

Laboratory 2

Frequency Response of Active Filters

Please complete the activities in [Lab 1](#) and repeat the steps for the following *active* high-pass filter with values $R_s = 1\text{ k}\Omega$, $C_s = 0.1\text{ }\mu\text{F}$, $R_f = 10\text{ k}\Omega$.

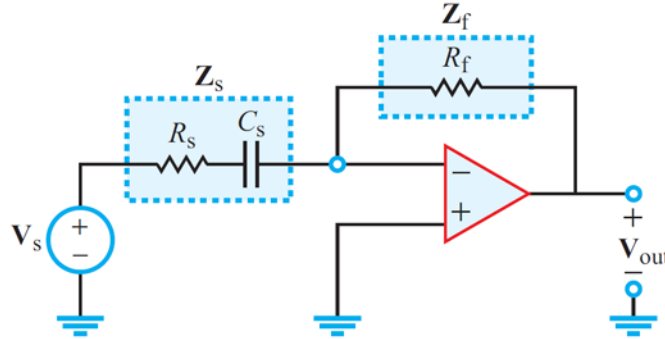


Figure 9-24: Single-pole active highpass filter.

- **Analysis:** Derive the complex frequency response $\mathbf{H}(\omega)$ and the magnitude and phase angle functions, $M(\omega) = |\mathbf{H}(\omega)|$ and $\phi(\omega) = \angle \mathbf{H}(\omega)$.
 - Determine the cutoff (or corner) frequency ω_c in terms of the R and C values.
 - Determine the “passband gain” of the circuit in terms of the resistor values.
 - Use Matlab to plot $M(\omega)$ and $\phi(\omega)$ versus ω as Bode plots. As in Lab 1, the formulas are expressed with radian frequency ω , but the plots use Hz frequency.
- **Measurement:** Use the signal generator and oscilloscope to measure the voltage gain and phase shift at several frequencies, and use Matlab to plot the measured values on the same graph as your analytical plots. Compare the analytical and measured results. Tips:
 - Make the plots versus log frequency, and use dB for the voltage gain (Bode plot).
 - Measure the values of the resistors, and use the measured values in your analytical formulas when you create the plots (for better agreement with measured results).
 - Compare the cutoff (or corner) frequency obtained by analysis and measurement.
 - For the voltage gain, be sure to measure both the input and output voltage amplitudes. For low frequencies (where the gain is small in the high-pass filter), it helps to use larger input amplitudes.
 - Devise an experiment to measure the value of your capacitor (in farads). Compare your measured value with the nominal value printed on the face of the capacitor.
- **PSpice Simulation:** Use PSpice to simulate the circuit and produce Bode plots of $M(\omega)$ and $\phi(\omega)$ (versus frequency in Hz), and compare with the Matlab results.

Lab Report: Each pair of students should submit a report in class on **Thursday, February 9**.

For each circuit in Lab 1 and Lab 2, present your analysis of the frequency response. Show all of the steps that are used to obtain the complex frequency response $\mathbf{H}(\omega)$ and the magnitude and phase angle functions, $M(\omega) = |\mathbf{H}(\omega)|$ and $\phi(\omega) = \angle \mathbf{H}(\omega)$. This can be handwritten.

Present Bode plots of the magnitude (gain) and phase that show the analytical and measured results on the same graph (using Matlab). You should also state the measured value of the cutoff frequency (compare with the analytical value) and your measured value for C (in farads). Present the Bode plots of $M(\omega)$ and $\phi(\omega)$ from PSpice. Make sure all of your Matlab plots have the axes labeled (with units), a title, and a legend (if more than one curve). Briefly comment on the agreement between analysis and measurement in your report.