Homework 3 (Due Date: Thursday, Feb 7th In Class)

Sanjay Krishna: University of New Mexico

Problem 4.5

An n-channel MOSFET is biased in the saturation region at a constant V_{GS}. (a) The drain current is $I_D = 0.250$ mA at $V_{DS} = 1.5$ V and $I_D = 0.258$ mA at $V_{DS} = 3.3$ V. Determine the value of λ and r_o. (b) Using the results of part (a), determine I_D at $V_{DS} = 5$ V.

Problem 4.9

The circuit shown in Figure 4.1 has parameters $V_{DD} = 2.5$ V and $R_D = 10$ kΩ. The transistor is biased at $I_{DQ} = 0.12$ mA. The transistor parameters are $V_{TN} = 0.3$ V, $k_n' = 100\,\mu$A/V^2, and $\lambda = 0$. (a) Design the W/L ratio of the transistor such that the small-signal voltage gain is $A_v = -3.8$. (b) Repeat part (a) for $A_v = -5.0$.

Problem 4.13

Consider the circuit in Figure 4.14 in the text. The circuit parameters are $V_{DD} = 3.3$ V, $R_D = 8\ \text{k}\Omega$, $R_1 = 240\ \text{k}\Omega$, $R_2 = 60\ \text{k}\Omega$, and $R_{Si} = 2\ \text{k}\Omega$. The transistor parameters are $V_{TN} = 0.4$ V, $k_n' = 100\,\mu\text{A/V}^2$, $W/L = 80$, and $\lambda = 0.02\ \text{V}^{-1}$. (a) Determine the quiescent values I_{DQ} and V_{DSQ}. (b) Find the small-signal parameters g_m and r_o. (c) Determine the small-signal voltage gain.

Problem 4.15

For the NMOS common-source amplifier in Figure P4.15, the transistor parameters are: $V_{TN} = 0.8$ V, $K_n = 1$ mA/V^2, and $\lambda = 0$. The circuit parameters are $V_{DD} = 5$ V, $R_S = 1\ \text{k}\Omega$, $R_D = 4\ \text{k}\Omega$, $R_1 = 225\ \text{k}\Omega$, and $R_2 = 175\ \text{k}\Omega$. (a) Calculate the quiescent values I_{DQ} and V_{DSQ}. (b) Determine the small-signal voltage gain for $R_L = \infty$. (c) Determine the value of R_L that will reduce the small-signal voltage gain to 75 percent of the value found in part (b).

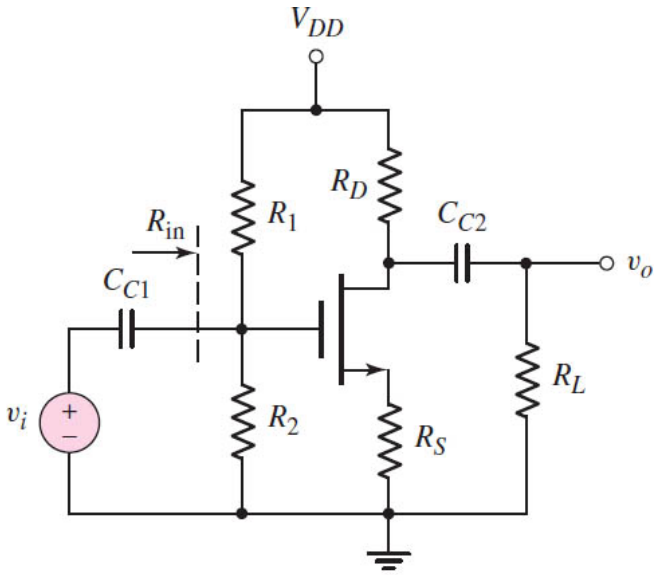

Figure P4.15

Problem 4.19

Consider the ac equivalent circuit shown in Figure P4.18. Assume $r_o = \infty$ for the transistor. The small-signal voltage gain is $A_v = -8$ for the case when $R_S = 1$ k Ω.
(a) When R_S is shorted ($R_S = 0$), the magnitude of the voltage gain doubles. Assuming the small-signal transistor parameters do not change, what are the values of g_m and R_D? (b) A new value of R_S is inserted into the circuit and the voltage gain becomes $A_v = -10$. Using the results of part (a), determine the value of R_S.

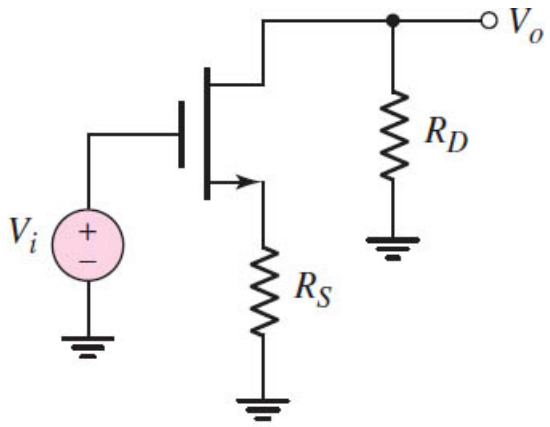

Figure P4.18