EN.520.216 Homework 3

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February 2023

Problem 1

Problem 2 We use the fact that the current is expressed by $I_D = \frac{k'W}{2L}((V_{GS} - V_T)V_{DS} - V_{DS}^2)$ in saturation, and see if the resulting V_O makes sense, and if necessary, evaluate the linear mode equation (since $V_{GS} - V_T > 0 \forall$ R).

Problem 3

1. C_1 removes any potential bias from the ac voltage source that might interfere with the quiescent point of operation. C_2 also removes bias at the output such that the only output is the ac amplified signal.

2. At the dc operating point, the gate sees the output of a voltage divider, with value $V_{dd}\frac{R_g}{R_g+R_b} = 0.3V = V_{GS}$. This gives a drain current $I_D = \frac{k'W}{2L}(V_{GS} - V_T) = 3.072\mu A$ (we are told that the transistor is in saturation mode).

3. $\lambda = 0$, therefore it follows that $\frac{dI_D}{dV_{DS}} = 0$ and r_o is reduced to an open circuit. For small signals, we can ground all commons and treat capacitors as wires, as in figure The voltage at the gate is the output of a voltage divider formed by R_1 and $R_2||R_G||R_B$, where the former is $2k\Omega$ and the latter $\approx 1.66k\Omega$. We write this as $V_{GS} = V_i\frac{1.66}{3.66}$. The transconductance parameter g_m can be derived to be $2\sqrt{K_n I_D}$ where $K_n = \frac{k'W}{2L} = 0.48mAV^{-2}$ and I_d is as before, so $g_m = 0.0768mAV^{-1}$. The current through R_D is then given by $0.0768v_{gs}$, and $V_o = 46.08v_{gs}$. $\frac{V_o}{V_i} = \frac{v_{gs}46.08}{V_{gs}3.66/1.66} = 20.90$, which is our gain.