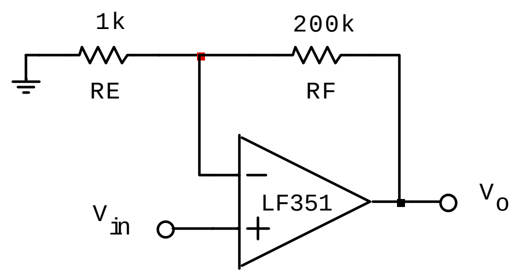
OP AMP CIRCUITS FREQUENCY RESPONSE

PART 1 NON-INVERTING AMPLIFIER

PRE-LAB

Determine the amplifier bandwidth for GBW values of 1 MHz,10 MHz and 100 MHz. Sketch the three frequency responses, along with op amp gain, on a single graph showing LF gains, bandwidths and rolloff rate.



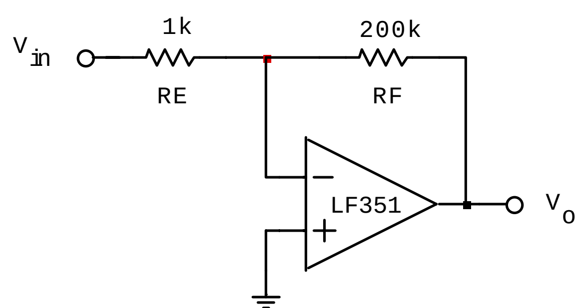
Simulate with µCAP stepping GBW value in order to plot all three closed-loop responses plus the op amp gain response on the same graph. Use cursors and measure all relevant parameters then label all the results directly on the graph using the text mode. Also show pre-lab values right next to corresponding µCAP values.

What is the gap between op amp response and the closed-loop response?

PART 2 INVERTING AMPLIFIER

PRE-LAB

Determine the amplifier bandwidth for R_E values of 1K, 10K and 50K. Sketch the three frequency responses, along with op amp gain, on a single graph showing LF gains, bandwidths and rolloff rate.



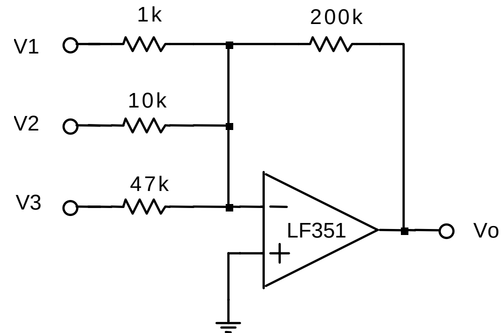
Simulate with µCAP stepping the R_E value in order to plot all three closed-loop responses plus the op amp gain response on the same graph. Use cursors and measure all relevant parameters then label all the results directly on the graph using the text mode. Also show pre-lab values right next to corresponding µCAP values.

What is the gap between op amp response and the closed-loop response?

PART 3 SUMMING AMPLIFIER

PRE-LAB

Calculate the theoretical bandwidth of the summing amplifier shown beside and sketch the three frequency responses V_o/V_1, V_o/V_2 and V_o/V_3, , along with op amp gain, on a single graph showing LF gains, bandwidth and rolloff rate.



Simulate with V_2 and V_3 grounded and V_{in} applied to V_1 in order to plot V_o/V_1 plus the op amp gain response on the same graph. Repeat for input applied to V_2 alone and then V_3 alone. Use cursors and measure all relevant parameters then label all the results directly on the graph using the text mode. Also show pre-lab values right next to corresponding µCAP values.

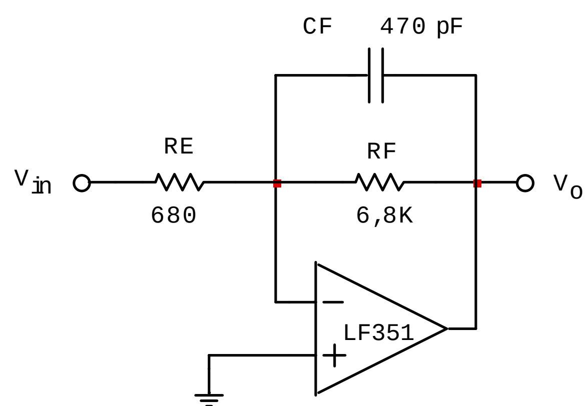
NOTE: In order to plot all three gain responses on the same graph, draw three summing amps with the input applied to V1 in the first summing amp, the input applied to V2 in the second summing amp and the input applied to V3 in the third summing amp.

PART 4 LOW-PASS FILTER

PRE-LAB

Sketch the ideal gain response and label with relevant parameters. Will the LF351 GBW alter the ideal cutoff frequency? By how much? Refer to theory notes.

Calculate the rise and fall times of V_O for a 0,1 Vp input suarewave and a 5 Vp input squarewave - specify whether edges will be linear or exponential.



1. Simulate with µCAP for GBW values of 1MHz, 10 MHz and 100 MHz and plot all three closed-loop responses on the same graph - use stepping feature. Use cursors and measure all relevant parameters then label all the results directly on the graph using the text mode. Also show pre-lab values right next to corresponding µCAP values. What is the gap between the op amp response and the closed-loop response? How does it affect F_C?

2. Measure the 10%-90% rise and fall times of the output squarewave (set GBW=4 MHz) using a 5 kHz-0,1V_{pp} squarewave input. Show rise and fall times directly on the waveform. Calculate the theoretical rise and fall times using $t_r=t_f=0,35/F_C$ and compare to measured results. What shape did the rising and falling edges have here? Why were they not linear?

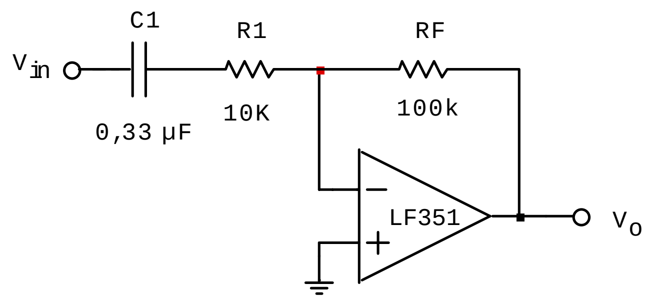
3. Measure the 10%-90% rise and fall times of the output squarewave (GBW=4 MHz) using a 5 kHz-5V_{pp} squarewave input. Show rise and fall times directly on the waveform. Measure the +ve and the -ve slew rates and using mesured slew rates calculate the theoretical rise and fall times and compare to measured results. What shape did the rising and falling edges have here? Why were they not exponential?

PART 5 <u>HIGH-PASS FILTER</u>

PRE-LAB

Sketch the actual gain response and label with relevant parameters. Will the LF351 GBW alter the ideal response? How so?

Calculate the amount of tilt on V_O for a 0,1 Vp input squarewave at 500 Hz, 5 kHz and 50 kHz.



1. Simulate with µCAP for a GBW value 4MHz and plot the closed-loop response and the op amp gain response on the same graph. Use cursors and measure all relevant parameters then label all the results directly on the graph using the text mode. Also show pre-lab values right next to corresponding µCAP values. Is a true high-pass filter realisable? Explain.

2. Measure the output squarewave (GBW=4 MHz) using a 500 Hz-0,1V_{pp} squarewave input. Repeat for 5 kHz and 50 kHz.

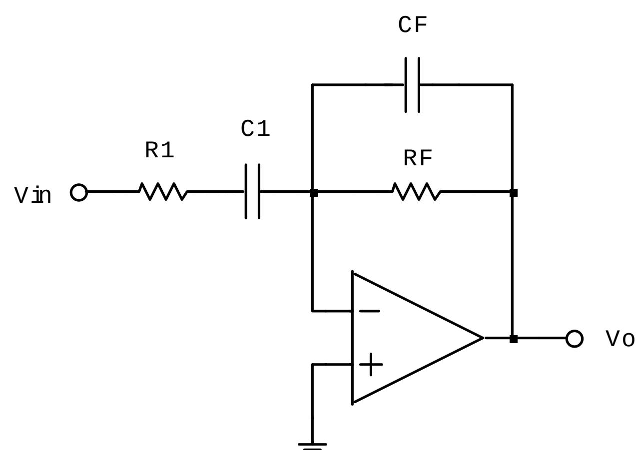
PART 6 <u>BAND-PASS FILTER</u>

PRE-LAB

Calculate the component values to meet the following specifications.

- Band-pass gain of 14 dB
- F_L= 45 Hz
- F_H= 40 kHz

Modify C_F in order to account for GBW of op amp and obtain an accurate F_H of 40 kHz.



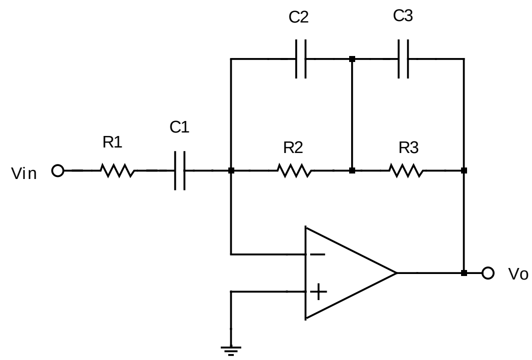
Verify your design with µCAP.

PART 7 ACTIVE FILTER

PRE-LAB

1. Show that the transfer function of the filter shown beside is given by the expression shown below.

2. For values of R_1=3.3K, R_2=15K, R_3=1.5K, C_1=10 µF C_2=0.01µF and C_3=1nF, determine the frequency response and draw an accurate Bode diagram on precision semilog paper for a range of 1 Hz to 1 MHz.



$$\frac{V_o}{V_{in}} = -\frac{(R_2 + R_3)}{R_1}\frac{j\omega C_1 R_1\left(1 + j\omega(C_2 + C_3)R_2 \| R_3\right)}{(1 + j\omega C_1 R_1)(1 + j\omega C_2 R_2)(1 + j\omega C_3 R_3)}$$

PROCEDURE

1. Simulate the frequency response with MicroCap for a range of 1 Hz to 1 MHz. Print out the response and draw the Bode asymptotes of the pre-lab directly on the printout and compare the results.

2. Simulate the frequency response with MicroCap for a range of 1 Hz to 100 MHz and notice what happens at high frequency - sketch result. This effect is caused by the op amp gain being nearly 0 V/V at high frequency and threreby makes the filter entirely a passive filter.