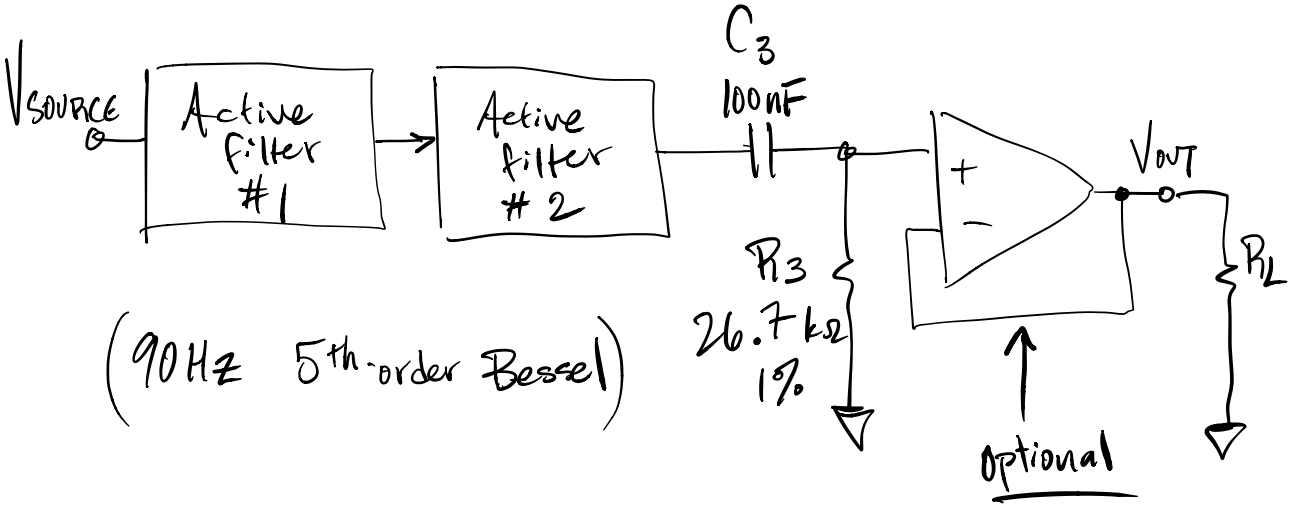
homework solution (refer to uploaded document):



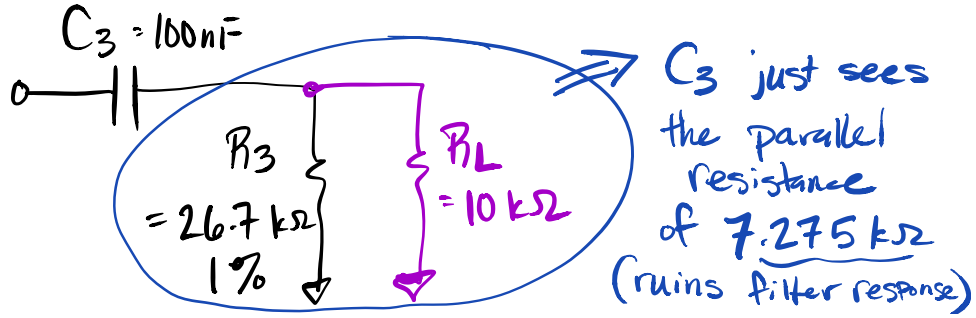

(90Hz 5th-order Bessel)

reality: these filters will be driving some external load, $R_L$

∴ for the active filter sections, no problem;
as long as the op-amp can drive the load
(kΩ-range)

∴ but for the passive section (and all passive filters!),
need to consider the effects of $R_L$.

ex:



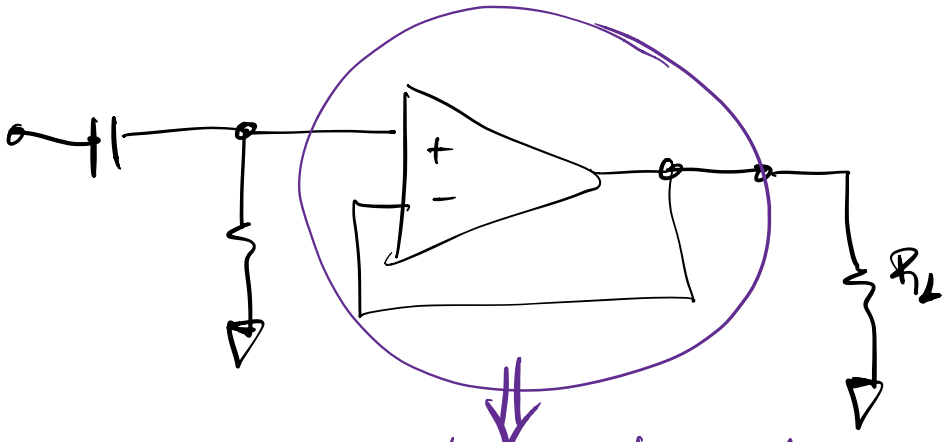
∴ we could try to calculate $C_3$ for an expected load, if we're sure it'll never change

∴ in this case, awkward value, possibly not available!

∴ we could try to calculate some $R_3$ such that $R_3 \| R_L$ gives the right value

etc. etc. etc.

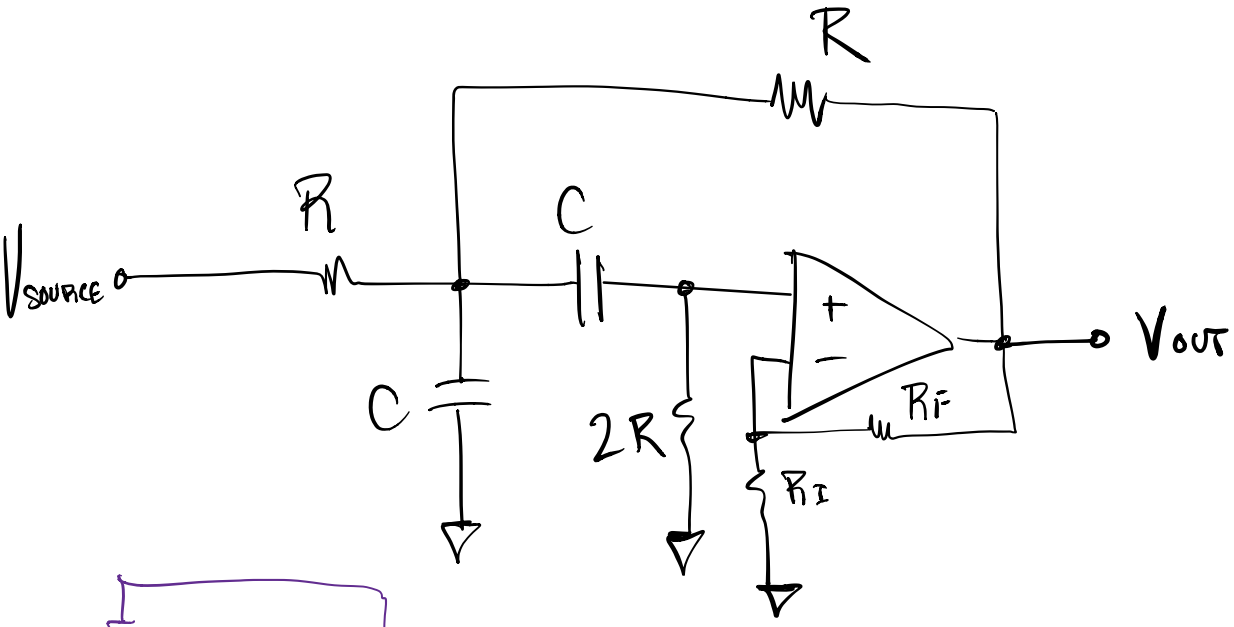
∴ better: buffer it!

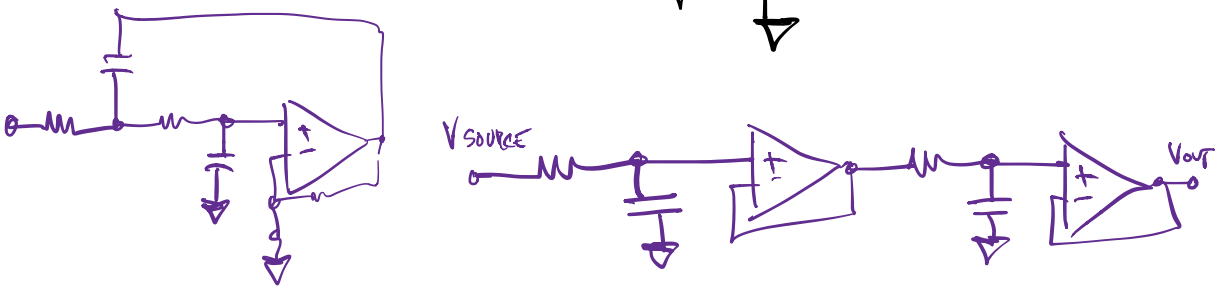



unity gain buffer!

∴ doesn't change frequency response nor passband gain, but isolates $R_L$ from $R_3$ : $C_3$!

# Sallen-Key Equal-Component Band-Pass




- two first-order low-pass filters in cascade → max. Q of 0.5 !
- positive feedback impedance is what underdamps (raises Q) the response!

- Same design procedure as other active S-K E.C. filters; but notice 2R term.

1.) pick $C$

2.) $R = \frac{1}{2\pi f_0 C}$

3.) $A_V = 3 - \frac{1}{Q}$

ex: $f_0 = 500$ Hz

$Q = 4$

↑ pretty sharp!

pick $C = 10$ nF

then $R = 31831 \rightarrow$ use 31.6 kΩ 1%

$2R = 63662 \rightarrow$ use 63.4 kΩ 1%

$A_V = 3 - \frac{1}{Q} = 3 - \frac{1}{4} = 2.75 = 1 + \frac{R_F}{R_I}$

$\frac{R_F}{R_I} = 1.75$

pick $R_F = 10$ kΩ 1%

then $R_I = 5714$

use 5.76 kΩ 1%

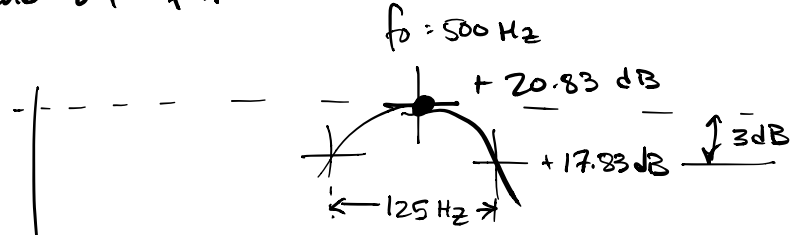
∴ for this configuration, passband gain is <u>not</u> simply $A_V$ !!!

$$A_V(f_0) = A_V \cdot Q$$

$$\therefore A_V(500\ Hz) = 4 \cdot 2.75 = 11$$

or <u>20.83 dB</u>

∴ that's a <u>lot</u> of gain !!! Check for amplifier clipping / saturation ; may need to attenuate signal level ahead of filter




$$Q = \frac{f_0}{f_H - f_L}$$

$$\therefore f_H - f_L = \frac{500}{4}$$

$$= 125\ Hz$$