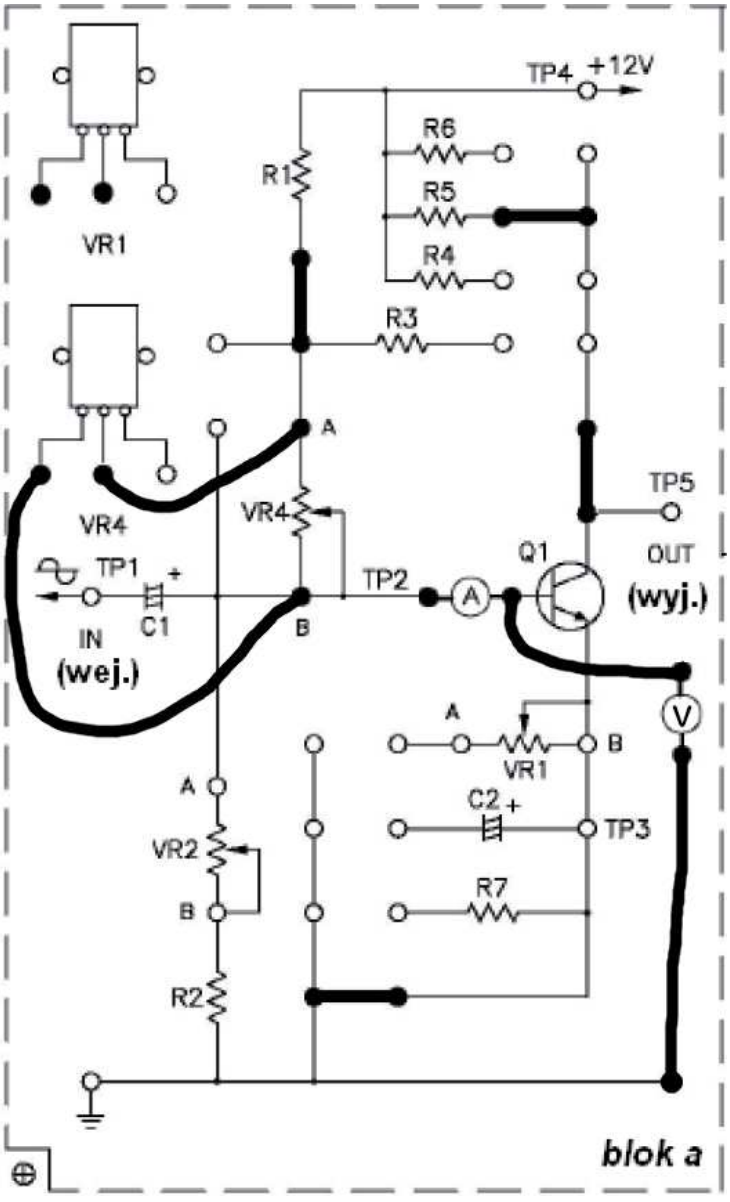

Fig. 1: Electrical assembly schematic (KL-25003 part a) – transistor base current and u_{BE} voltage measurement [1]

EXERCISE 2 – Transfer characteristic of the bipolar transistor *[2p]*

Find the transfer characteristic (relation $i_C = f(i_B)$) of the NPN bipolar transistor. Determine the value of the current gain factor β.

PROCEDURE

1. Make the connections according to the assembly schematic fig. 2. Use two multimeters as ammeters. The circuit should be powered with 12V DC.
2. Make several measurements of the base (i_B) and collector (i_C) current in order to draw the transfer characteristics of the transistor. The base current can be changed by the VR4 potentiometer.
3. Draw the transfer characteristic of the transistor in the range of the collector current 1.5 - 10 mA. Why does an increase in the base current not increase the collector current more than approx.15 mA?

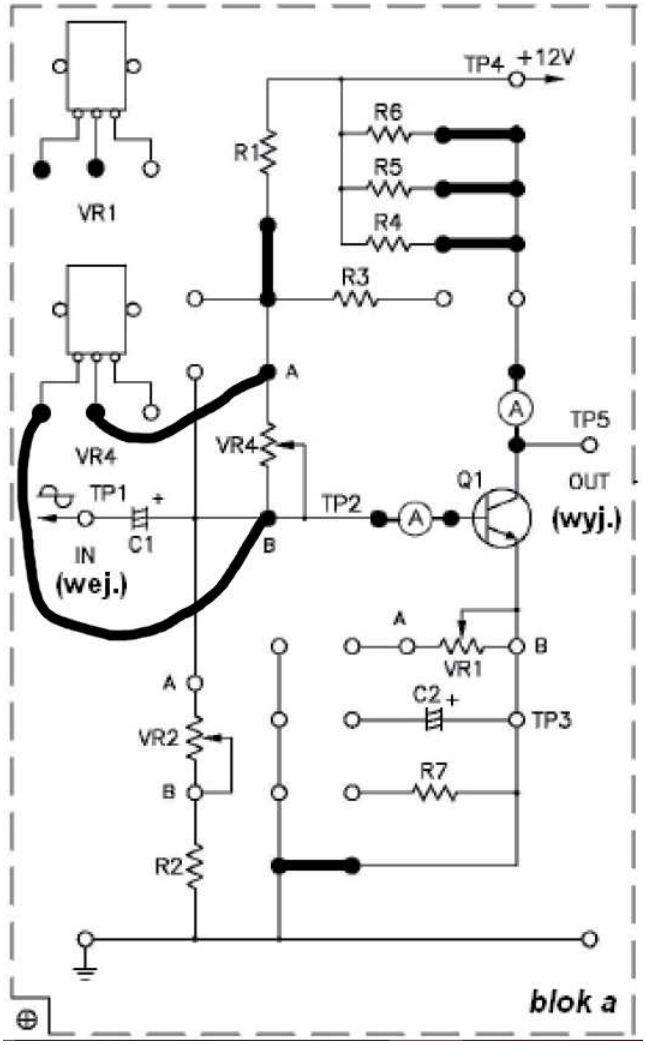

Fig. 2: Electrical assembly schematic (KL-25003 part a) – measurement of the base and collector currents of the transistor [1]

EXERCISE 3 – CE amplifier - case A (basic) *[2p]*

Assemble the measuring system of the amplifier, set the operating point of the transistor, read the parameters of the operating point of the transistor, calculate the voltage gain of the amplifier, find the maximum amplitude not distorting output signal, and find the lower and upper cut-off frequency. Draw the amplitude-frequency characteristics of the amplifier.

PROCEDURE

1. Make the connections according to the assembly schematic fig. 4 and the electrical diagram fig. 3. The circuit should be powered with 12V DC.

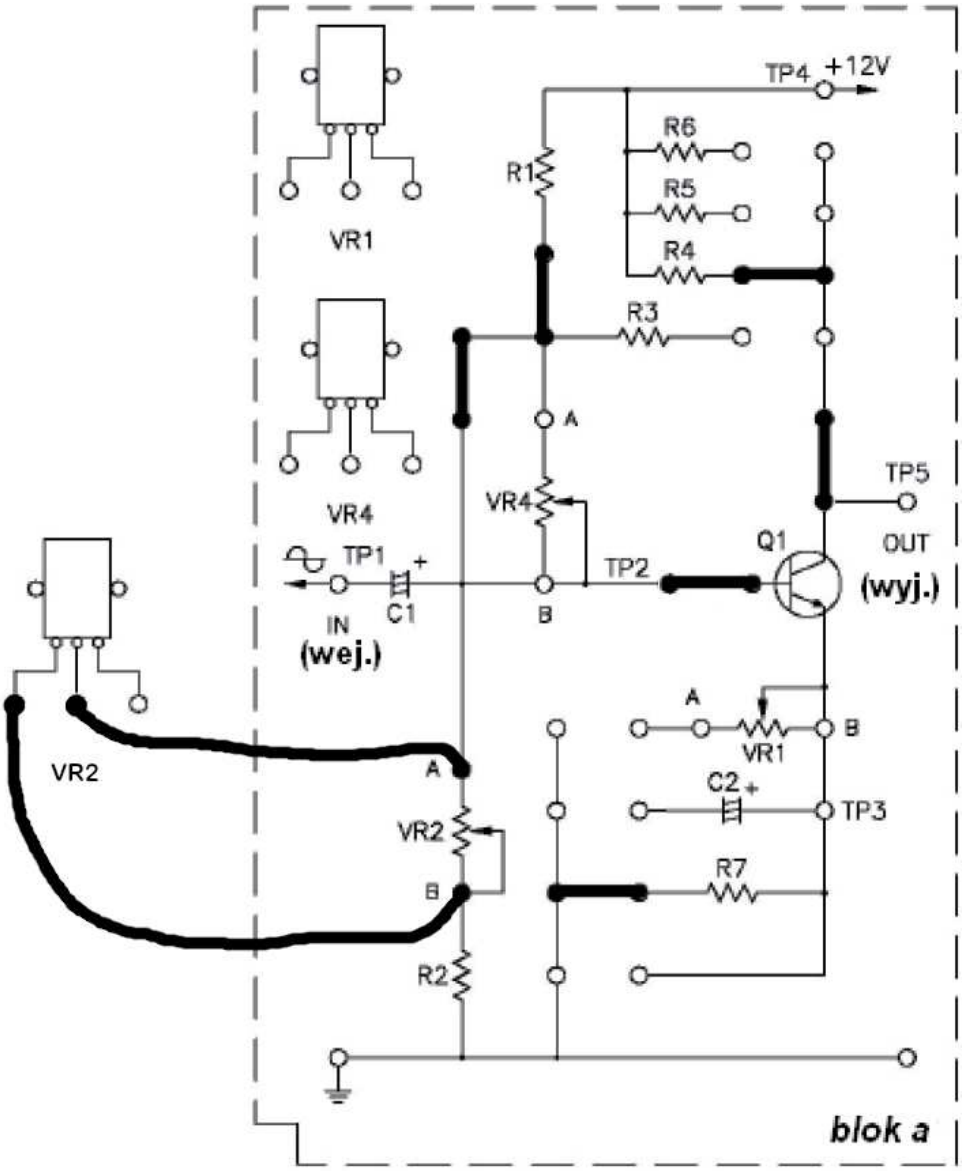

Fig. 3: Electrical assembly schematic (KL-25003 part a): CE amplifier - case A [1]

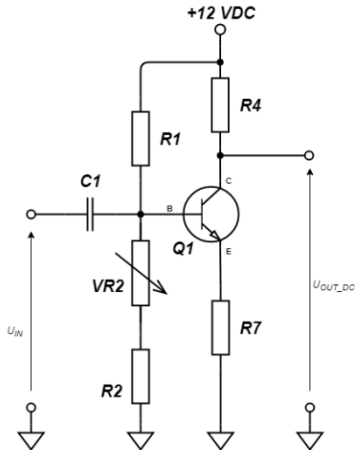

Fig. 4: Electrical diagram of the CE amplifier - case A

2. Connect the 2nd channel of the oscilloscope to the amplifier output (TP5), don't connect the input signal from the generator (TP1).
3. Use the VR2 potentiometer to set the operating point of the transistor – set the output voltage value to 6.5 - 7 V.
4. Measure the U_{BE} and U_{CE} voltages and the base I_B and collector I_C currents.
5. Set generator to 500 mV_{PP}, 1kHz sine wave. Check the parameters by using an oscilloscope.
6. Connect the signal from the generator to the input (TP1) and the first channel of the oscilloscope.
7. Read the input and output signal peak-to-peak values, and calculate the gain of the amplifier k.
8. Check the maximum amplitude of the output signal without distortion. What causes distortion of the output signal?
9. Find the amplitude-frequency characteristics (relation of the gain on frequency) in the range 0.4 Hz - 1 MHz.

Idx.	***Frequency [Hz]***	***Input signal [mV_{PP}]***	***Output signal [mV_{PP}]***	***k [V/V]***
1.	0.4	500		
2.	0.6	500		
3.	1	500		
4.	5	500		
5.	10	500		
6.	100	500		
7.	1 000	500		
8.	10 000	500		
9.	100 000	500		
10.	200 000	500		
11.	300 000	500		
12.	400 000	500		
13.	500 000	500		
14.	750 000	500		
15.	1 000 000	500		

10. Estimate the lower and upper cut-off frequency of the amplifier from the plotted characteristic.

EXERCISE 4 – CE amplifier - case B (with a capacitor and a resistor in the emitter circuit) *[2p]*

Assemble the measuring system of the amplifier. Find: the voltage gain of the amplifier, the maximum amplitude not distorting output signal, and the lower and upper cut-off frequency. Draw the amplitude-frequency characteristics of the amplifier.

PROCEDURE

1. Make the connections according to the assembly schematic fig. 5 and the electrical diagram fig. 6. Don't change the operating point of the transistor. Set the VR1 potentiometer value to 200 Ω. The circuit should be powered with 12V DC.

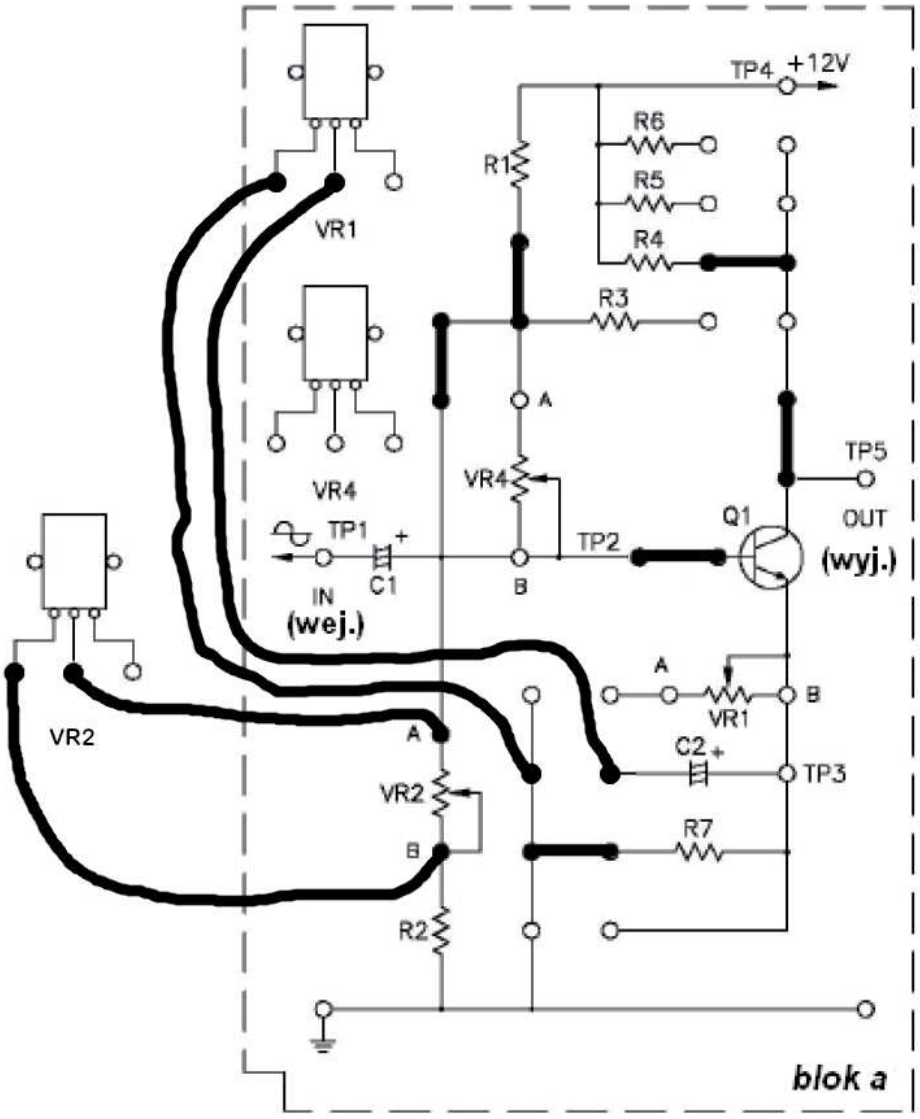

Fig. 5: Electrical assembly schematic (KL-25003 part a): CE amplifier - case B [1]

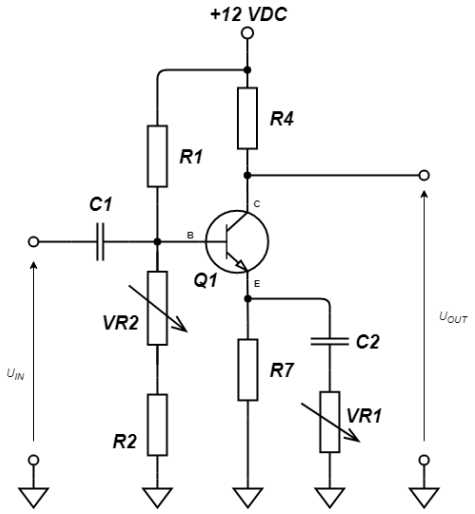

Fig. 6: Electrical diagram of the CE amplifier - case B

2. Set generator to 200 mV_{PP}, 1kHz sine wave. Check the parameters by using an oscilloscope.
3. Connect the signal from the generator to the input (TP1) and the first channel of the oscilloscope. Connect the 2nd channel of the oscilloscope to the amplifier output (TP5).
4. Read the input and output signal peak-to-peak values, and calculate the gain of the amplifier k.
5. Check the maximum amplitude of the output signal without distortion.
6. Find the amplitude-frequency characteristics (relation of the gain on frequency) in the range 0.4 Hz - 1 MHz.

Idx.	***Frequency [Hz]***	***Input signal [mV_{PP}]***	***Output signal [mV_{PP}]***	***k [V/V]***
1.	0.4	200		
2.	0.6	200		
3.	1	200		
4.	5	200		
5.	10	200		
6.	100	200		
7.	1 000	200		
8.	10 000	200		
9.	100 000	200		
10.	200 000	200		
11.	300 000	200		
12.	400 000	200		
13.	500 000	200		
14.	750 000	200		
15.	1 000 000	200		

7. Estimate the lower and upper cut-off frequency of the amplifier from the plotted characteristic.
8. What is the effect of adding the resistor and the capacitor in the emitter circuit? How have the parameters of the amplifier changed?

EXERCISE 5 – CE amplifier - case C (other polarity and the value of the collector resistor) *[2p]*

Assemble the measuring system of the amplifier, set the operating point of the transistor, and read the parameters of the operating point of the transistor. Find: the voltage gain of the amplifier, the maximum amplitude not distorting output signal, and the lower and upper cut-off frequency. Draw the amplitude-frequency characteristics of the amplifier.

PROCEDURE

1. Make the connections according to the assembly schematic fig. 7 and the electrical diagram fig. 8. The circuit should be powered with 12V DC.

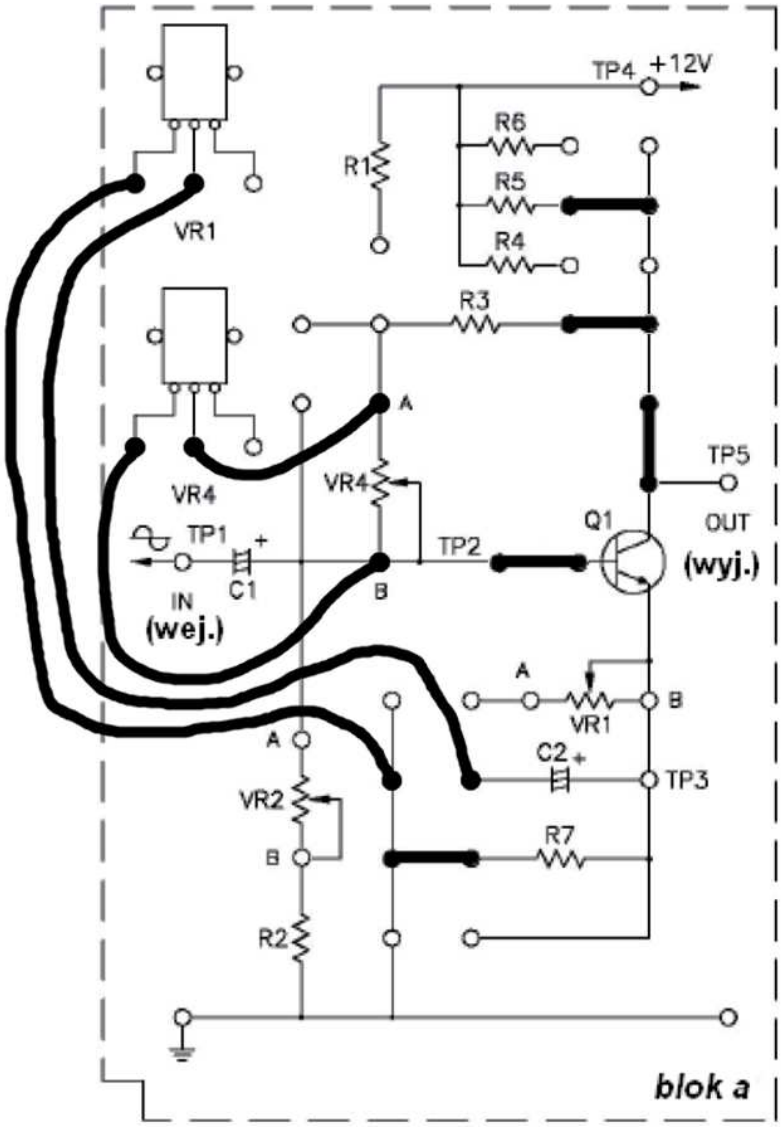

Fig. 7: Electrical assembly schematic (KL-25003 part a): CE amplifier - case C [1]

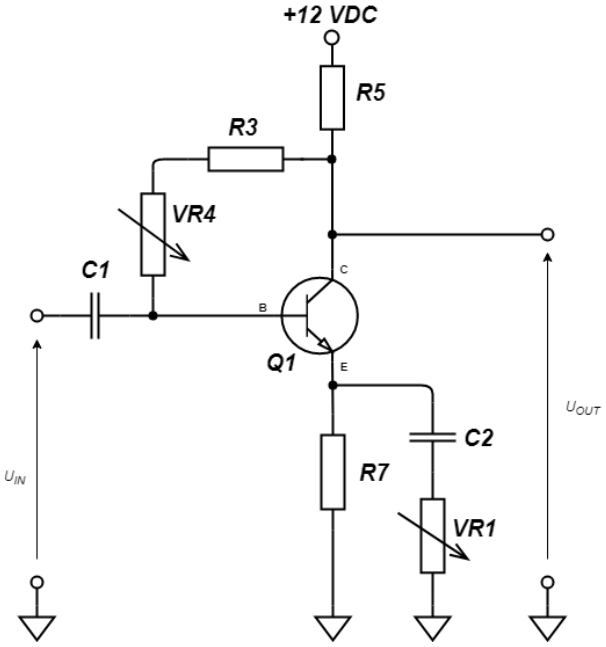

Fig. 8: Electrical diagram of the CE amplifier - case C

2. Connect the 2nd channel of the oscilloscope to the amplifier output (TP5), don't connect the input signal from the generator (TP1).
3. Use the VR4 potentiometer to set the operating point of the transistor – set the output voltage value to 6.5 - 7 V.
4. Measure the U_{BE} and U_{CE} voltages and the base I_B and collector I_C currents.
5. Set generator to 200 mV_{PP}, 1kHz sine wave. Check the parameters by using an oscilloscope.
6. Connect the signal from the generator to the input (TP1) and the first channel of the oscilloscope.
7. Read the input and output signal peak-to-peak values, and calculate the gain of the amplifier k.
8. Check the maximum amplitude of the output signal without distortion.
9. Find the amplitude-frequency characteristics (relation of the gain on frequency) in the range 0.4 Hz - 1 MHz.

Idx.	***Frequency [Hz]***	***Input signal [mV_{PP}]***	***Output signal [mV_{PP}]***	***k [V/V]***
1.	0.4	200		
2.	0.6	200		
3.	1	200		
4.	5	200		
5.	10	200		
6.	100	200		
7.	1 000	200		
8.	10 000	200		
9.	100 000	200		
10.	200 000	200		
11.	300 000	200		
12.	400 000	200		
13.	500 000	200		
14.	750 000	200		
15.	1 000 000	200		

10. Estimate the lower and upper cut-off frequency of the amplifier from the plotted characteristic.
11. What is the effect of changing the resistor in the collector circuit? How have the parameters of the amplifier changed?

REFERENCES

[1] Laboratorium z podstawowych układów elektronicznych KL-210: Rozdział 6 – Wzmacniacze tranzystorowe