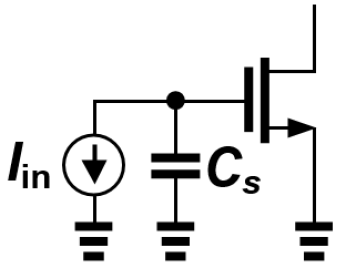
Problem Set 3
Due Fri Mar 8, 2019
Submit through bCourses

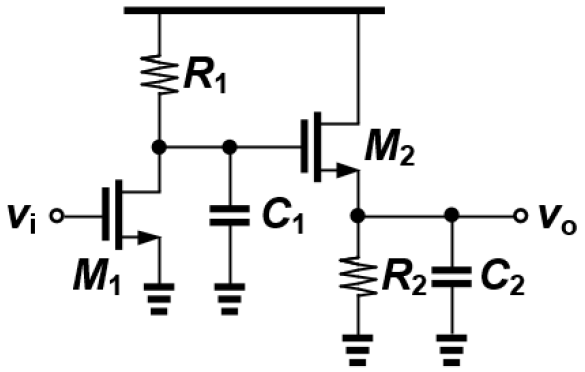
1. **Amplifier Noise**

   For the circuit below calculate the transconductance g_m that minimizes the minimum detectable signal (when I_{in} equals to input-referred current noise) as a function of γ, ω_T and C_s. In the plot of MDS vs g_m, comment briefly on why there is a minimum and how the slope relates to g_m. (Consider C_{GS} and ignore C_{GD}.)



2. **Amplifier Design**

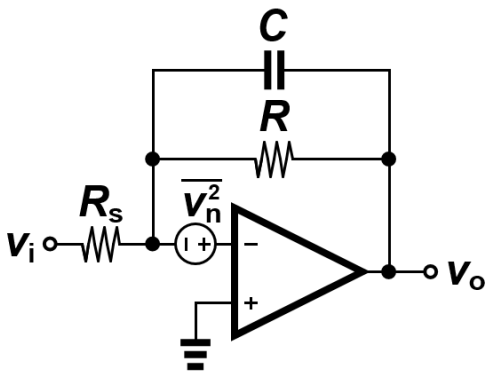
(a) What is the total noise at the output of the common-source-common drain cascade shown below? Ignore flicker noise, r_o , and capacitor except those explicitly drawn in the diagram. You should provide your answer in terms of $kT, C_1, C_2, \gamma, A_{v1}, A_{v2}, \omega_{p1}$,and ω_{p2}. $A_{v1,v2}$ and $\omega_{p1,p2}$ are the low-frequency voltage gains and dominant poles of the two stages.



(b) We have a fixed power budget for the two stages of amplifer and we would like to minimize the total noise at the output. To simplify the analysis, we can assume the V^*'s and GBW's of the two stages are identical, $R_1C_1 = R_2C_2$, and $g_{m1}R_1, g_{m2}R_2 >> 1$. What potion of the power would you allocate to the M_1 in order to minimize the total noise at the output? (Hint: In order to maintain fixed GBW, the power consumption of each stage is linearly proportional to its load capacitance.)

3. **Filter Noise.**

You are given an active RC low pass filter with noisy resistors and noisy op-amp shown below.



(a) Assume the op-amp has infinite dc gain and infinite GBW(ω_u). Calculate v_0/v_i and total output noise. What issue did you find?

(b) Assume the op-amp has infinite dc gain and finite GBW(i.e. You can model the op-amp gain $A(s) = -\omega_u/s$, where $\omega_u >> 1/RC$). Calculate v_0/v_i and total output noise. How does the noise relate to ω_u?