Analog Integrated Circuit Design

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Assignment 1

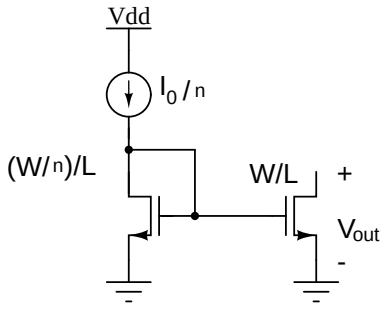

Figure 1: Problem 1

1. A current mirror generating I_0 is realized as shown in Fig. 1. It is required to support a minimum output voltage of V_{out}. It is proposed that the reference branch have a current I_0/n in order to minimize "overhead" currents. How do the power consumption and noise compare with a 1:1 current mirror?

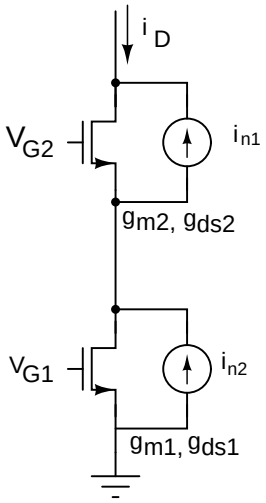

Figure 2: Problem 2

2. Compute the contribution to output current noise from noise current i_{n1} and i_{n2} in the two devices in Fig. 2.

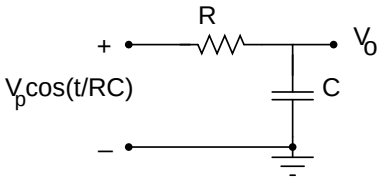

Figure 3: Problem 3

3. For the RC filter shown in Figure 3, determine the following:

   (a) Mean Squared output signal (S)

   (b) Mean squared output noise (N)

   (c) Ratio S/N

   (d) Power Dissipated in the resistor (P_d)

   (e) Bandwidth in Hz (f_B)

   Express the power dissipated (P_d) in terms of the signal to noise ratio and the bandwidth.

4. Determine the rms signal, rms noise, signal to noise ratio (as a ratio of mean squared quantities) at the output of Fig. 4. Assume an low frequency input. What is the amplifier's transfer function? The opamp can be either (i) class A (Fig. 4(b)): In this case a constant current I_{bias}, equal to the highest possible output current) is drawn from the amplifier; or (ii) class B (Fig. 4(c)): In this case, currents out of the opamp are drawn from the positive supply and currents into the opamp are pushed into the negative supply. In each case, calculate the power dissipation. Relate the power dissipation to amplifier specifications: gain, bandwidth, and signal to noise ratio.

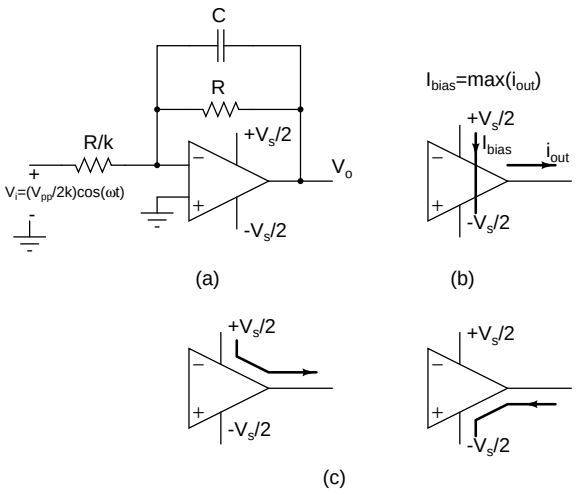

Figure 4: Problem 4

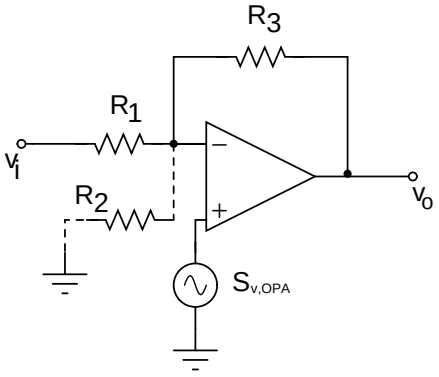

Figure 5: Problem 5

5. In Figure 5 calculate the output noise PSD and the input referred noise PSD due to the opamp noise (PSD = Sv,opa) with and without R2.

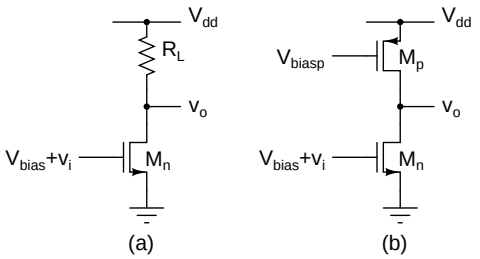

Figure 6: Problem 6

6. Fig. 6 shows two common source amplifiers designed for the same small signal gain. Determine the output noise of the two amplifiers in terms of the small signal parameters of M_p and M_n and comment on the results. Assume that the transistors are biased correctly in saturation region.