Homework #9

MOSFET Circuits: DC Biasing and Common Source Amplifier – *100 points*

DUE @ Beginning of Class: Thursday, November 16

1) E-Book, problem 3.26 (10 points)

2) E-Book, problem D3.28 (find R_1 and R_2) (10 points)

3) E-Book, problem 3.29 (20 points)

4) E-Book, problem 3.40 (10 points)

5) E-Book, problem 4.8 (10 points)

6) E-Book, problem 4.15 (12 points)

7) E-Book, problem 4.18 (10 points)

8) E-Book, problem D4.26 (18 points)

1) E-Book, problem 3.26 (10 points)

3.26 In the circuit in Figure P3.26, the transistor parameters are $V_{TN} = 0.8$ V and $K_n = 0.5$ mA/V^2. Calculate V_{GS}, I_D, and V_{DS}.

2) E-Book, problem D3.28 (find R_1 and R_2) (10 points)

D3.28 The transistor in Figure P3.28 has parameters $V_{TN} = 0.4\,\text{V}$, $k_n' = 120\ \mu\text{A/V}^2$, and $W/L = 80$. Design the circuit such that $I_Q = 0.8\,\text{mA}$ and $R_{\text{in}} = 200\,\text{k}\Omega$.

3) E-Book, problem 3.29 (20 points)

3.29 The transistor in the circuit in Figure P3.29 has parameters $V_{TP} = -0.8$ V and $K_p = 0.20$ mA/V^2. Sketch the load line and plot the Q-point for (a) $V_{DD} = 3.5$ V, $R_D = 1.2$ kΩ and (b) $V_{DD} = 5$ V, $R_D = 4$ kΩ. What is the operating bias region for each condition?

4) E-Book, problem 3.40 (10 points)

3.40 The PMOS transistor in Figure P3.40 has parameters $\tilde{V}_{TP} = -0.7\,\text{V}$, $k_p' = 50\,\mu\text{A/V}^2$, $L = 0.8\,\mu\text{m}$, and $\lambda = 0$. Determine the values of W and R such that $I_D = 0.1\,\text{mA}$ and $V_{SD} = 2.5\,\text{V}$.

5) E-Book, problem 4.8 (10 points)

4.8 The parameters of the circuit in Figure 4.1 are $V_{DD} = 3.3\,\text{V}$ and $R_D = 5\,\text{k}\Omega$. The transistor parameters are $k_n' = 100\,\mu\text{A/V}^2$, $W/L = 40$, $V_{TN} = 0.4\,\text{V}$, and $\lambda = 0.025\,\text{V}^{-1}$. (a) Find I_{DQ} and V_{GSQ} such that $V_{DSQ} = 1.5\,\text{V}$. (b) Determine the small-signal voltage gain.

6) E-Book, problem 4.15 (12 points)

4.15 For the NMOS common-source amplifier in Figure P4.15, the transistor parameters are: $V_{TN} = 0.8\,\text{V}$, $K_n = 1\,\text{mA/V}^2$, and $\lambda = 0$. The circuit parameters are $V_{DD} = 5\,\text{V}$, $R_S = 1\,\text{k}\Omega$, $R_D = 4\,\text{k}\Omega$, $R_1 = 225\,\text{k}\Omega$, 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).

7) E-Book, problem 4.18 (10 points)

4.18 The ac equivalent circuit of a common-source amplifier is shown in Figure P4.18. The small-signal parameters of the transistor are $g_m = 2$ mA/V and $r_o = \infty$. (a) The voltage gain is found to be $A_v = V_o/V_i = -15$ with $R_S = 0$. What is the value of R_D? (b) A source resistor R_S is inserted. Assuming the transistor parameters do not change, what is the value of R_S if the voltage gain is reduced to $A_v = -5$.

8) E-Book, problem D4.26 (18 points)

*D4.26 Design the common-source circuit in Figure P4.26 using an n-channel MOSFET with $\lambda = 0$. The quiescent values are to be $I_{DQ} = 6$ mA, $V_{GSQ} = 2.8$ V, and $V_{DSQ} = 10$ V. The transconductance is $g_m = 2.2$ mA/V. Let $R_L = 1$ kΩ, $A_v = -1$, and $R_{in} = 100$ kΩ. Find R_1, R_2, R_S, R_D, K_n, and V_{TN}.