

Physics 262

Homework #3

Show your work.

For design problems, work to within 5% of specifications.

1. Design an example circuit with only passive components (L, R, C) to demonstrate that it is possible to have gain > 1 without an amplifier at 1 kHz. Could this be done using only resistors and capacitors?
2. For a 2nd order filter described by the general formulae, what is the gain at $\omega = \omega_0$? Give the result for high pass, low pass, band pass, and band stop filters.
3. Draw the circuit of a Sallen-Key high pass filter. Show that $Q = 1/(3 - k)$ and $\omega_0 = 1/RC$ (same as for the low-pass version analyzed in the lecture).
4. Using the general expression for a 2nd order low pass filter with DC gain $k = 1$, derive the formula given in the notes for the frequency of the -3 dB point:

$$\omega_{3dB} = \omega_0 \sqrt{b + \sqrt{1 + b^2}}, \quad \text{where } b = 1 - \frac{1}{2Q^2}.$$

How does this expression change for a high pass filter?