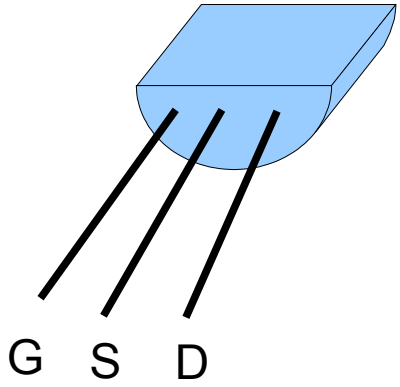
Lab 3

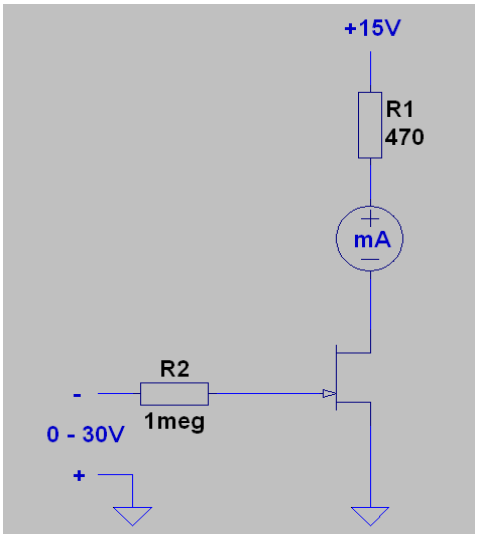
Circuits with field effect transistors

1. During this lab, an N-channel JFET 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. Measuring the transfer characteristic of a field effect transistor.
Please build the circuit shown below:



ATTENTION**!** 1meg = 1 000 000 Ω

ATTENTION 2! Please pay attention to the polarization of the voltage source connected to the gate. Gate potential has to be lower than source potential!

Please change the gate voltage from 0 to the voltage for which the drain current drops to 0. Please record the drain current I_d and gate-source voltage U_{GS}. Please draw a plot $I_d = f(U_{gs})$.
Basing on the results read out the U_{th} voltage and I_{dss} current. Please derive the analytical dependency of the transconductance ($g_m = \frac{\partial I_D}{\partial U_{GS}}$) of a FET on U_{GS} voltage.

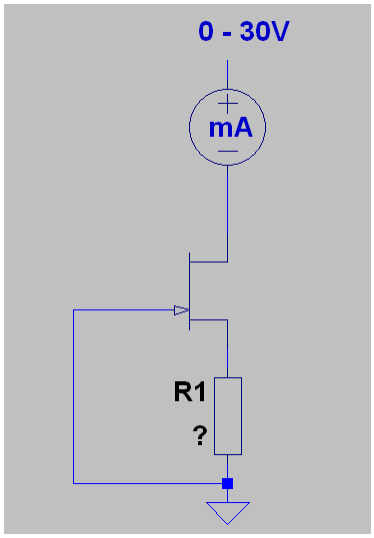
Drain current formula for FET:

$$I_D = I_{DSS} \cdot \left(1 - \frac{U_{GS}}{U_{th}}\right)^2$$

Please show the relationship $g_m=f(U_{GS})$ on a graph.

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. Measurements of a JFET based current source.
Please build the circuit shown below:



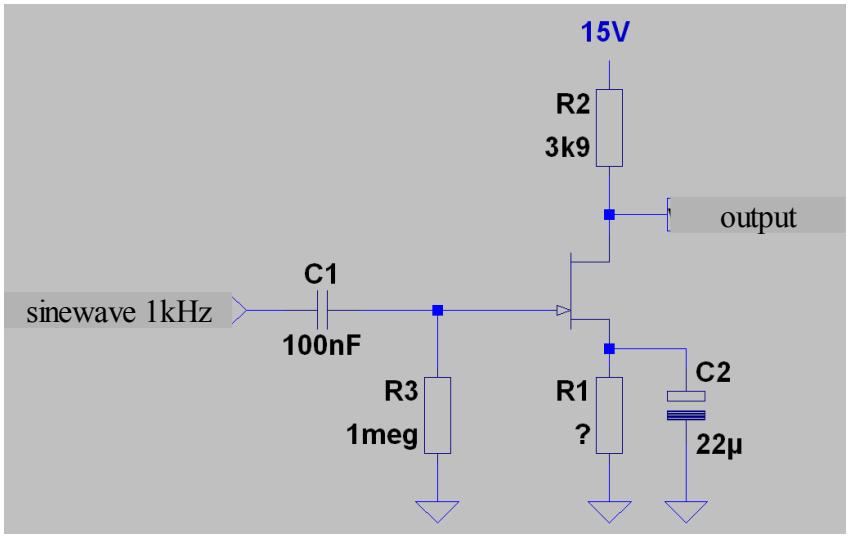
The value of the R1 resistor needs to be selected with the use of results obtained before. The desired current source current is 2mA. Please measure the dynamic resistance of the current source as a relation of the input voltage change to the current source current change. Please examine the supply voltage range from 15V to 20V.

Please take the following steps:

a. read out from the plot prepared before the gate-source voltage U_{GS1}, for which the I_D is 2 mA,
b. calculate the R1 resistance value from the formula: $R_1 \cdot I_D = U_{GSI}$

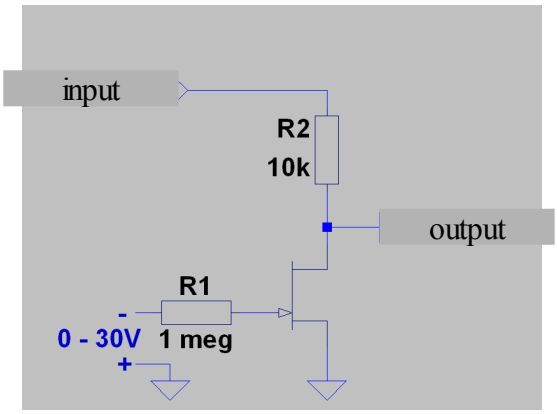
The calculated resistance should be constructed using the available resistor values. Please use the closest possible value of resistance.
Please check the drain current value. It should be 2mA ±10%.

5. Common source amplifier
Please modify the circuit from the previous task by adding components according to the schematic below:



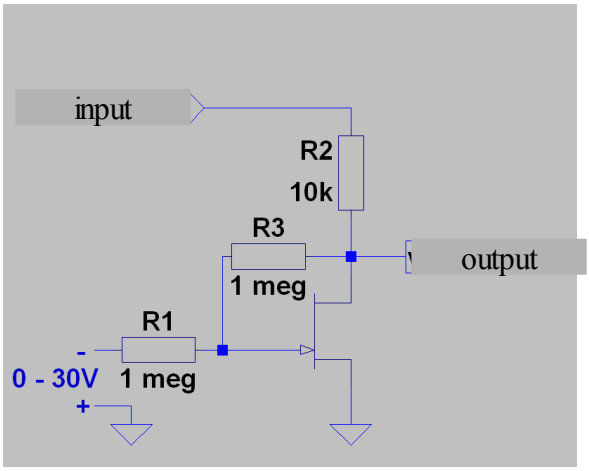
Use the R1 from the previous task.
Pleas connect the sinewave signal of the 1kHz frequency from the signal generator. Adjust the amplitude so that the signal on the output is not distorted due to the overdrive. Please measure the voltages on the gate and on the drain of the transistor and use those results to calculate the voltage gain k_u of the amplifier.

6. FET used in a voltage controlled attenuator.
Please build the following circuit:



Connect a sinevawe of the 1kHz frequency with peak to peak voltage of 0.2V. Please measure the dependency of the attenuation on the control voltage. Please express the attenuation in decibels (attenuation = $20 \log_{10}(u_{out}/u_{in})$).
Please change the input signal shape to triangle. Observe the distortions on the output.

7. Modify the circuit as shown below. Please check if the distortions observed before are reduced.


input
R2
10k
R3
1 meg
output
R1
-
0 - 30V
1 meg
+