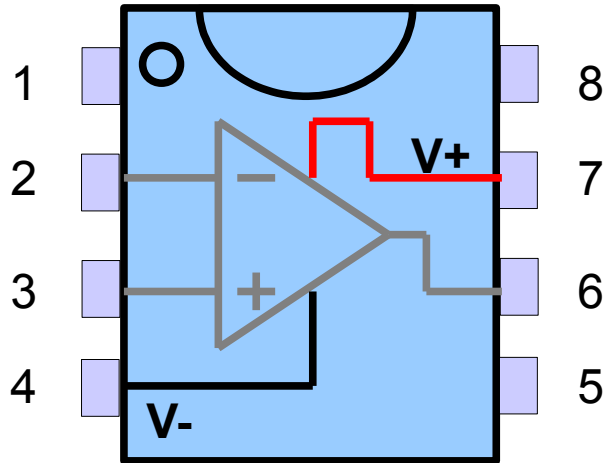


Semiconductor Devices and Analog Circuits

Lab 4

Circuits with operational amplifiers

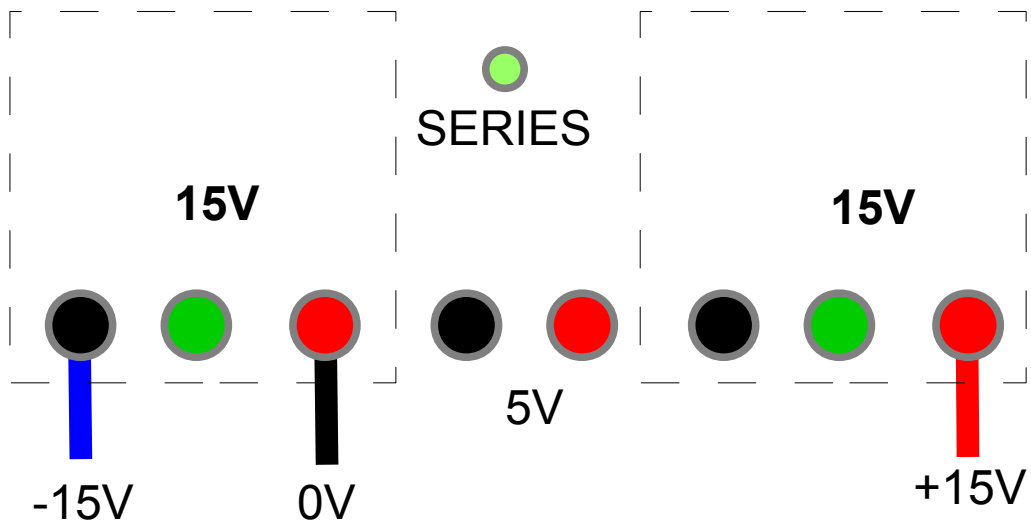
1. During this lab an operational amplifier type 741 will be used. The pinout of the device in the view from above is shown below.



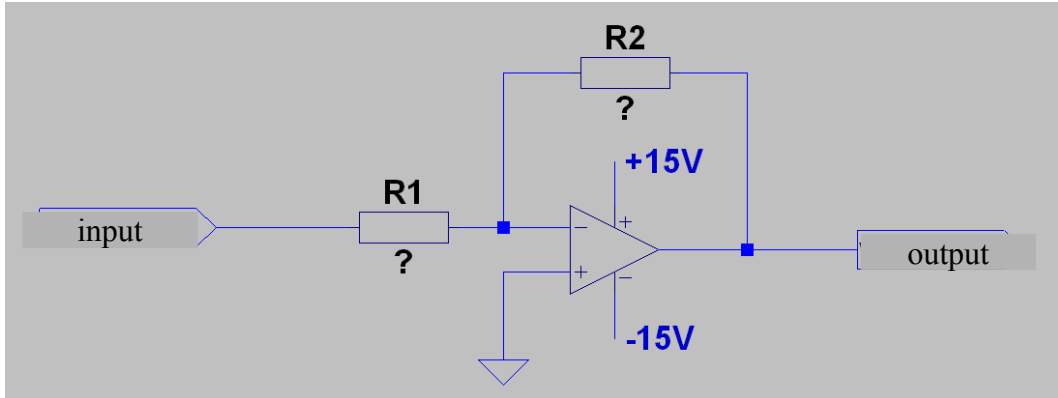
2. Please decode markings of all the resistors and capacitors used in today's lab. Measure the resistance and capacitance and compare it to the decoded values.

POWER SUPPLY for opamp

Please apply power to the opamp using the following connection with *Series* mode turned on, as shown below.

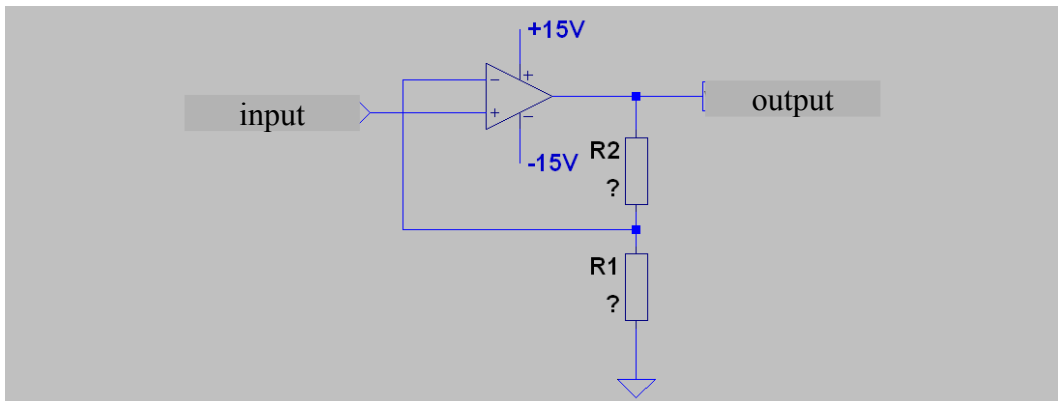


3. Please build the following circuit.
 Please calculate the values based on the following assumptions:
 $R_{in} = 2k\Omega$
 $K_u = -5 \text{ V/V}$

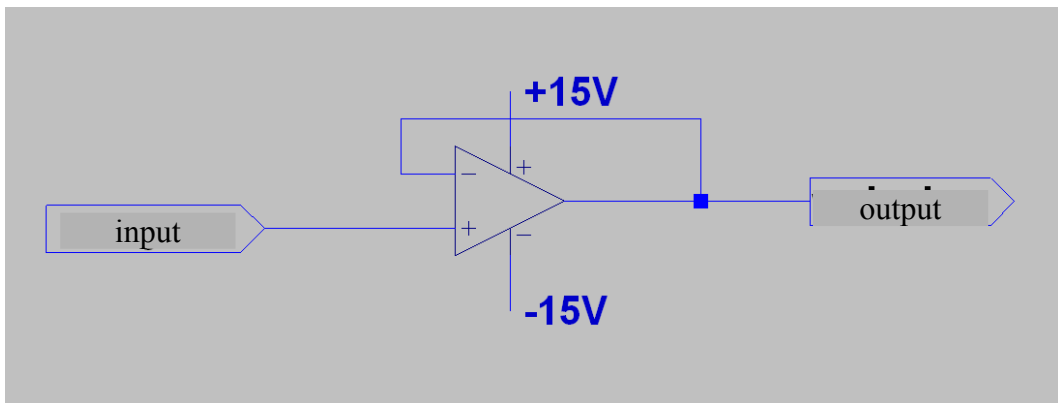


For this circuit please measure the small signal bandwidth (small signal: for $U_{out} = 1V_{pp}$) and the bandwidth for the case when the input voltage is adjusted so that the output signal has the highest possible undistorted amplitude.

4. Please build the noninverting amplifier circuit with the gain of 5. Please calculate the values of the resistors with the assumption that their sum can not be smaller than $10k\Omega$. Please measure the small and large signal bandwidth as in the previous point.



5. Please build the follower circuit ($k_u=1$). Please observe the output voltage for square signal input of the frequency of 1kHz. Please measure the slew rate $S_R = \frac{\Delta U_{out}}{\Delta t}$ Express the result in $V/\mu s$.



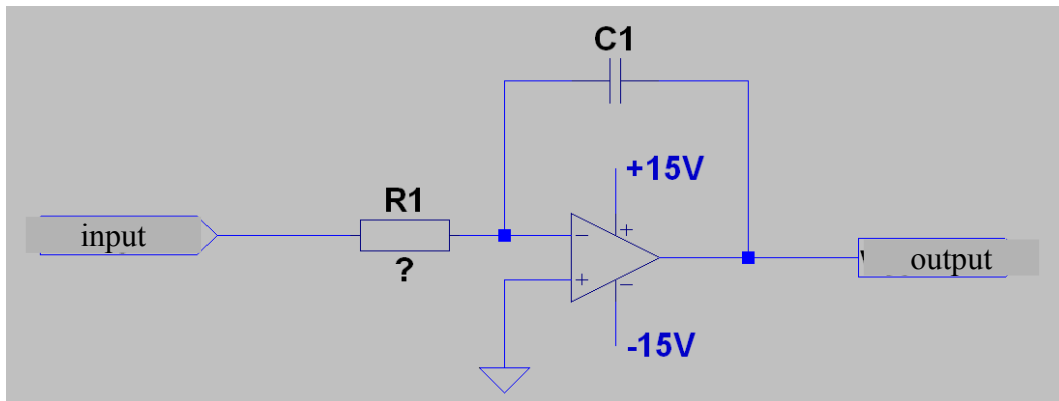
6. Please design and build an integrator circuit satisfying the following requirements: for U_{in} of a square signal of frequency 1 kHz and 5V peak to peak value, the output voltage should be a triangular waveform with an amplitude of 6V. Input resistance should be not less than $2k\Omega$. The required formulas are given below.

$$I_{RI} = I_C$$

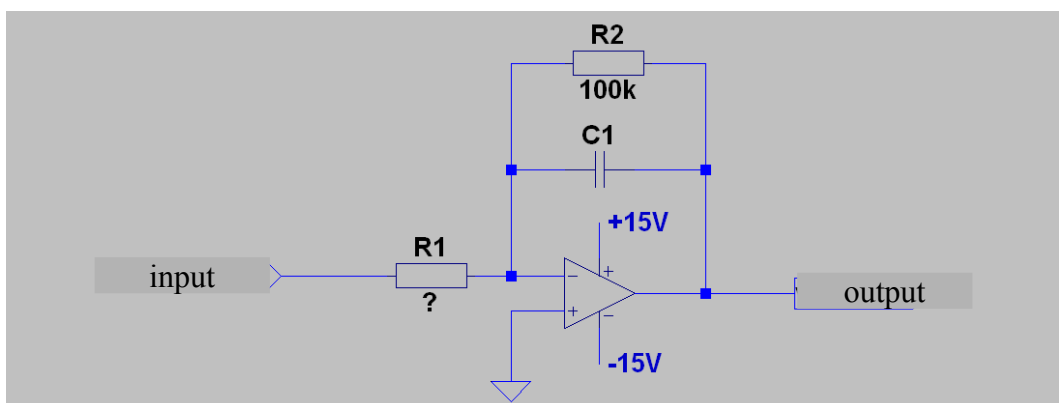
$$I_{RI} = \frac{U_{in}}{R_1}$$

$$I_C = C \frac{\Delta U}{\Delta t}$$

Attention! It will be helpful to draw the input and output signal with correct voltage values marked.

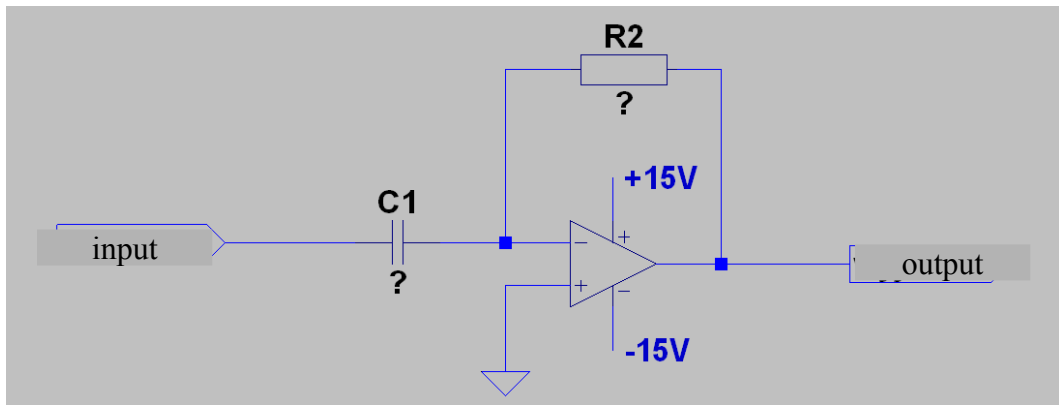


Please check the output signal when a parallel resistor is connected to the capacitor.

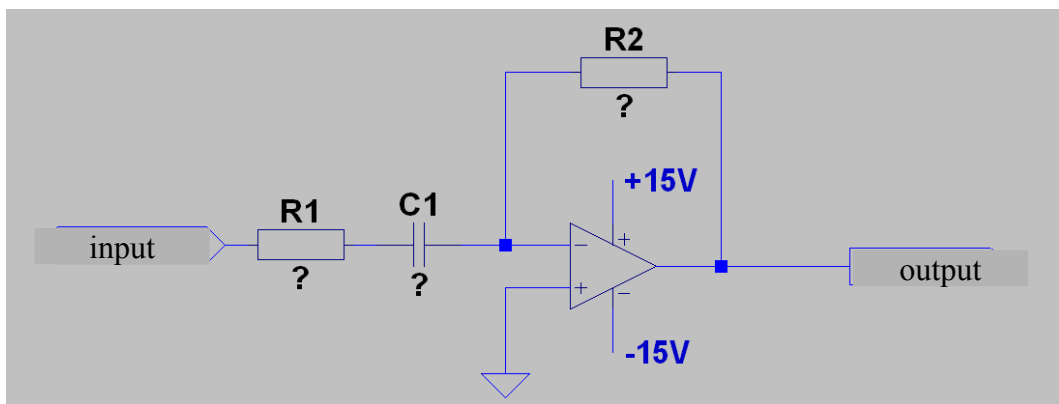


Please apply the sinusoidal signal to the input and measure the circuit frequency behaviour in the range from 1 Hz to 1kHz.

7. Please design and measure the differentiator circuit of the following properties: for the triangular input signal of peak to peak voltage 5V and frequency of 1kHz the output is a square wave of an amplitude equal to 10V.



Please observe the changes in the behaviour of the circuit with a connected resistor as shown below. The R_1 value needs to be chosen experimentally to obtain fast rising slopes with minimal ringing on the output.



Please observe how does this circuit behave when the square wave is fed to the input of the differentiator.

Please measure the frequency characteristics using sinusoidal input signal.. **Attention:** the amplitude has to be chosen so that there is no clipping over the full frequency range of measurement!