EE5320: Analog Integrated Circuit Design; Assignment 2

Nagendra Krishnapura (nagendra@iitm.ac.in)

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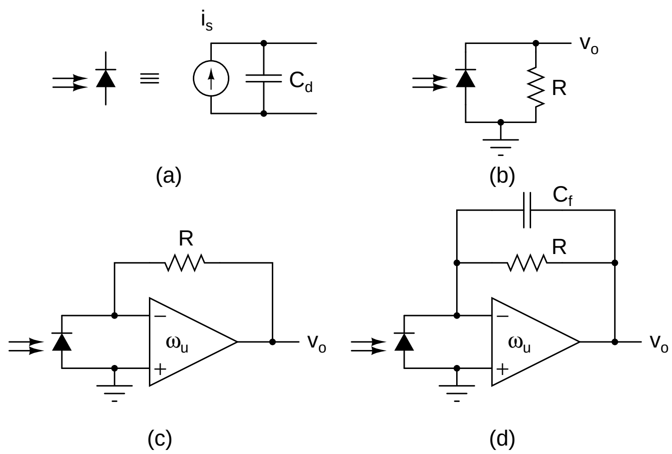

Figure 1: Problem 1

1. Fig. 1 shows the model for a photodiode. The diode is setup in reverse bias (biasing arrangement not shown) and when light shines on it, a current is produced. The current can be converted to voltage using the schemes in Fig. 1(b) to (d). This circuit is used in optical communication systems. The goal is to maximize the gain as well as the bandwidth of conversion from i_s to v_o. Do the following for a given R (gain)

   - What is the bandwidth in Fig. 1(b)? What is the gain bandwidth product?
   - What is the bandwidth in Fig. 1(c)? Choose the opamp's ω_u such that you get a maximally flat magnitude response (maximum possible bandwidth without peaking; derivatives $d^n/d\omega^n|H(j\omega)|^2$ should be zero to the maximum degree n that is possible.). What is the gain bandwidth product? What are the advantages and disaadvantages of Fig. 1(c) when compared to Fig. 1(b)? (One sentence each!)
   - What is the bandwidth in Fig. 1(c)? Choose an ω_u for the opamp and then choose C_f such that you get a maximally flat magnitude response (maximum possible bandwidth without peaking; derivatives $d^n/d\omega^n|H(j\omega)|^2$ should be zero to the maximum degree n that is possible.). What is the gain bandwidth product? What are the advantages and disaadvantages of Fig. 1(d) when compared to Fig. 1(b, c)? (One sentence each!)

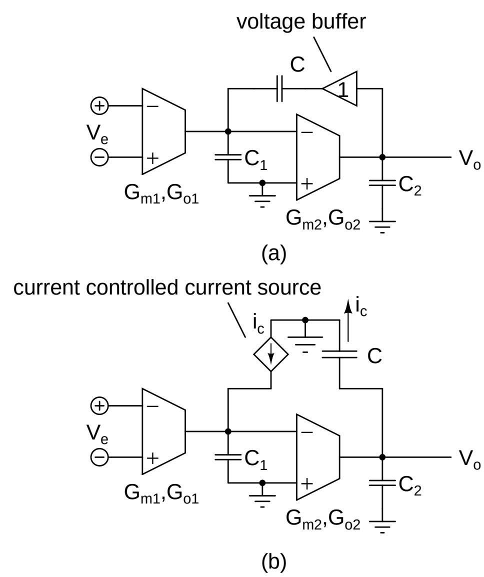

Figure 2: Problem 2

2. The circuits in Fig. 2(a, b) are modified versions of the two stage miller compensated opamp. Calculate their transfer functions and compare them to that of the conventional structure. What is the difference? Explain the results.

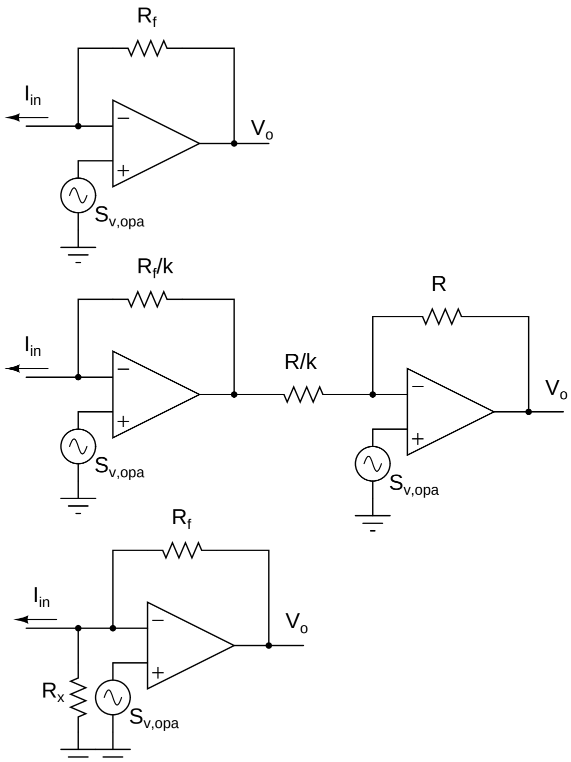

Figure 3: Problem 3

3. Determine the output noise spectral density and input referred (current) noise spectral density of the transimpedance amplifiers in Fig. 3. This is the current source that must be connected to the input of the noiseless versions of these circuits so that the output noise is the same as in the real, noisy, circuits. The opamp has an input referred voltage noise spectral density of $S_{v,opa}$ V^2/Hz and is otherwise ideal. Don't just be satisfied with calculating the expressions—draw logical conclusions from them!

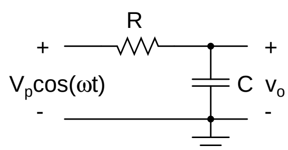

Figure 4: Problem 4

4. The filter in Fig. 4 is driven by a sinusoid at $\omega = 1/RC$. Calculate the output noise voltage, output signal to noise ratio SNR (ratio of mean squared signal to mean squared noise voltages), and the power dissipated in the circuit.

If the impedances of all components are scaled up by a factor α, what happens to the transfer function of the circuit, output noise voltage, output signal to noise ratio, and the power dissipation?

Express the power dissipation in terms of the signal to noise ratio and the bandwidth of the circuit (in Hz). What tradeoffs does this relationship represent?