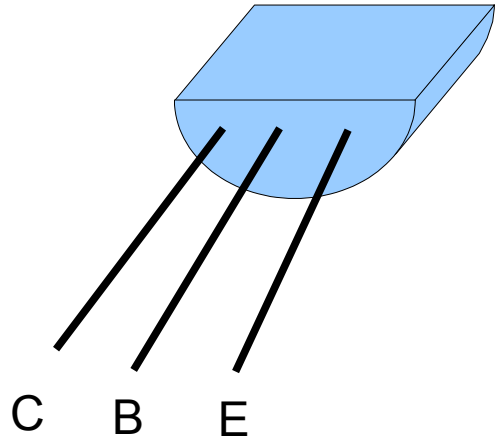
Lab 2

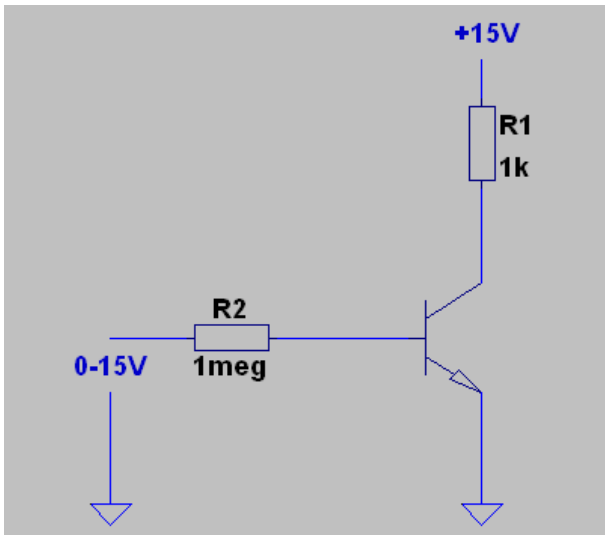
Circuits with bipolar transistors

1. During this lab, an NPN type transistor will be used. The pinout of the device is given on the figure below.



2. Please decode markings of all the resistors and capacitors used in today's lab. Measure the resistance and capacitance and compare it to the decoded values.

3. Establishing current gain factor of a transistor. In this task we will neglect a small influence of U_{CE} on the results of the measurements.
Please build the following circuit.

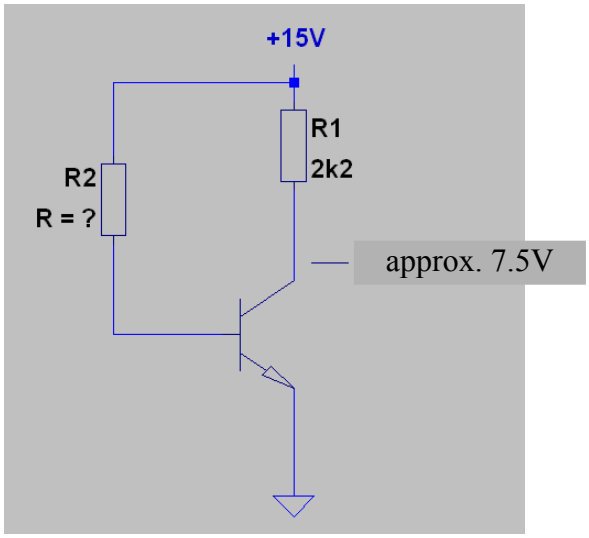


ATTENTION! 1meg = 1 000 000 Ω

Please change the voltage applied to the base resistor in the range from 0 to 15 volts. By measuring the voltages on R1 and R2 please establish the base and collector currents I_B and I_C for each voltage setting. Then, for each point calculate the current gain β. Please prepare a graph showing the dependency $\beta = f(I_C)$.

Since now please take a special care about this exact transistor, since the results obtained are needed in next tasks and are specific only for this single transistor!

4. Constant base current circuit
Please build the following circuit.



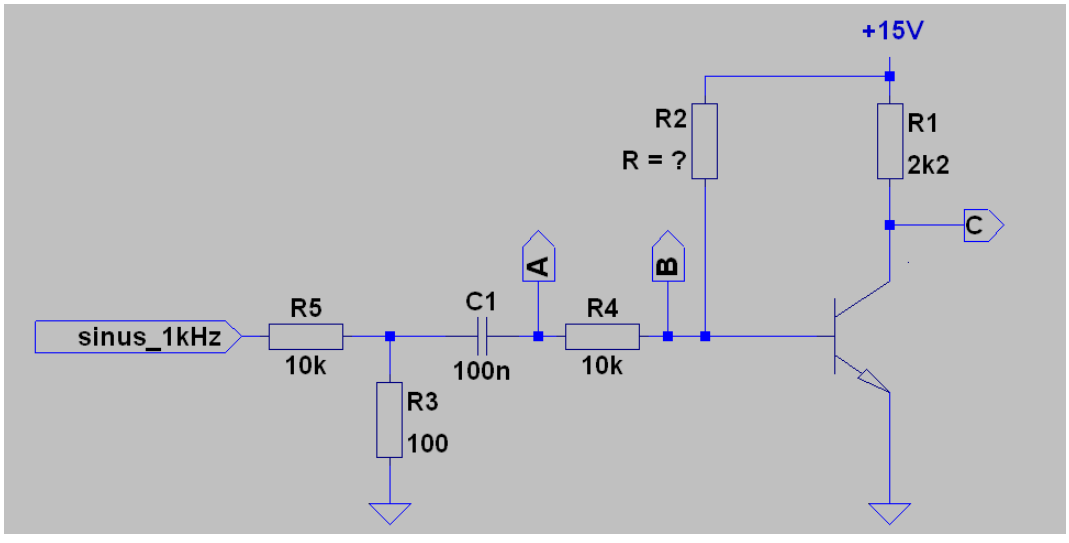
Calculate the value of R2 using the previously measured $\beta = f(I_C)$ characteristic.

Follow the steps below:

a. calculate required collector current,
b. from the $\beta = f(I_C)$ graph, read the required base current,
c. calculate the R2 value from the formula: $R2 \cdot I_B + 0{,}7 = 15$

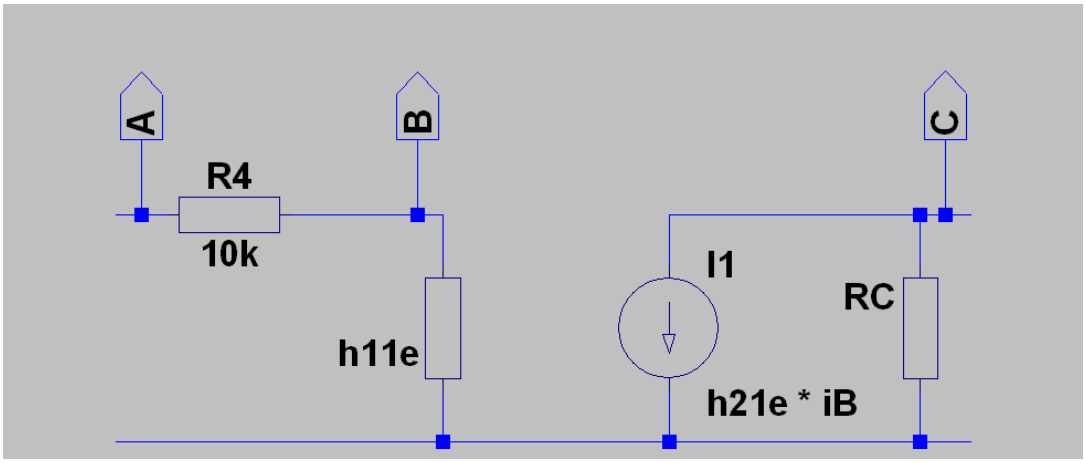
The required resistance must be composed from the available components. Please use the closest possible value. Please verify the collector voltage value. It should be 7.5V ±1V.

5. Common emitter amplifier.
Please extend the circuit from the previous task according to the schematic below:



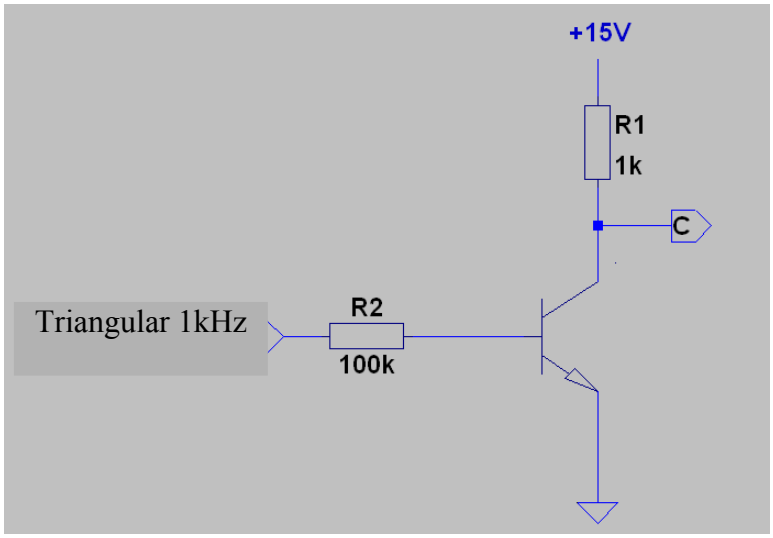
Please adjust the amplitude of the input sinusoidal signal so that the output AC voltage (oscilloscope in AC mode) in the point marked as C is about 2.5V. Please measure the AC voltages in points A and B using oscilloscope in AC mode.
Basing on the amplitudes of signal in points A, B and C, please calculate the voltage gain k_u (input

signal is the signal in point B) as well as the input impedance h_{11e}. For establishing the input impedance please use the circuit below:



Please assume that $h_{21e} = \beta$ and calculate the theoretical gain of the circuit. How does it compare to the result of measurements?.

6. Transfer characteristic of a transistor inverter.
Please build the following circuit:



Triangular input signal must have an amplitude of a few volts. Switch the oscilloscope to XY mode. Please feed the input signal to one channel and the output signal (point C) to the other channel. This should produce a plot of the transfer characteristics of the circuit $U_{out} = f(U_{in})$. Please calculate the slope of the characteristics in the area of active operation of the transistor. Basing of this calculation, please calculate the gain of the circuit. Please compare the obtained value with the value from the following equation:

$$k_u = \beta \cdot \frac{R_C}{R_B}$$
$$R_C = R1$$
$$R_B = R2$$