Physics 48 01X

Lab #9 – Operational Amplifiers II

The purposes of this lab are

- to construct an elementary differentiator or integrator circuit using an op-amp.
- to construct at least one active filter (either low-pass, high-pass, band-pass, or notch), measure the transfer function, and cascade with other filters and observe the end-to-end transfer function.
- to become familiar with the frequency counter.

Equipment at each station:	Centrally available:
digital oscilloscope	wire and wire cutters/stripper
2 multimeters	red and black banana plug cables
2 power supplies	alligator clips
signal generator	assorted resistors
standard breadboard	assorted capacitors
potentiometer	op-amps (741 and 318)
frequency counter	

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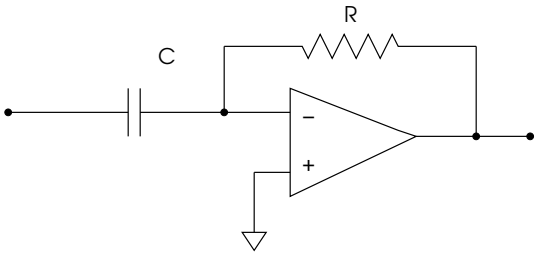
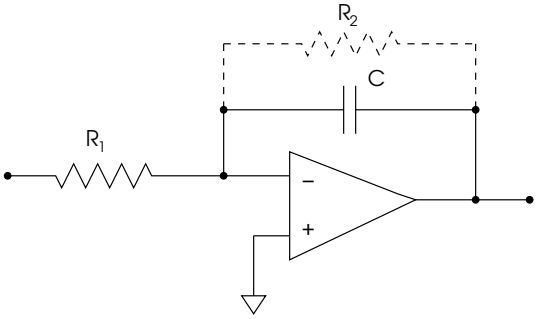
1. Differentiator/Integrator

Differentiator:



R ~ 10k
C ~ 2.2 μ F
f < 1 MHz

Integrator:



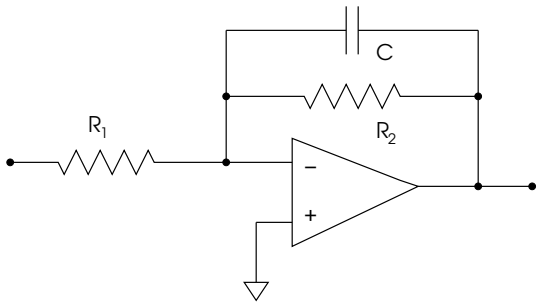
R_1 ~ 10k
R_2 ~ 10M
C ~ 0.02 μ F
f ~ 1 kHz

- Construct an integrator or differentiator following the suggestions in the figures or in the book.
- Verify its functionality using a variety of input wave shapes.
- You might try different op-amps and different frequencies to determine when the circuit behaves non-ideally.
- Note: in the second circuit R_2 is needed to provide a DC feedback path. Without it, the DC gain is huge and amplifies even the tiny input voltage offset to nearly the rail.

2. Active Filters

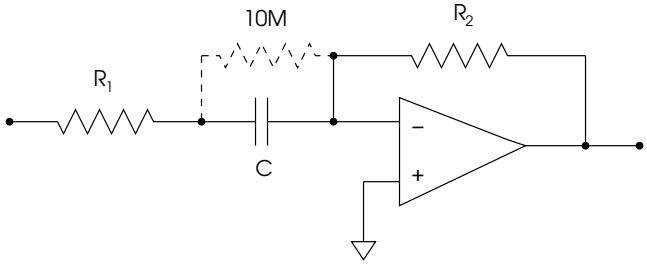
- Build one of the following active filter designs. Try and build a different one from your neighbor.

Low-pass:



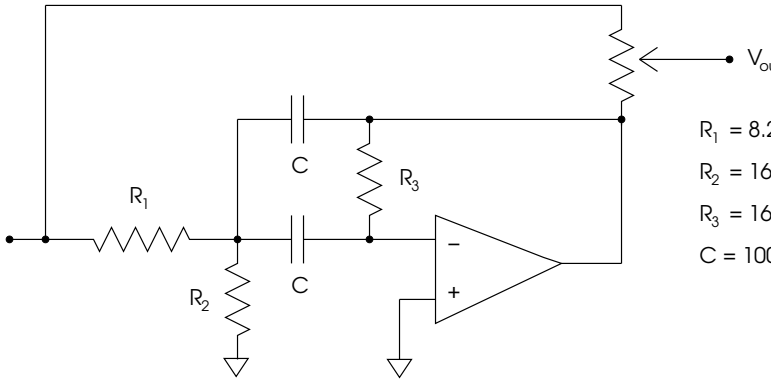
R_1 = 1k
R_2 = 1k
C = 0.02 μ F

High-pass:



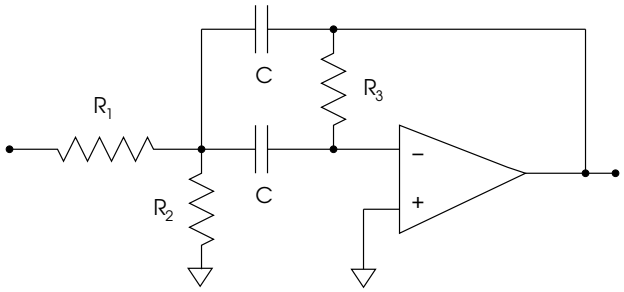
R_1 = 1k
R_2 = 1k
C = 0.2 μ F

Notch:



R_1 = 8.2k
R_2 = 160
R_3 = 16k
C = 100nF

Band-pass:



R_1 = 8.2k
R_2 = 160
R_3 = 16k
C = 10nF

- Alternatively you can look at the handout from *Horowitz and Hill* to design and build a Butterworth, Chebyshev, or Bessel filter. Use as many poles as you dare using parameters from Table 4.2.
- Using the frequency counter to monitor frequency, measure your filters transfer function, including phase.
- Plot the transfer function. You can do this after lab with a plotting program if you like, but make a rough sketch in your lab book.
- Finally, cascade your filter with another (or several to make a super filter) and observe the different response. Measure the transfer function and compare it with the individual functions.
