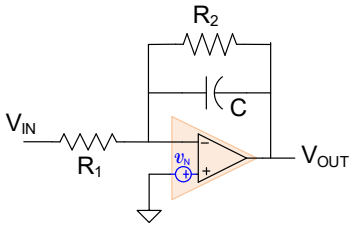
EE 508 Laboratory Experiment 1
Fall 2024

Noise Analysis of Filter Structures

Purpose: The purpose of this experiment is to develop familiarity with methods for predicting the effects of noise on filter structures. This topic will be investigated both analytically and by computer simulations with a comparison of the results obtained by both methods. The computer simulations will be based upon both a time-domain and a frequency-domain noise analysis. To keep the analysis analytically tractable, a lossy integrator structure will be used as a test vehicle.

Test Vehicle: A lossy integrator is shown below. Assume the input-referred spectral density of the op amp is $S_{INV} = 8nV/\sqrt{Hz}$ ($S_{IN} = S_{INV}^2$). In this circuit assume R_1=1K, R_2=100K and C=100nF.



Part 1 Derive an expression for the noise spectral density of the output voltage of the lossy integrator in terms of R_1, R_2, C, and v_N. From the results of this derivation, plot the output noise spectral density with the values of R_1, R_2, C, and v_N specified above.

Part 2 Do a frequency-domain spectral analysis of this integrator in Spectre and compare the results with those obtained in Part 1.

Part 3 Do a time-domain noise analysis of this integrator in Spectre and compare the results with those obtained in Part 1.

Part 4 Repeat Part 2 if the operational amplifier has a GB of 1MHz and compare the results with those obtained in Part 2.

Part 5 Determine the input-referred noise spectral density of this lossy integrator.

Part 6 Determine the signal to noise ratio at V_{OUT} if $V_{IN}=5\sin(2\pi \cdot 10^4 t)$

Part 7 Which noise source is the dominant contributor to the noise in this circuit? What errors would be introduced in the noise analysis if only the noise in the dominant source is included in the noise analysis?