

# Introduction to Time-Varying Electrical Networks: Assignment Week 3

In the problems that follow, assume that the opamps are ideal, but are associated with a noise voltage at their inputs denoted by  $v_{n,a}$  (the corresponding spectral density is denoted by  $S_{va}(f)$ .)

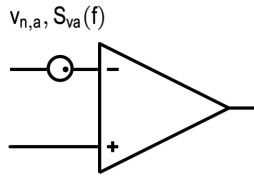


Figure 1: Noise model for an opamp, which is otherwise ideal.

## Problem 3

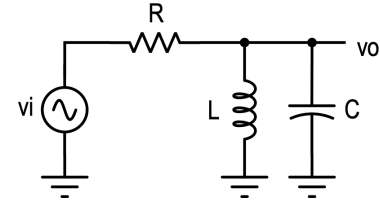


Figure 4: Network for problem 3.

The network of Fig. 4 shows a second-order bandpass filter whose transfer function is of the form

$$H(s) = \frac{G}{1 + \frac{s}{\omega_0 Q} + \frac{s^2}{\omega_0^2}} \quad (1)$$

Determine  $G$ ,  $\omega_0$ ,  $Q$  in terms of circuit parameters. Determine the output noise-voltage spectral density, and the total integrated output noise.

## Problem 4

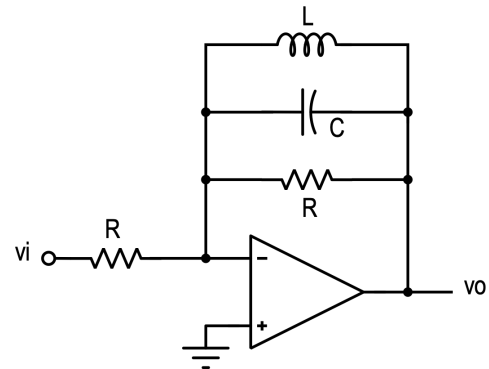


Figure 5: Network for problem 4.

Repeat problem 3 for the circuit shown in Fig. 5. Assume that the opamp is ideal and noiseless.

## Problem 1

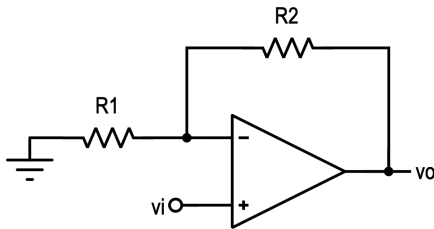


Figure 2: Circuit for problem 1.

For the circuit of Fig. 2 determine the output noise voltage spectral density.

## Problem 2

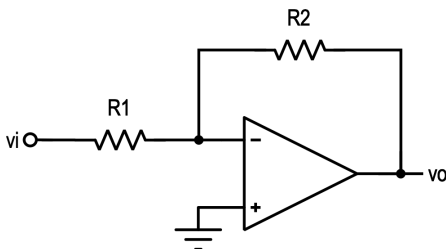


Figure 3: Circuit for problem 2.

Repeat problem 1 for the circuit of Fig. 3.

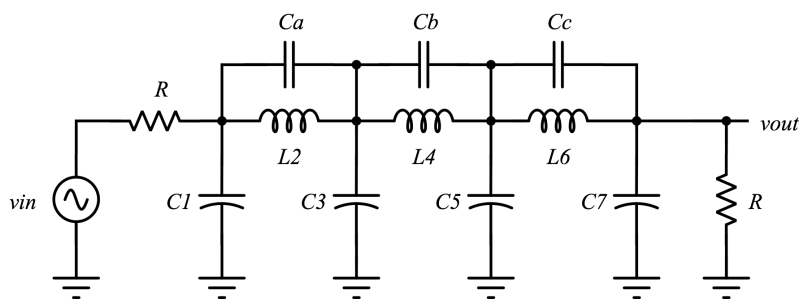


Figure 6: Network for problem 5.

## Problem 5

Determine the total integrated output noise of the lowpass filter circuit shown in Fig. 6. Repeat if the output terminating resistor is made an open circuit.