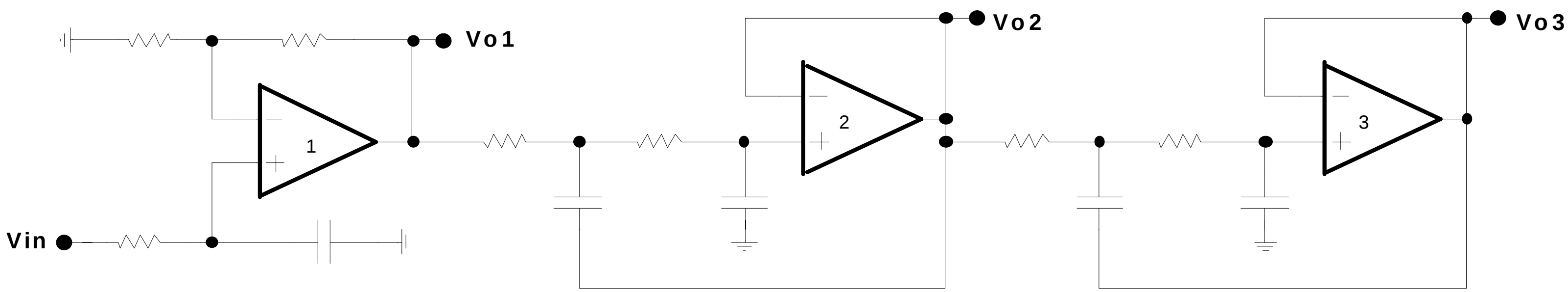
LOW-PASS ACTIVE FILTER LAB .

#		F_c (Hz)	LF gain (dB)	Type 5th order	#		F_c (Hz)	LF gain (dB)	Type 5th order
1	ALLEN, JOSHUA	1000	9	Bessel	1	LORRAIN, MICHEL	1000	9	Butterworth
2	BLACKBURN, STUART	1500	12	Bessel	2	ST-ONGE, PATRICK	1500	12	Butterworth
3	BURNETT, KRAIG	2000	15	Bessel	3	JACKSON, MATTHEW	2000	15	Butterworth
4	CAMPBELL, ALEXANDRE	2500	18	Bessel	4	RADULESCU, ANGEL	2500	18	Butterworth
5	FLAHVENELFORD, RYAN	3000	21	Bessel	5		3000	21	Butterworth
6	GIGNAC, MARC	3500	24	Bessel	6	MCMAHON, MATTHEW	3500	24	Butterworth
7	PROSS, ALEXANDER	4000	7.5	Bessel	7	STANISCI, PAUL	4000	7.5	Butterworth
8	SANDIP, GILL	4500	10.5	Bessel	8	XIAO, WEIWEI	4500	10.5	Butterworth
9		5000	13.5	Bessel	9		5000	13.5	Butterworth
10		5500	16.5	Bessel	10		5500	16.5	Butterworth



Stage 1

Pole: _______________

F_{n1} = ________

A_1 = _________

$F_1(S)$ = ___________________________

Stage 2

Poles: _____________________

F_{n2} = ________

ζ_2 = ________

A_2 = _________

$F_2(S)$ = ___________________________

Stage 3

Poles: _____________________

F_{n3} = ________

ζ_3 = ________

A_3 = _________

$F_3(S)$ = ___________________________

PRE-LAB

1. Determine the poles and zeros of the filter and then find the values of A_o, F_n and ζ of each stage. Label values next to each stage as shown on the previous page.

2. Determine the transfer function of each stage – state numerical coefficients, not general TF – and write it below each stage as shown on the previous page.

3. Design the actual circuit that will meet the specifications that you have been assigned. Use standard capacitor values and any theoretical resistor value needed to obtain an accurate F_n and an accurate gain. Assume that the op amps are LF347's with FET inputs that do not require balancing of resistance. **Write all final component values directly on the circuit diagram.**

5% standard resistors and capacitors

1	1.1	1.2	1.3	1.5	1.6	1.8	2	2.2	2.4	2.7	3	x 10^N
3.3	3.6	3.9	4.3	4.7	5.1	5.6	6.2	6.8	7.5	8.2	9.1	N = … -3,-2,-1,0,1,2,3 …

LAB PROCEDURE

1. For each simulation, open the µCap simulation file and change the component values to your values.
2. Obtain the gain response (sim. file LPF-ACT-GAIN-LAB) of each stage and the overall gain response on the same graph. Label all LF gains, resonant peaks and the 3 dB attenuation frequency of each stage and overall. Why are the peaks different in the 2nd order stages?
3. Obtain the phase response (sim. file LPF-ACT-PHASE-LAB) of each stage and the overall phase response on the same graph.

   i) For the first-order stage, measure the frequency where phaseshift is -45^o that is F_n of this stage.
   ii) For the second-order stages, measure the frequency where phaseshift is -90^o that is F_n of those stages.
   iii) What is the phaseshift range of each stage and the overall filter phaseshift range.

4. Obtain the overall group delay response (sim. file LPF-ACT-DELAY-LAB) of the filter. Read/label the LF delay and the peak delay (if any) – the difference between the LF delay and the peak delay is the passband delay distortion, how much is it?
5. Obtain the transient response (sim. file LPF-ACT-TRANSIENT-LAB) of the overall filter to a 0.1 V_{PP} square wave with a frequency equal to $0.05 {*} F_C$. Measure/label the 0% to 100% rise time, the 1% settling time and the % overshoot.
6. Compare the overall gain, phase, delay and transient responses of the Bessel and Butterworth filters and comment – compare with your partner's results.