Homework #10

MOSFET Amplifiers and Single-Stage MOSFET IC – *100 points*

DUE @ Beginning of Class: Tuesday, November 28

1) E-Book, problem 4.31 (10 points)

2) E-Book, problem 4.44 (15 points)

3) E-Book, problem 4.52 (10 points)

4) E-Book, problem 4.53; hint: see Ex. 4.11 (15 points)

5) E-Book, problem 4.59 (20 points)

6) E-Book, problem 4.61 (15 points)

7) E-Book, problem 4.65; hint: $I_{dD} = I_Q = I_{dL}$ (15 points)

1) E-Book, problem 4.31 (10 points)

4.31 The open-circuit ($R_L = \infty$) voltage gain of the ac equivalent source-follower circuit shown in Figure P4.31 is $A_v = 0.98$. When R_L is set to 1 kΩ, the voltage gain is reduced to $A_v = 0.49$. What are the values of g_m and r_o?

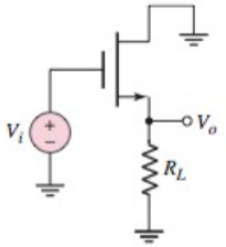


Figure P4.31

2) E-Book, problem 4.44 (15 points)

4.44 The transistor in the circuit in Figure P4.44 has parameters $V_{TN} = 0.4$ V, $K_n = 0.5$ mA/V^2, and $\lambda = 0$. The circuit parameters are $V_{DD} = 3$ V and $R_i = 300\,\text{k}\Omega$. (a) Design the circuit such that $I_{DQ} = 0.25$ mA and $V_{DSQ} = 1.5$ V. (b) Determine the small-signal voltage gain and the output resistance R_o.

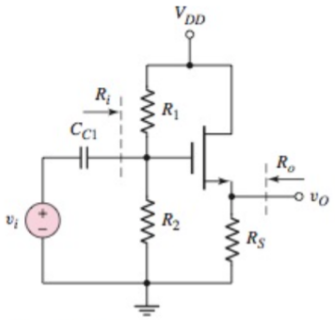


Figure P4.44

3) E-Book, problem 4.52 (10 points)

4.52 For the common-gate amplifier in Figure 4.35 in the text, the PMOS transistor parameters are $V_{TP} = -0.8\,\text{V}$, $K_p = 2.5\,\text{mA/V}^2$, and $\lambda = 0$. The circuit parameters are $V^+ = 3.3\,\text{V}$, $V^- = -3.3$, $R_G = 100\,\text{k}\Omega$, and $R_L = 4\,\text{k}\Omega$. (a) Determine R_S and R_D such that $I_{DQ} = 1.2\,\text{mA}$ and $V_{SDQ} = 3\,\text{V}$. (b) Determine the small-signal voltage gain $A_v = v_o/v_i$.

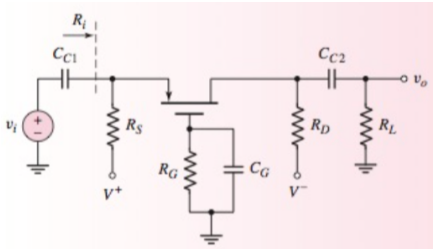
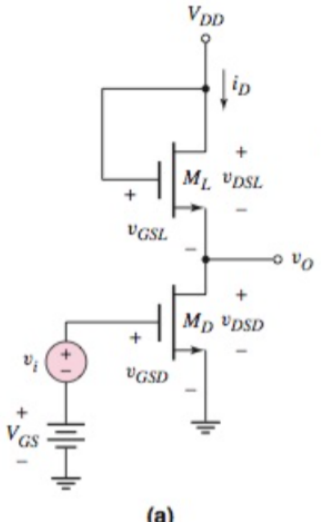


Figure 4.35 Figure for Exercise Ex 4.10

4) E-Book, problem 4.53; hint: see Ex. 4.11 (15 points)

4.53 Consider the NMOS amplifier with saturated load in Figure 4.39(a). The transistor parameters are $V_{TND} = V_{TNL} = 0.6\,\text{V}$, $k_n' = 100\,\mu\text{A/V}^2$, $\lambda = 0$, and $(W/L)_L = 1$. Let $V_{DD} = 3.3\,\text{V}$. (a) Design the circuit such that the small-signal voltage gain is $|A_v| = 5$ and the Q-point is in the center of the saturation region. (b) Determine I_{DQ} and V_{DSDQ}.



(a)

5) E-Book, problem 4.59 (20 points)

4.59 The transistor parameters for the common-source circuit in Figure P4.59 are $V_{TND} = 0.4\,\text{V}$, $V_{TPL} = -0.4\,\text{V}$, $(W/L)_L = 50$, $\lambda_D = 0.02\,\text{V}^{-1}$, $\lambda_L = 0.04\,\text{V}^{-1}$, $k_n' = 100\,\mu\text{A/V}^2$, and $k_p' = 40\,\mu\text{A/V}^2$. At the Q-point, $I_{DQ} = 0.5\,\text{mA}$. (a) Determine $(W/L)_D$ such that the small-signal voltage gain is $A_v = V_o/V_i = -40$. (b) What is the required value of V_B? (c) What is the value of V_{GSDQ}?

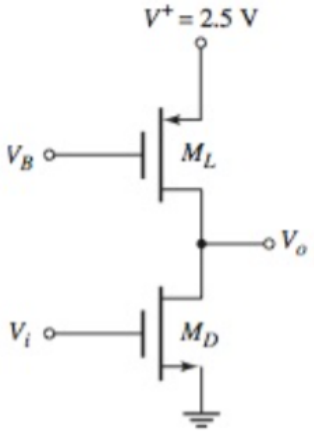


Figure P4.59

6) E-Book, problem 4.61 (15 points)

4.61 The ac equivalent circuit of a CMOS common-source amplifier is shown in Figure P4.61. The transistor parameters for M_1 are $V_{TN} = 0.5$ V, $k_n' = 85\ \mu A/V^2$, $(W/L)_1 = 50$, and $\lambda = 0.05\,V^{-1}$, and for M_2 and M_3 are

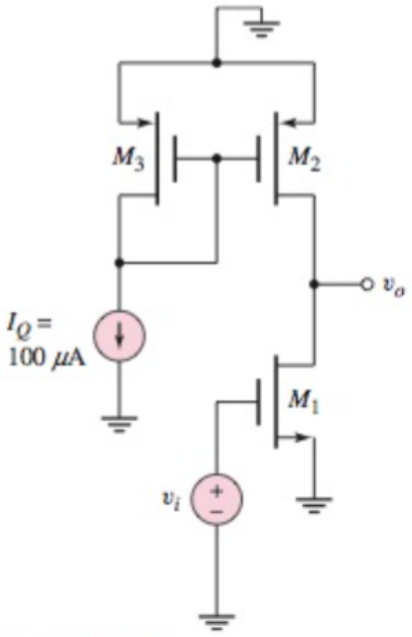


Figure P4.61

7) E-Book, problem 4.65; hint: $I_{dD} = I_Q = I_{dL}$ (15 points)

4.65 Figure P4.65 shows a common-gate amplifier. The transistor parameters are $V_{TN} = 0.6\,\text{V}$, $V_{TP} = -0.6\,\text{V}$, $K_n = 2\,\text{mA/V}^2$, $K_p = 0.5\,\text{mA/V}^2$, and $\lambda_n = \lambda_p = 0$. (a) Find the values of V_{SGLQ}, V_{GSDQ}, and V_{DSDQ}. (b) Derive the expression for the small-signal voltage gain in terms of K_n and K_p. (c) Calculate the value of the small-signal voltage gain $A_v = V_o/V_i$.

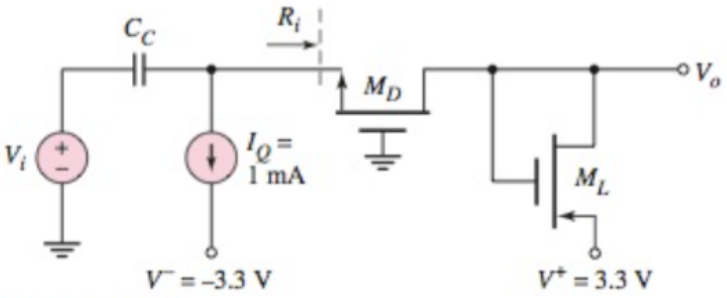


Figure P4.65