EE539: Analog Integrated Circuit Design; HW3

Nagendra Krishnapura (nagendra@iitm.ac.in)

due on 23 Feb. 2007

$0.18\,\mu$m technology parameters: $V_{Tn} = 0.5\,$V; $V_{Tp} = 0.5\,$V; $K_n = 300\ \mu\text{A}/V^2$; $K_p = 75\ \mu\text{A}/V^2$; $A_{VT} = 3.5\,mV\,\mu$m; $A_\beta = 1\%\,\mu$m; $V_{dd} = 1.8\,$V; $L_{min} = 0.18\ \mu$m, $W_{min} = 0.24\ \mu$m; Ignore body effect unless mentioned otherwise.

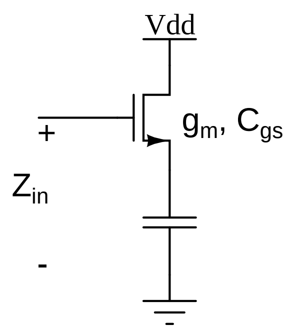

Figure 1: Problem 1

1. Determine the real part of the input impedance of the source follower (Fig. 1). Model the transistor with g_m and C_{gs}. What is its significance?

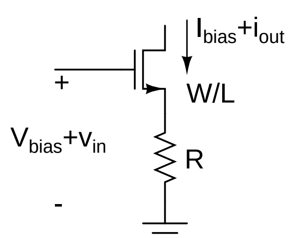

Figure 2: Problem 2

2. A source degenerated common source amplifier is biased at current I_{bias}. Determine the first 4 terms of the Taylor series expansion of i_{out} as function of v_{in}. What is the effect of degeneration? Assume that the MOSFET obeys square law.

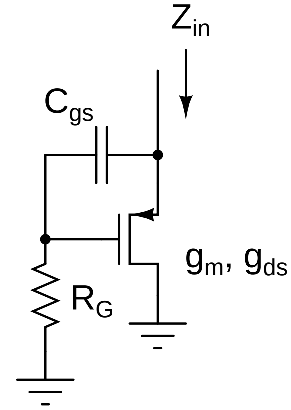

Figure 3: Problem 3

3. Determine the small signal impedance Z_{in} in Fig. 3. Represent Z_{in} with a passive equivalent circuits.

   Simulate the circuit using a $10\,\mu\text{m}/0.5/mum$ transistor biased at $50\,\mu$A and $R_G = 10\,\text{k}\Omega$. Plot the magnitude and phase response of the impedance. Repeat for $R_G = 0$ and overlay the plots. Is the expected behavior seen in simulation?

4. The circuit in Fig. 4(b) is the miller equivalent of Fig. 4(a). Determine the transfer functions of Fig. 4(a) and Fig. 4(b)? Are they the same?

   Determine the transfer function of Fig. 4(c). Replace Fig. 4(c) by its miller equivalent Fig. 4(d)

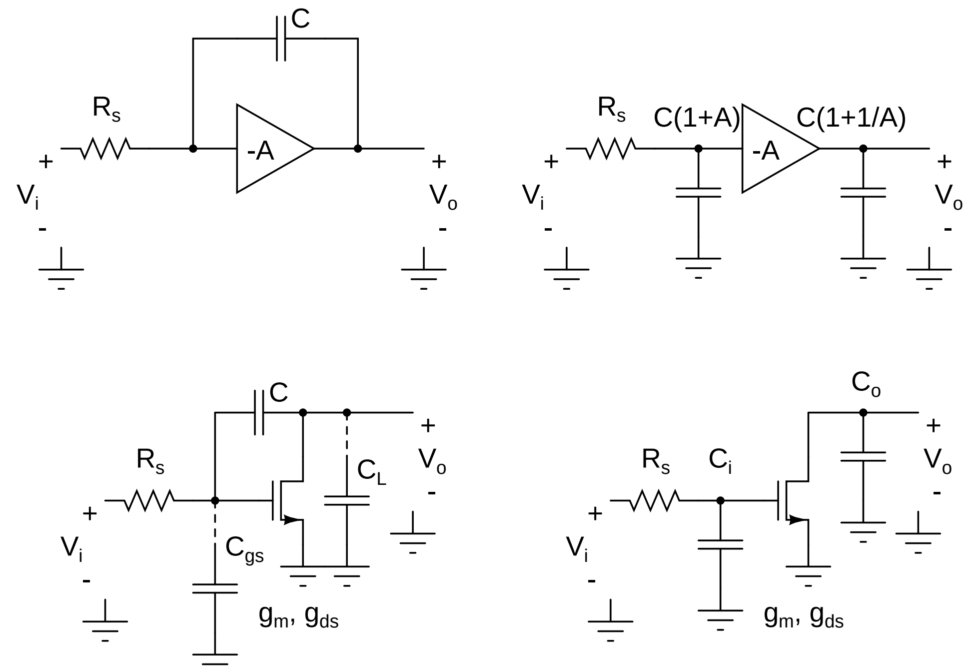

Figure 4: Problem 4

and determine its transfer function. Are the results the same? If not, what are the differences and why? Carry out this exercise by first omitting C_{gs} and C_L, and then including them in the analysis.

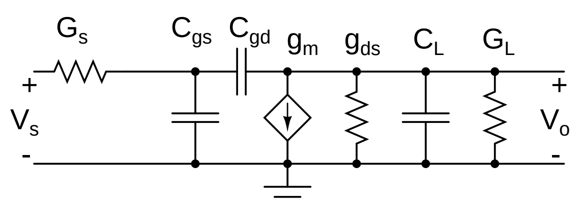

Figure 5: Problem 5

5. $g_m = 100\mu$S, $g_{ds} = 1\mu$S, $G_L = 2\mu$S, $G_s = 1\mu$S, $C_{gs} = 0.1$ pF, $C_{gd} = 0.05$ pF, $C_L = 0.5$ pF. Plot the magnitude and phase response of the circuit (overlaid) for the following cases: a) $C_{gd} = \{0, 0.05, 0.1, 0.2, 0.4, 0.8, 1.6\}$ pF, b) $C_L = \{0, 0.05, 0.1, 0.2, 0.4, 0.8, 1.6\}$ pF, c) $G_L = \{0, 1, 2, 4, 8, 16\}$ μS. (In each case all other components have their nominal values). Comment on the results.

Don't submit the following problems, just try them out.

1. Calculate the poles and zeros for each case in the above problem. How do they compare to the approximate expressions?