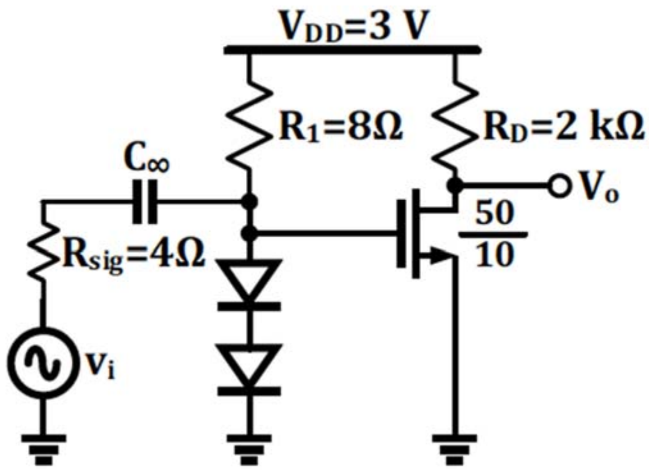
ECE 342: Electronic Circuits | **Summer 2024**
Problem Set #5 | **Professor Schutt-Aine**
Due Date: 5pm, Tue, Jul 2nd

Assume the following for all problems: $k_n' = 200\mu A/V^2, V_{tn} = 0.5V$; $k_p' = 100\mu A/V^2, V_{tp} = -0.5V$. Assume $r_{ds} = \infty$ unless otherwise stated.

1. Assume $n = 1$ for the diodes. Consider the CS amplifier below:



a) Obtain the DC bias point, i.e., $V_G, V_D = V_O, and\ I_D$. Assume constant voltage drop model for the diodes with $V_{D(on)} = 0.7V$.

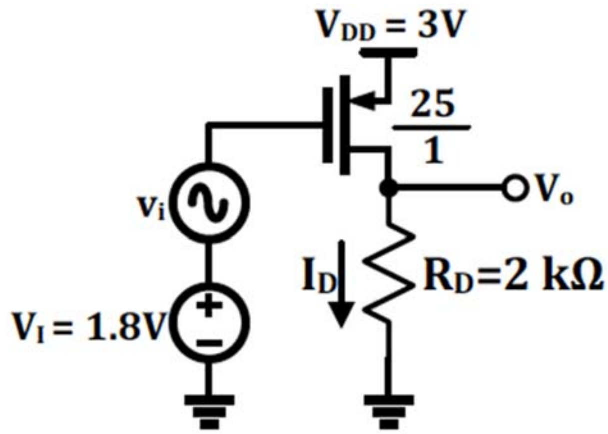
b) Draw the small-signal model of this circuit.

c) Determine the small-signal gain $A_v = v_o/v_i$.

d) If $v_i = 0.005\sin(w_c t)$, derive an expression for the total output $V_o(t) = V_O + v_o(t)$.

e) Repeat part d) but this time in the presence of supply voltage ripple $v_{dd} = 0.001\sin(w_s t)$.

2. For the CS amplifier below (assume $r_{ds} = \infty$ for part a)-d)):



a) Calculate I_D and V_O.

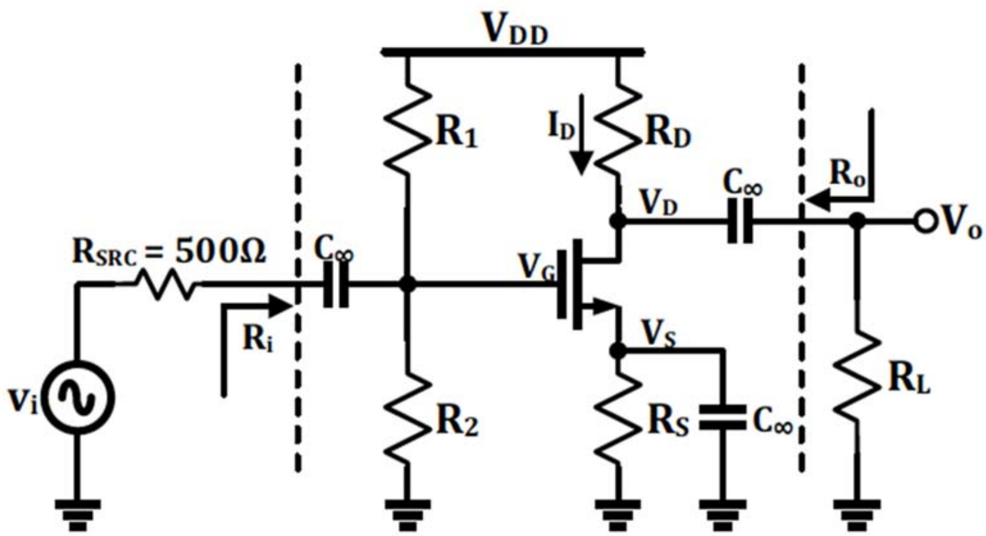
b) Draw the small-signal model of this circuit.

c) Determine the small-signal gain $A_v = v_o/v_i$.

d) Determine R_i and R_o of this amplifier.

e) If the Early voltage $V_A = -15V$, redo parts c) and d).

3. For the circuit below, $V_{DD} = 5V$; $R_1 = 40k\Omega$; $R_2 = 60k\Omega$; $R_D = 2k\Omega$; $R_S = 2k\Omega$; $R_L = 3k\Omega$, $\frac{W}{L} = \frac{40}{1}$ and $r_{ds} = \infty$.



a) Calculate I_D, V_D, and V_G. Show that the transistor is in saturation.

b) Draw the small-signal model of this circuit.

c) Determine the small-signal gain $A_v = v_o/v_i$.

d) Determine R_i and R_o of this amplifier.

e) Determine the maximum voltage gain $|A_v|$ you can obtain from this circuit if you are allowed to modify the value of R_D only.