ECE 3050 Analog Electronics Quiz 3

June 9, 2010

Professor Leach Last Name:____________________ First Name:____________________

Instructions. Print and sign your name in the spaces above. Place a box around answers when appropriate.

Honor Code Statement: *I have neither given nor received help on this quiz.* Initials __________

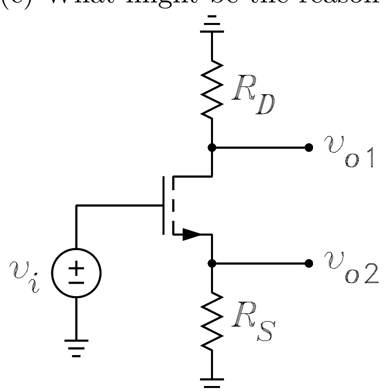
Equations: $I_D = K(V_{GS} - V_{TO})^2$, $G_m = (r_s + R_{ts})^{-1}$, $r_s = g_m^{-1}$, $r_{id} = r_0(1 + g_m R_{ts}) + R_{ts}$, $r_{is} = r_s$, $r_{ig} = \infty$.

1 of 2. The figure shows a MOSFET signal circuit that is called a phase splitter. It is given that $R_D = R_S = 2\,\mathrm{k}\Omega$, $g_m = 0.002\,\mathrm{S}$, and $r_0 = \infty$ (open circuit).

(a) Draw the Norton drain circuit and use it to solve for v_{o1} as a function of v_i.

(b) Draw the Thévenin source circuit and use it to solve for v_{o2} as a function of v_i.

(c) What might be the reason that the circuit is called a "phase splitter?"



$$v_{o1} = -G_m v_i R_D = -\frac{R_D}{r_s + R_S} v_i = -0.8 v_i \qquad v_{o2} = \frac{R_S}{r_s + R_S} v_i = -0.8 v_i$$

The two outputs are 180° out of phase.

2 of 2. The figure shows a MOSFET bias circuit. Given: $V^+ = 24\,\mathrm{V}$, $R_D = 11\,\mathrm{k}\Omega$, $R_G = 100\,\mathrm{k}\Omega$, $R_S = 1.2\,\mathrm{k}\Omega$, $K = 10\,\mu\mathrm{S/V}^2$, and $V_{TO} = 1.8\,\mathrm{V}$.

(a) Solve for V_{GG} and R_{GG}.

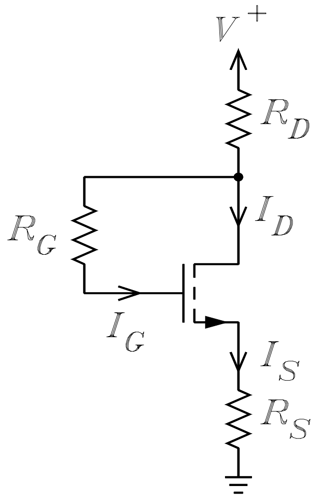
$$V_{GG} = V^+ - I_D R_D \qquad R_{GG} = R_G + R_D$$

(b) Write the loop equation for the gate-source loop and use it to solve for I_D assuming the MOSFET is in its saturation state.

$$V^+ - I_D R_D = \sqrt{\frac{I_D}{K}} + V_{TO} + I_D R_S \Longrightarrow I_D(R_D + R_S) + \frac{1}{\sqrt{K}}\sqrt{I_D} + \left(V_{TO} - V^+\right) = 0 \Longrightarrow I_D = 1\,\mathrm{mA}$$

(b) For the value of I_D, check to verify that $V_{DS} > V_{GS} - V_{TO}$ for the MOSFET to be in the saturation state.

$$V_{DS} = \left(V^+ - I_D R_D\right) - (I_D R_S) = 11.8\,\mathrm{V} \qquad V_{GS} - V_{TO} = \sqrt{\frac{I_D}{K}} = 10\,\mathrm{V}$$


V^+
R_D
I_D
R_G
I_G
I_S
R_S