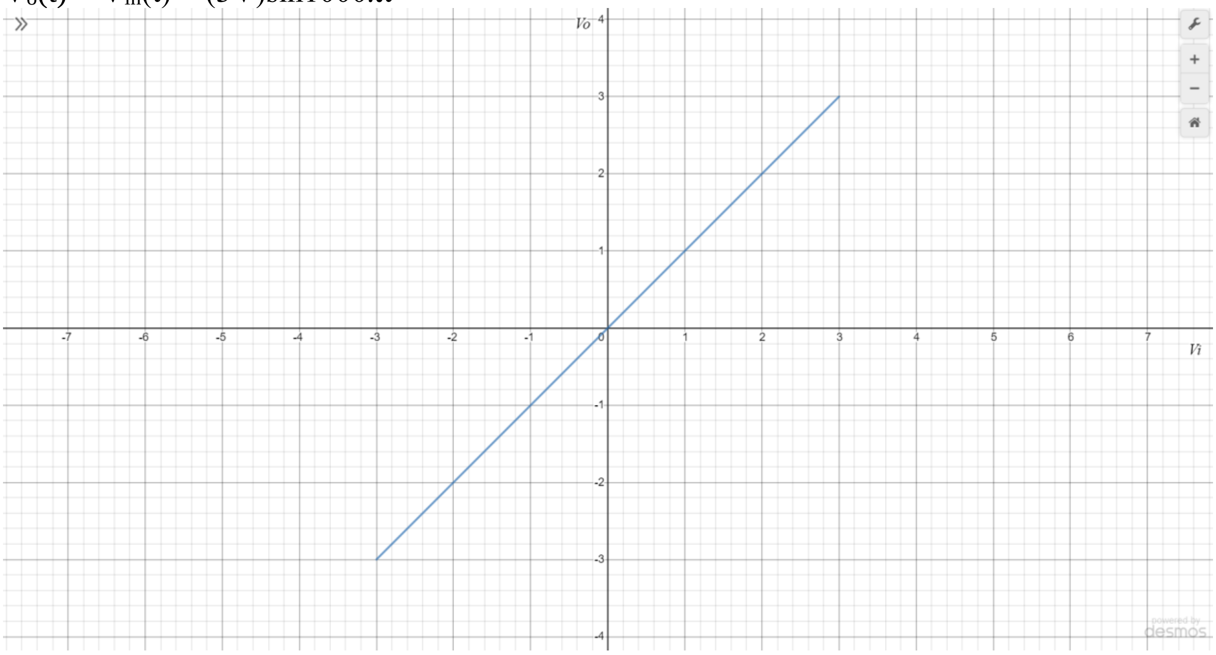
EXPERIMENT 4
REPORT SHEET
Full Name: Mustafa Sezgin
Date: 10.12.2020

Preliminary Work:

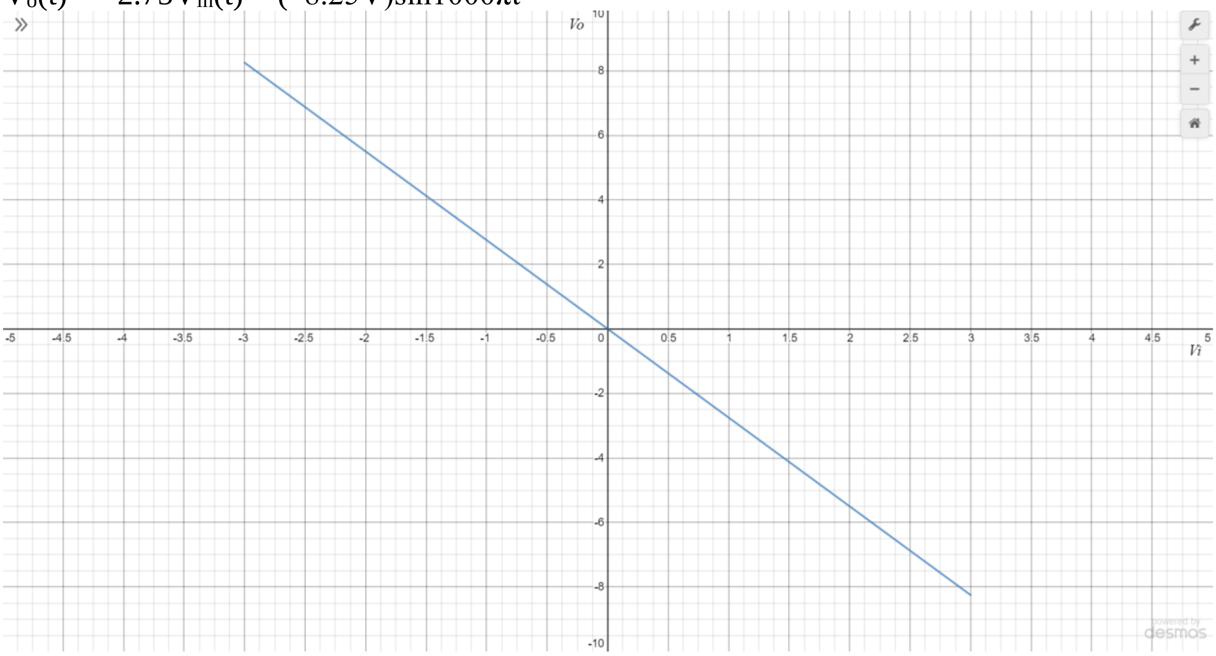
1)
a.

$V_o(t) = V_{in}(t) = (3V)\sin 1000\pi t$



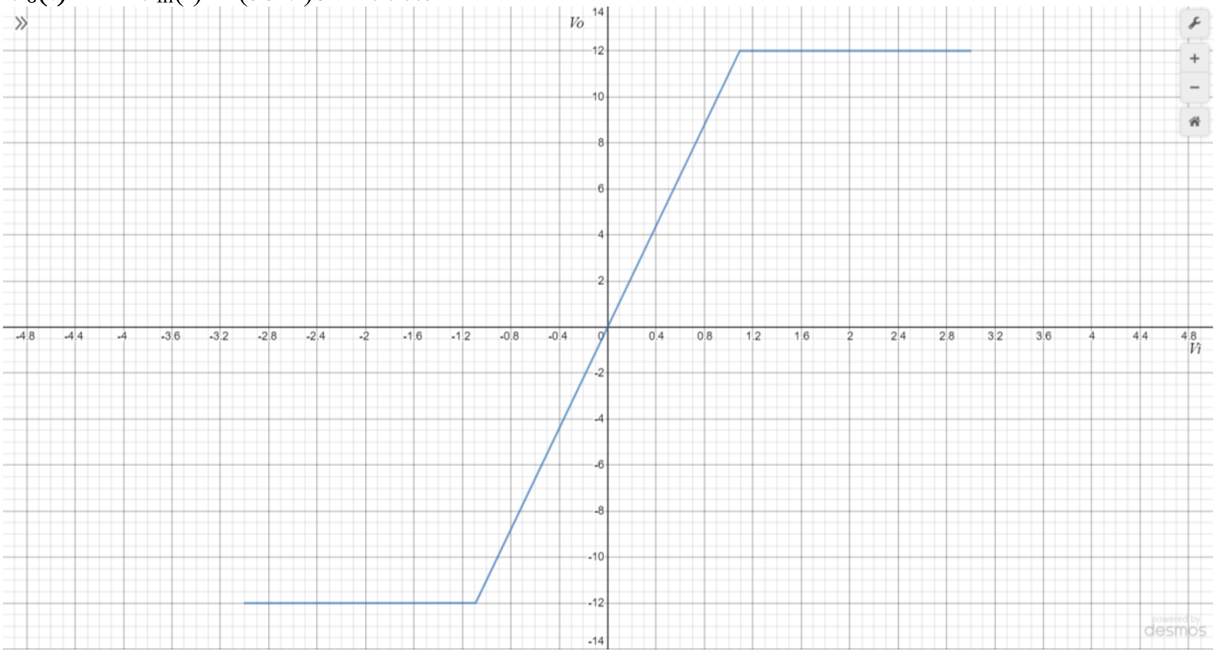
b.

$-V_{in}(t)/1.2k\Omega - V_o(t)/3.3k\Omega = 0$
$V_o(t) = -2.75V_{in}(t) = (-8.25V)\sin 1000\pi t$



c.

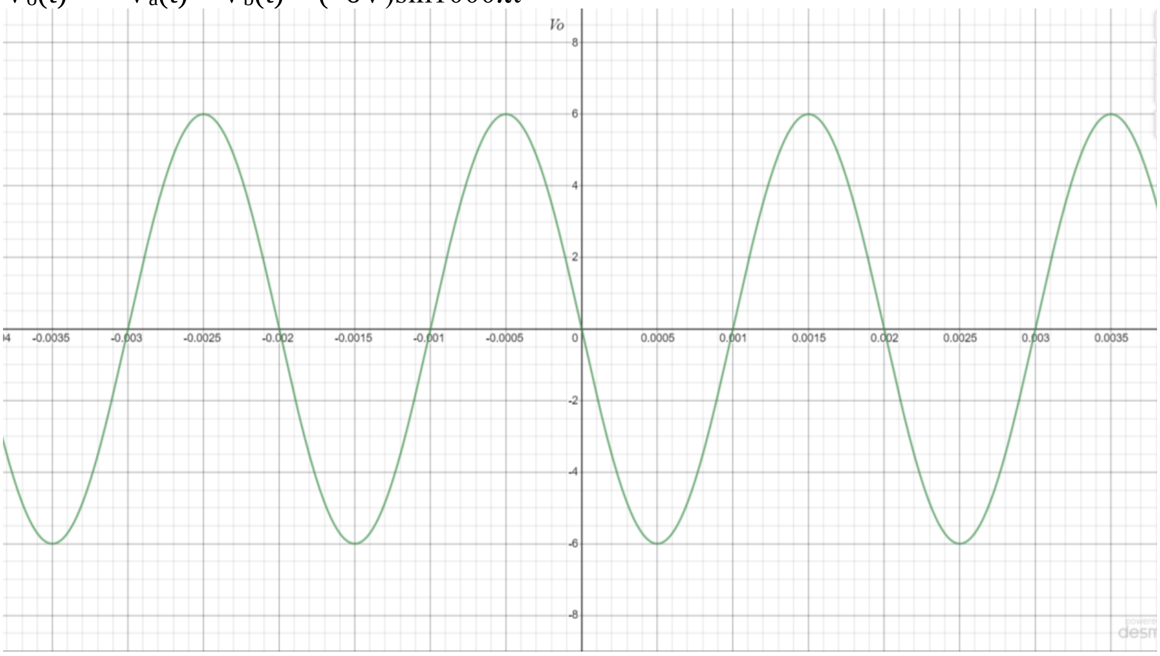
$V_{in}(t)/1.2k\Omega + (V_{in}(t) – V_o(t))/12k\Omega = 0$
$0.917V_{in}(t) – 0.083V_o(t) = 0$
$V_o(t) = 11V_{in}(t) = (33V)\sin 1000\pi t$



2)

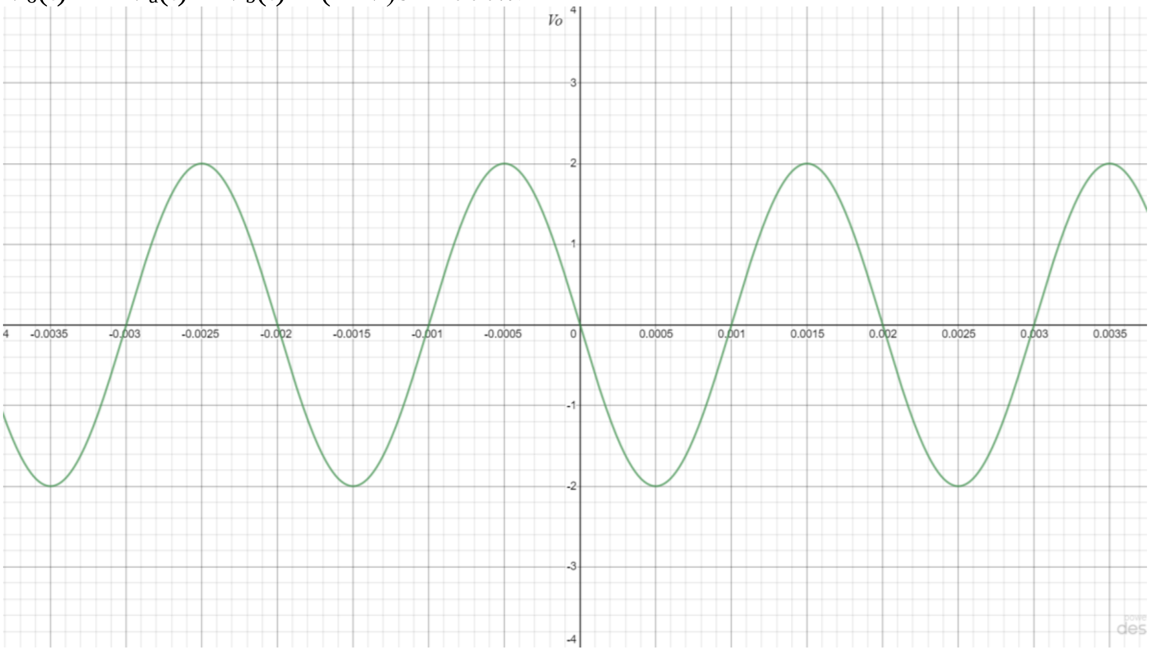
a.

$– V_a(t)/10k\Omega – V_b(t)/10k\Omega – V_o(t)/10k\Omega = 0$
$V_o(t) = – V_a(t) – V_b(t) = (–6V)\sin 1000\pi t$



b.

$(V_2(t) - V_a(t))/1k\Omega + (V_2(t) - V_o(t))/1k\Omega = 0$
$(V_3(t) - V_b(t))/1k\Omega + V_3(t)/1k\Omega = 0$
$V_a(t) + V_o(t) = 2V_2(t) = 2V_3(t) = V_b(t)$
$V_o(t) = -V_a(t) + V_b(t) = (-2V)\sin 1000\pi t$



3)
$V_2(t)/100k\Omega + (V_2(t) - V_o(t))/33k\Omega = 0$
$(V_3(t) - V_{in}(t))/100k\Omega + (V_3(t) - 2V)/33k\Omega = 0$
$100V_o(t) = 133V_2(t) = 133V_3(t) = 33V_{in}(t) + 200V$
$V_o(t) = 2V + 0.33V_{in}(t)$

Experimental Work:

1)

a) Fill the tables with LTspice circuit designs and the scope outputs of them asked in experimental work **1a**. Fill the desired captions below the figures.

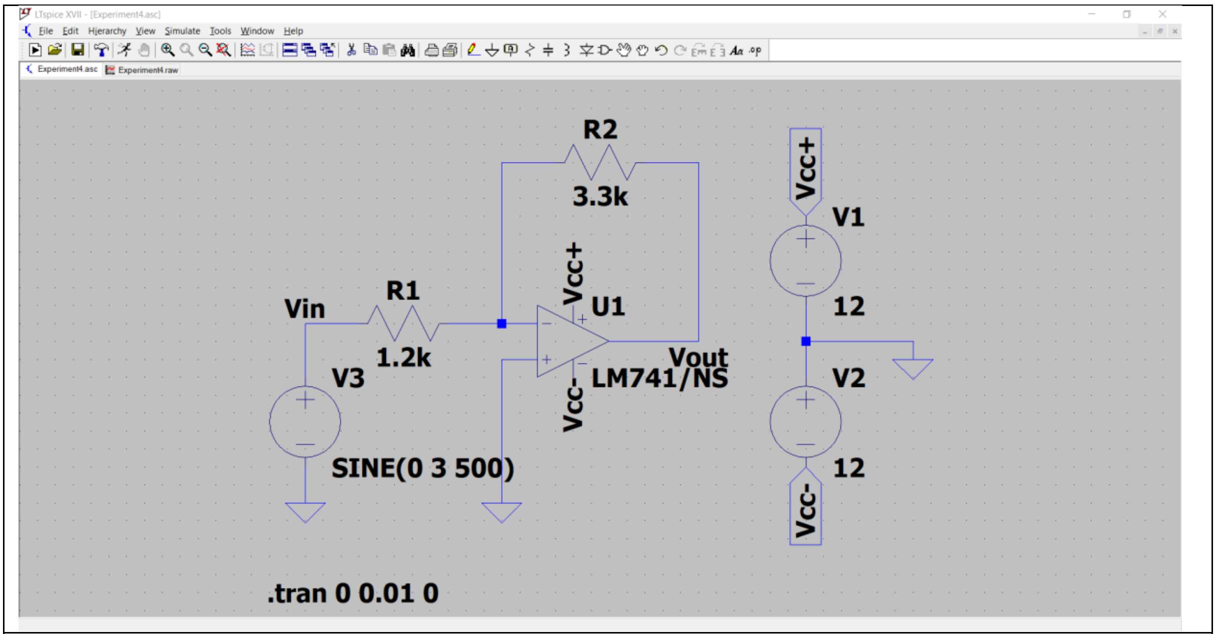


Figure 1: The function of the circuit is to reverse the input voltage multiplying by the ratio of R_2 and R_1, and the figure corresponds to *Figure 5* in the experiment worksheet.

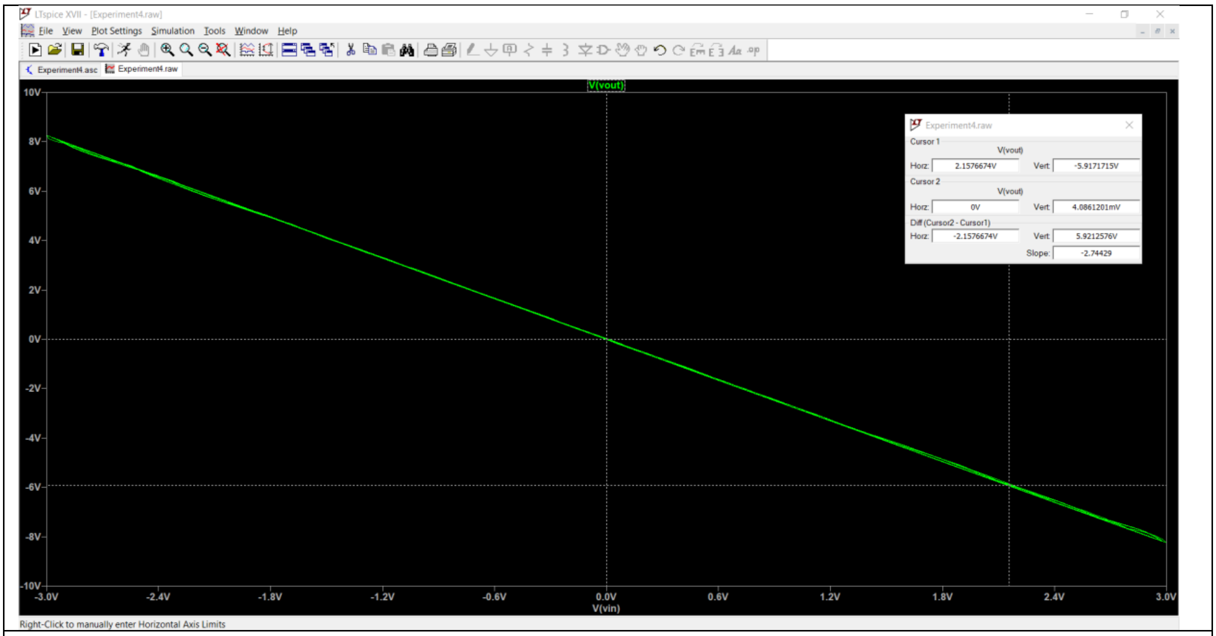


Figure 2: This is a linear graph with a negative slope due to inverting. The experimental gain, which is –2.74, is consistent with the theoretical value, which is –2.75.

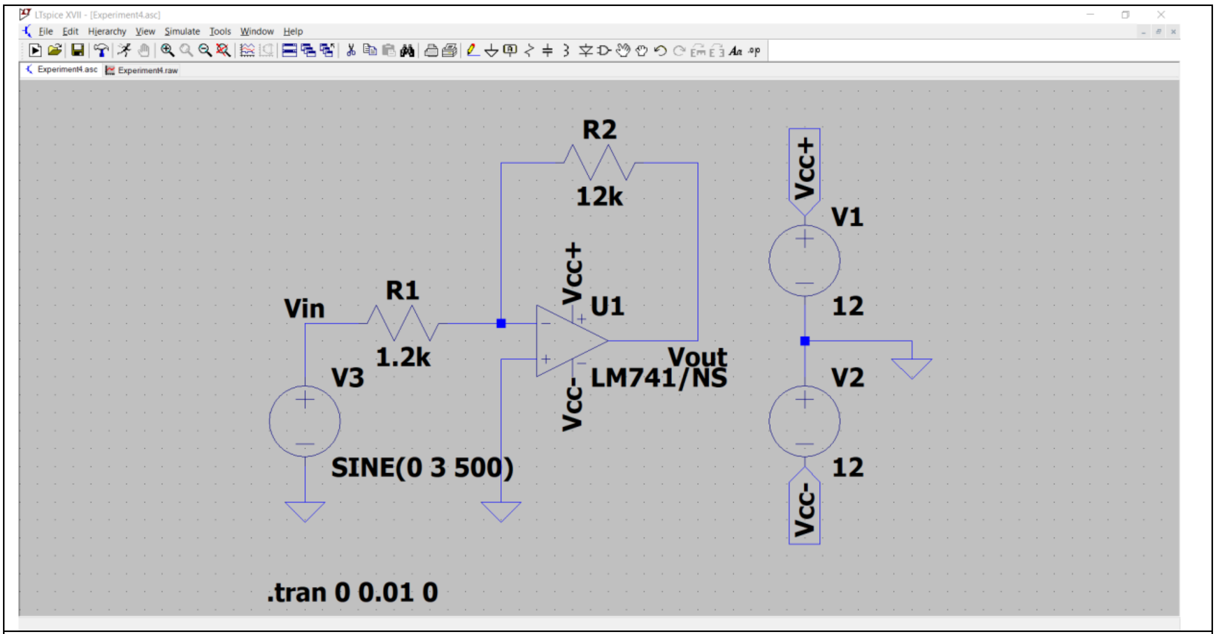


Figure 3: The function of the circuit is to reverse the input voltage multiplying by the ratio of R_2 and R_1, and the figure corresponds to *Figure 10* in the experiment worksheet.

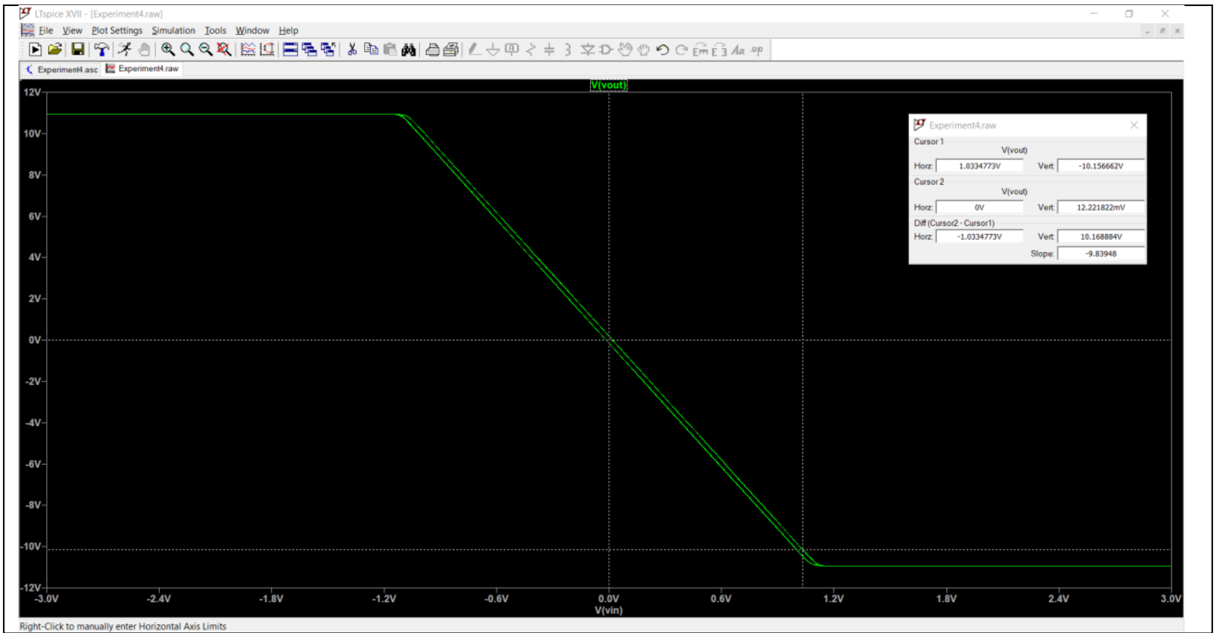


Figure 4: This is a linear graph with a negative slope due to inverting, and after some values there are horizontal parts, which are due to saturation. The experimental gain, which is –9.84, is consistent with the theoretical value, which is –10.

Comments:

b) Fill the tables with LTspice circuit design and the scope output of it asked in experimental work **1b**. Fill the desired captions below the figures.

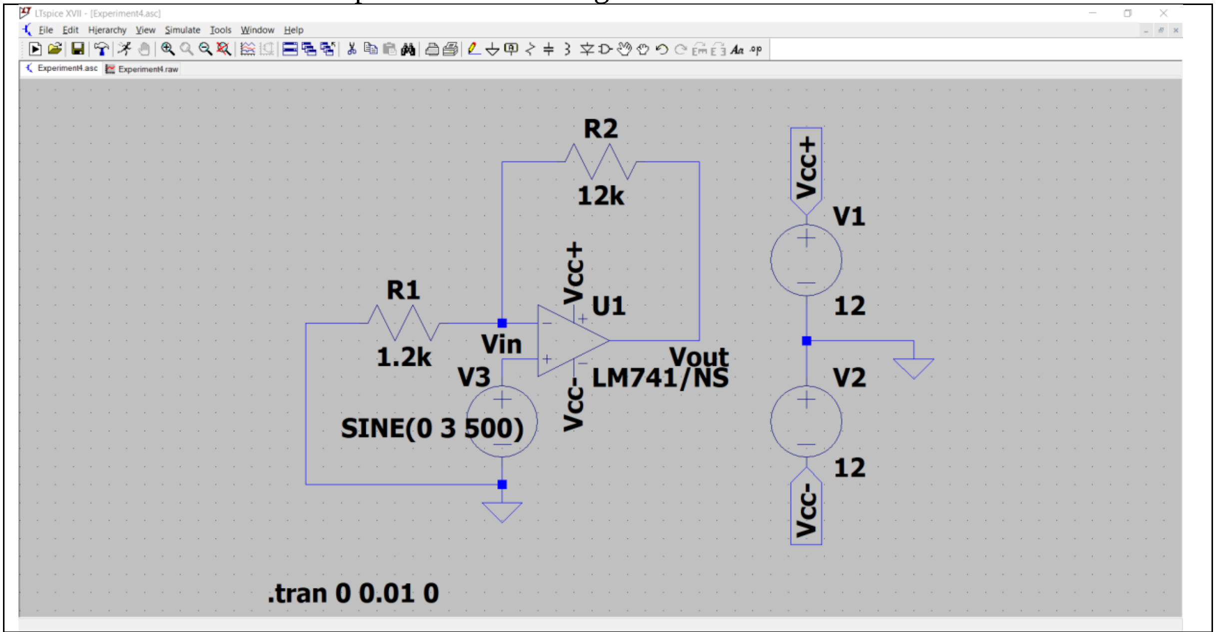


Figure 5: The function of the circuit is to multiply the input voltage by 1 plus the ratio of R_2 and R_1, and the figure corresponds to *Figure 6* in the experiment worksheet.

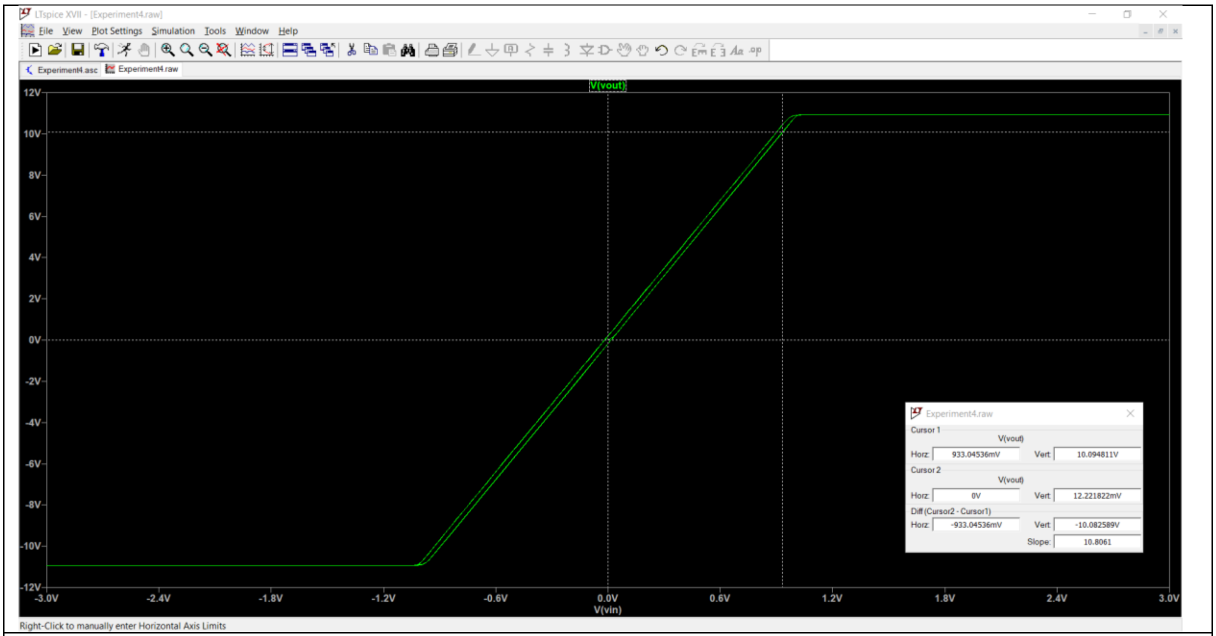


Figure 6: This is a linear graph with a positive slope due to non-inverting, and after some values there are horizontal parts, which are due to saturation. The experimental gain, which is 10.81, is consistent with the theoretical value, which is 11.

Comments:

2) Fill the tables with LTspice circuit designs and the scope outputs of them asked in experimental work **2**. Fill the desired captions below the figures.
Note: Skip the experimental gain calculations for this work.

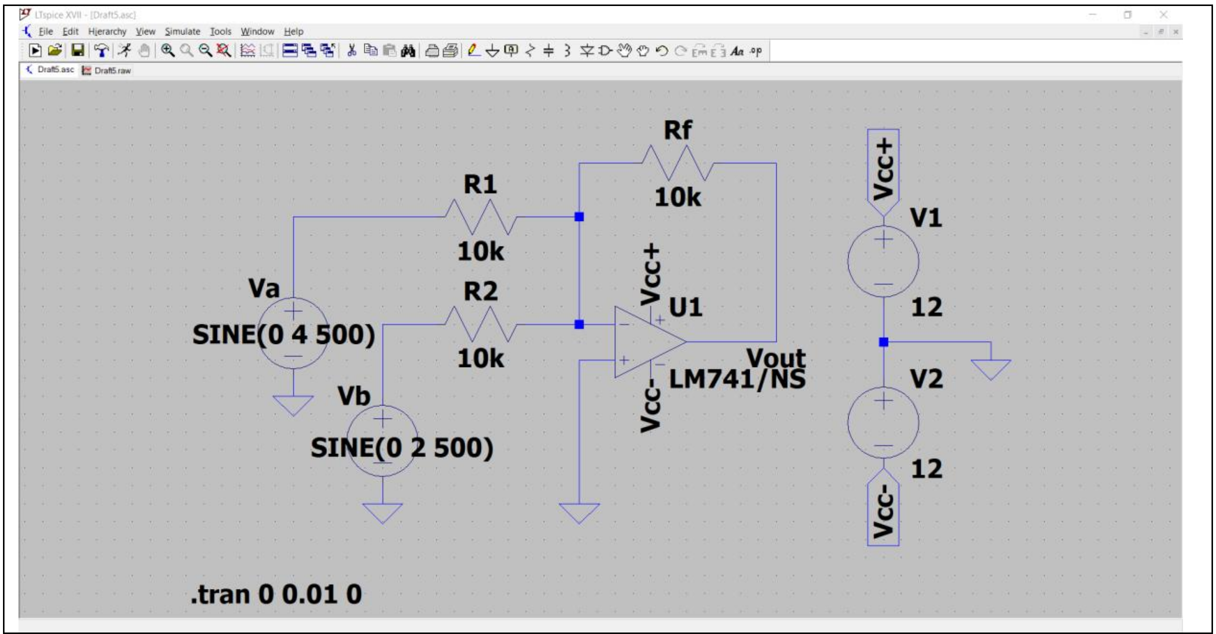


Figure 7: The function of the circuit is to invert the sum of two voltages V_a and V_b, and the figure corresponds to *Figure 7* in the experiment worksheet.

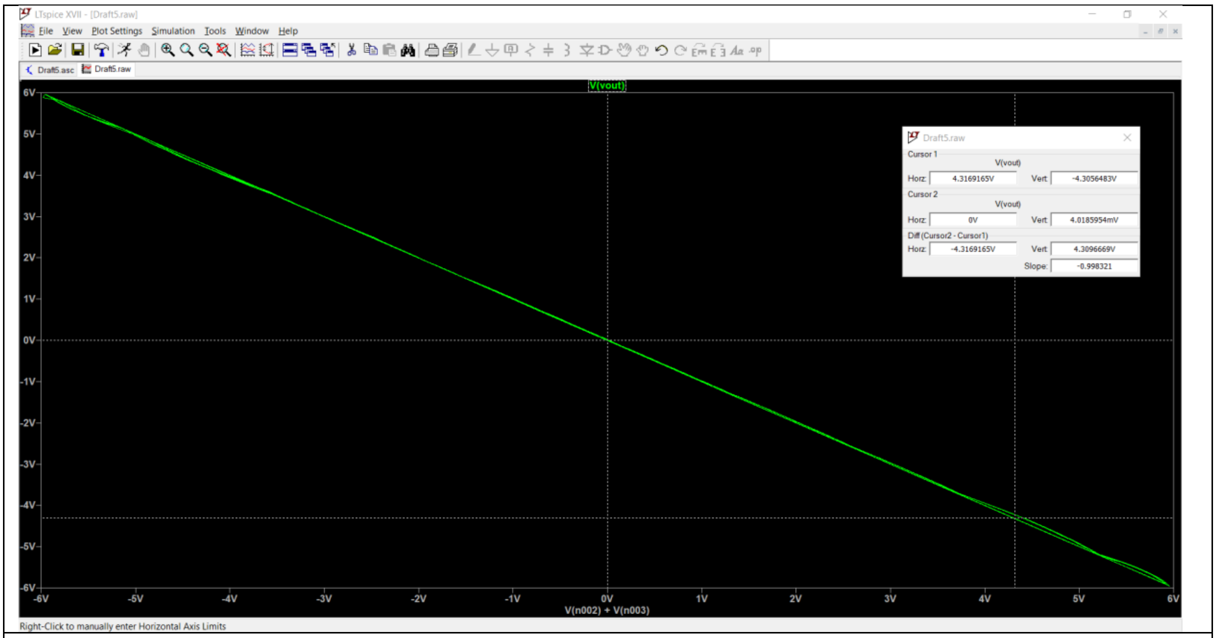


Figure 8: This is a linear graph with a negative slope due to inverting. The experimental gain, which is –1, is consistent with the theoretical value, which is –1.

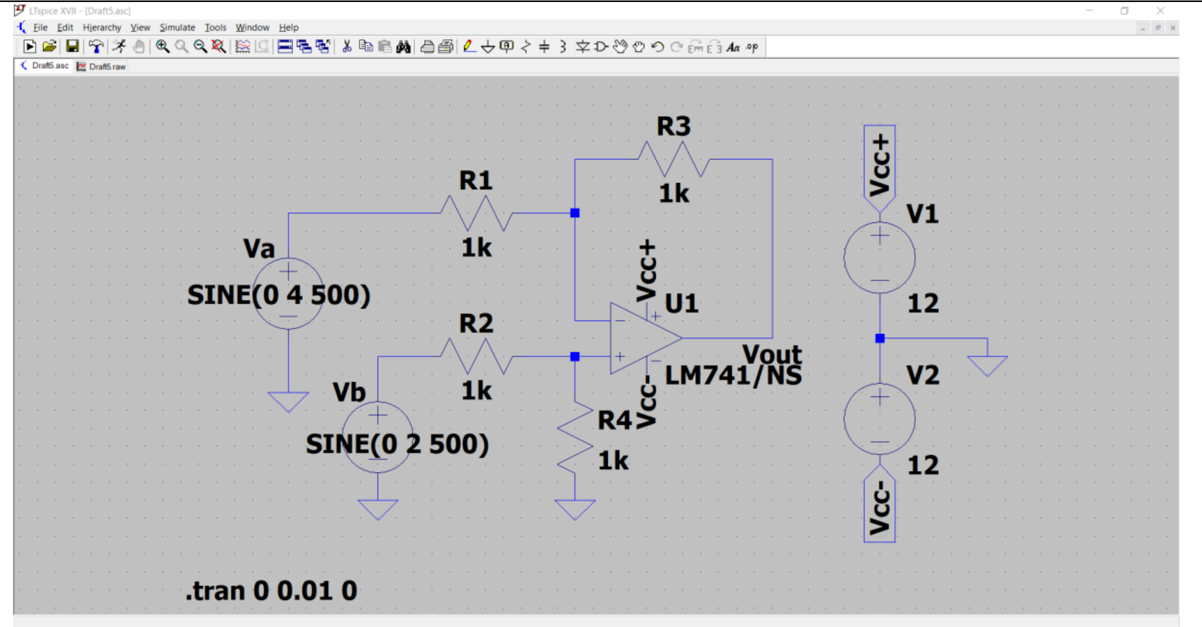


Figure 9: The function of the circuit is to invert the difference of two voltages V_a and V_b, and the figure corresponds to *Figure 8* in the experiment worksheet.

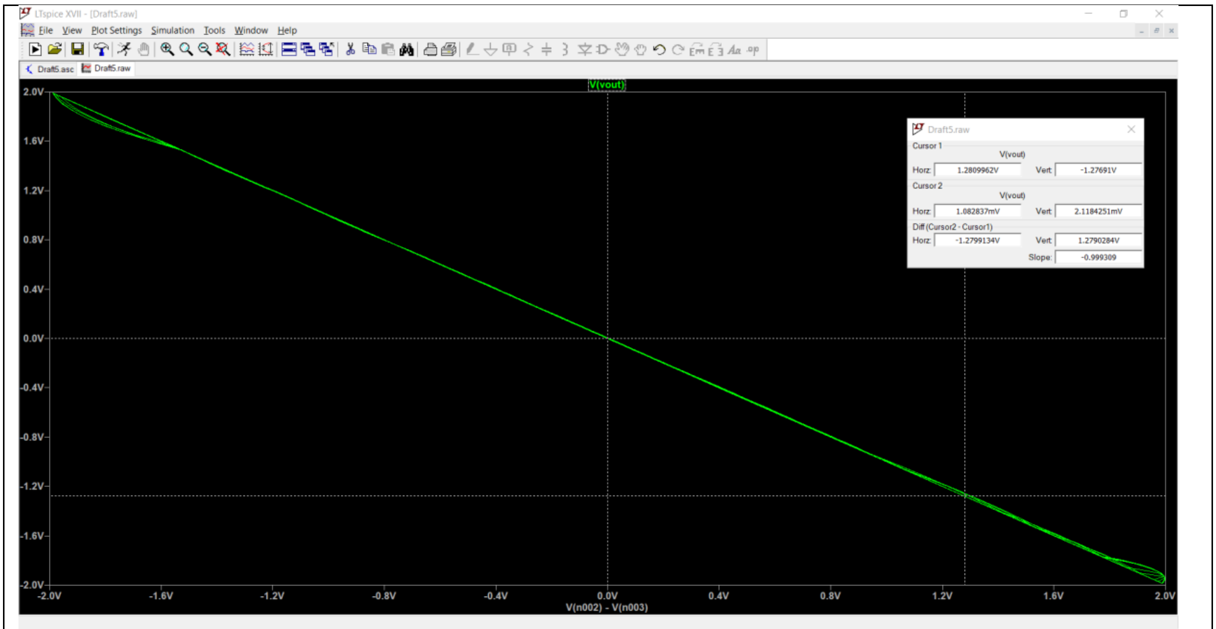


Figure 10: This is a linear graph with a negative slope due to inverting. The experimental gain, which is –1, is consistent with the theoretical value, which is –1.

Comments:

3) Fill the tables with LTspice circuit design and the scope output of them asked in experimental work **3**. Fill the desired captions below the figures.

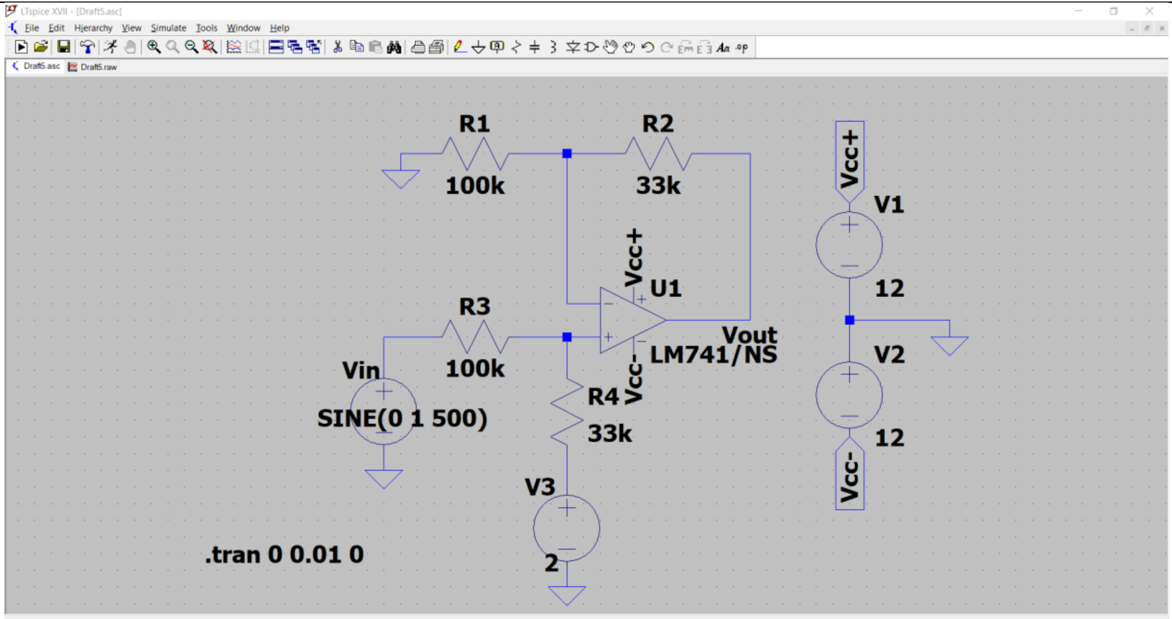


Figure 11: The function of the circuit is to multiply the input voltage by the ratio of R_2 and R_1 and add an offset of 2V, and the figure corresponds to *Figure 9* in the experiment worksheet.

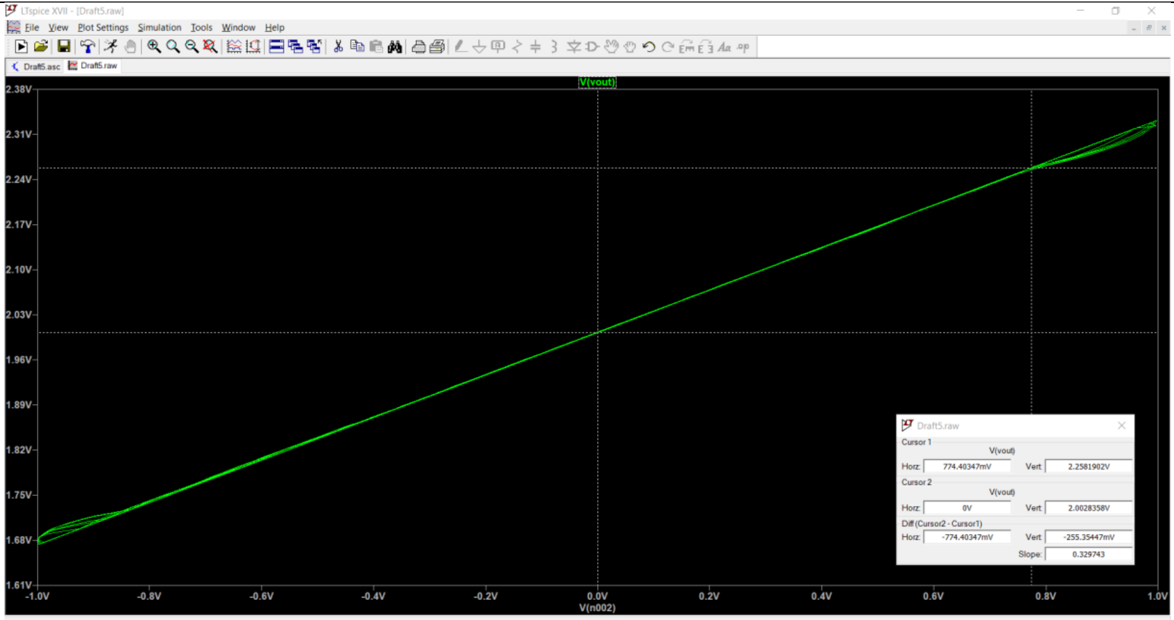


Figure 12: This is a linear graph with a positive slope. The experimental gain, which is 0.33, is consistent with the theoretical value, which is 0.33.

Comments:

4) Conclusions:

1. Why do the outputs saturate?

When the output voltage exceeds the limit that is determined by V_{cc} voltage, it saturates, and the output voltage becomes a positive or negative constant value. This is because we need to stop the infinite increase (or decrease) in the output voltage, which, for example, may become larger and larger when the input is connected to the non-inverting terminal, and this is not feasible.

2. What may happen if the inputs are not grounded correctly?

The node that is not grounded will be at an arbitrary potential. This will lead to a chaos in the voltage values of the nodes that have connections with such a node. The output voltage will also be a mess, and it will even saturate at unpredicted times.