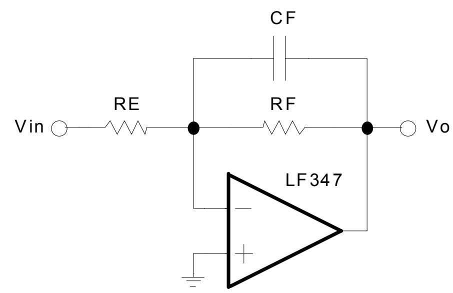
BASIC ACTIVE FILTER LAB

CASE	CF	RE	RF
1	1.10E-09	680	10000
2	1.10E-09	680	12000
3	1.10E-09	680	15000
4	1.10E-09	680	18000
5	1.10E-09	680	22000
6	1.10E-09	680	27000
7	1.65E-09	820	10000
8	1.65E-09	820	12000
9	1.65E-09	820	15000
10	1.65E-09	820	18000
11	1.65E-09	820	22000
12	1.65E-09	820	27000
13	2.20E-09	1000	10000
14	2.20E-09	1000	12000
15	2.20E-09	1000	15000
16	2.20E-09	1000	18000
17	2.20E-09	1000	22000
18	2.20E-09	1000	27000
19	3.30E-09	1200	10000
20	3.30E-09	1200	12000
21	3.30E-09	1200	15000
22	3.30E-09	1200	18000
23	3.30E-09	1200	22000
24	3.30E-09	1200	27000

CIRCUIT DIAGRAM



PRE-LAB

1. Derive the ideal transfer function of the filter.

2. Sketch the op amp gain response and the circuit's ideal response on the same graph and label all of the relevant values including the gap between the two responses at high frequency. Use the typical op amp parameters for the op amp gain response.

3. If the input is a 0.1 V_{PP} squarewave, determine the 10%-90% rise time of the O/P. Are the edges of V_o linear or exponential? Explain.

4. If the input is a squarewave, is it possible for for the O/P to become slew rate limited when not saturated? Explain.

5. What is the maximum frequency of a 10 V_{PP} output sinewave below which slew rate limitation does not occur?

PROCEDURE

1. **µCAP**: Simulate the circuit with GBW values of 400 kHz, 4 MHz and 40 MHz and plot all three op amp gain responses and all three closed-loop responses on the same graph - use the stepping feature. Using the cursors, read LF gain, cutoff frequency and HF gap between op amp response and closed-loop response - label all of the results directly on the graph using the text mode and include graph in report.

GBW	LF Gain (dB)		F_C (Hz)			GAP (dB)	
(Hz)	Expected	µCAP	Expected	µCAP	% dev	Expected	µCAP
0.4M							
4M							
40M							

From the above results, explain what determines the accuracy of F_C.

2. **µCap:** With GBW = 4 MHz, simulate the closed-loop gain response for a range of 10 Hz to 100 kHz using log "frequency step" and 300 points as shown below.

Double click on the simulation graph and save it to a file – the filename has a .usr extension. Now open MS Excel and import the simulation file (filename.usr) into excel, and remove any useless data.

Actual Circuit: Measure the gain response of the circuit and enter the results in a third column of the Excel spreadsheet and plot the points as you go, graphing both the µCap and the measured gain responses at the same time. Ensure that you measure gain at frequencies that are the same as the µCap values.

Use XY scatter graph option in Excel to obtain a semilog response. Scale graph appropriately for best display. Label relevant parameters directly on graph. Include graph in report. Compare LF gains and cutoff frequencies.

LF Gain (dB)			Cutoff Frequency (Hz)		
Predicted	µCap	Measured	Predicted	µCap	Measured

Explain what factors determine the accuracy of the LF gain and the accuracy of the cutoff frequency.

3. **µCap**: Measure the 10%-90% rise and fall times of the output squarewave (set GBW=4 MHz) using a 0,1V_{pp} squarewave input at a frequency equal to 10% of F_C. Show rise and fall times directly on the waveform and include simulation in report. Repeat for a C_F value 50% smaller.

Actual circuit: Measure the actual 10%-90% rise and fall times of the circuit with the oscilloscope – only the C_F value you were assigned. Compare measured values and µCap values to expected values.

	Rise time			Fall time		
	predicted	µCap	measured	predicted	µCap	measured
initial C_F						
50% of C_F			N/A			N/A

From the above results, explain what determines the rise time of a square wave in a low-pass filter?

4. **Actual circuit:** With a square wave input - F = 10% of F_C - observe the output waveform on the oscilloscope while increasing the input amplitude until the output amplitude is slightly below saturation. Did slew rate limitation occur? Explain why. You must zoom in on the edges of V_o to observe this.

Now drive the O/P hard into saturation and observe the edges of V_O again? Are they slew rate limited? If so, measure the new risetime of V_O.

5. **Actual circuit:** Remove C_F and adjust V_{in} to obtain a 10 V_{PP} O/P sinewave at F_{max} calculated in step #5 of the pre-lab. Observe the O/P on the scope while increasing the frequency above F_{max} and observe the slew rate effect – sketch the slew rate-distorted O/P waveform and label it with its "slopes". Explain results.