ORDRE DES INGÉNIEURS DU QUÉBEC

MAY 2020 SESSION

Open-book examination
Calculators: only authorized models
Duration: 3 hours

14-IF-A1 ELECTRONICS

QUESTION 1 (20 points)

For the circuit in Figure 1, $V_1 = 0\ V$, $V_2 = 25\ V$, $V_3 = 5\ V$, $V_4 = 40\ V$, $R_1 = R_2 = 1\ k\Omega$ and $R_3 = 20\ k\Omega$.

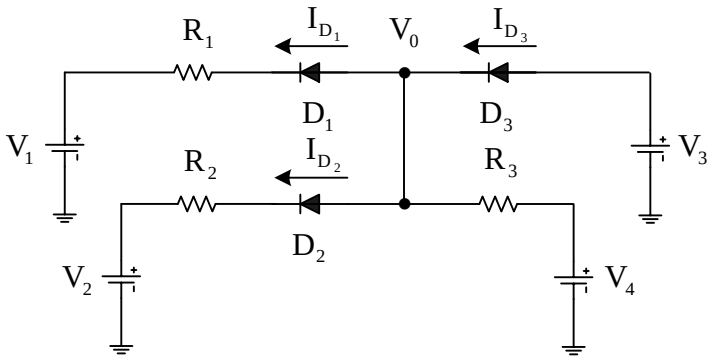

Figure 1

Find the values of I_{D_1}, I_{D_2}, I_{D_3} and V_0:

a. When the diodes ideal ($V_D = 0\ V$) (10 points)

b. When $V_D = 0.7\ V$. (10 points)

QUESTION 2 (20 points)

For the circuit of Figure 2, $V = 5\,V$, $R_1 = 10\ k\Omega$, $R_2 = 10\ k\Omega$, $V_{D_1} = V_{D_2} = 0.7\,V$ and $v_i = 20\sin(2\pi\frac{t}{T})\ V$:

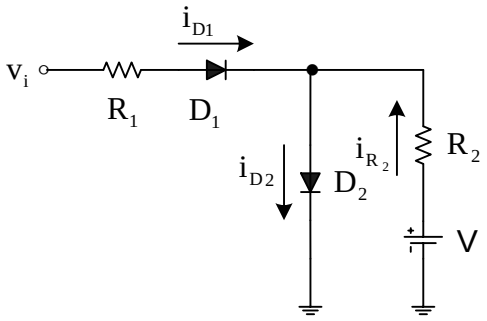

Figure 2

Find and sketch the currents i_{D_1} and i_{D_2} for $0 \le t \le T$. (20 points)

QUESTION 3 (20 points)

For the circuit in Figure 3, assuming the ideal operational amplifier, $R_1 = R_2 = R_3 = R_4 = R_5 = 10\ k\Omega$ and $C_1 = C_2 = 0.1\ \mu F$:

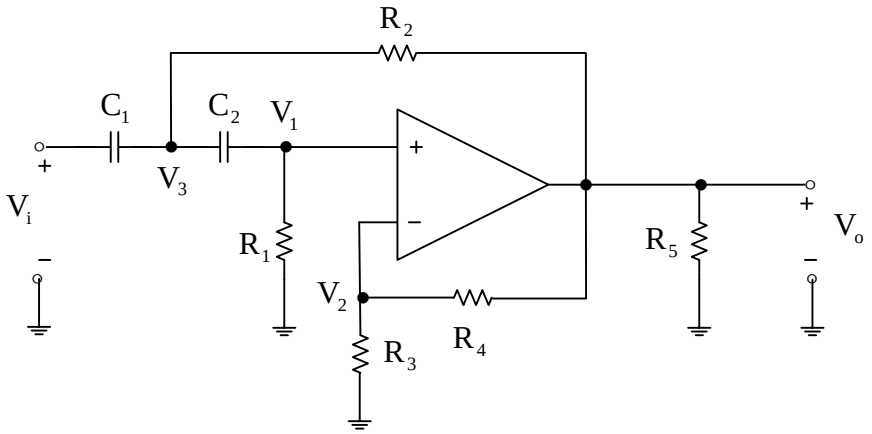

Figure 3

Find the gain $\frac{V_o}{V_i}$. (20 points)

QUESTION 4 (20 points)

For the circuit in Figure 4, $R_1 = R_3 = 6.8\,k\Omega$, $R_2 = R_4 = 56\,k\Omega$, $R_{C_1} = R_{C_2} = 2\,k\Omega$, $R_{E_1} = R_{E_2} = R_{E_3} = R_{E_4} = 120\,\Omega$, $R_L = 5.6\,k\Omega$, $V_{BE} = 0.7$ V, $V_{CC} = 12$ V, $V_T = 26$ mV and $\beta = 100$:

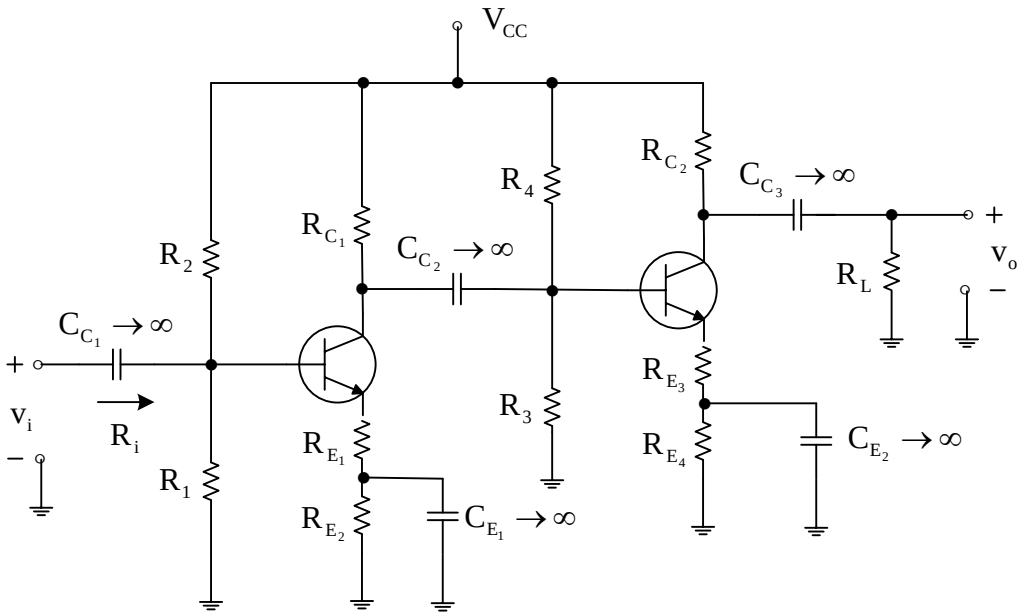

Figure 4

a. Find I_{CQ} and V_{CEQ} for each transistor. (8 points)

b. Find $A_v = \frac{v_o}{v_i}$ and R_i. (12 points)

QUESTION 5 (20 points)

For the circuit in Figure 5, $R_1 = 1\ M\Omega$, $R_S = 2.2\ k\Omega$, $R_L = 2.2\ k\Omega$, $V_P = -6\,V$, $I_{DSS} = 10\,mA$, $I_G \approx 0$, $r_d \approx \infty$ and $V_{DD} = 12\,V$:

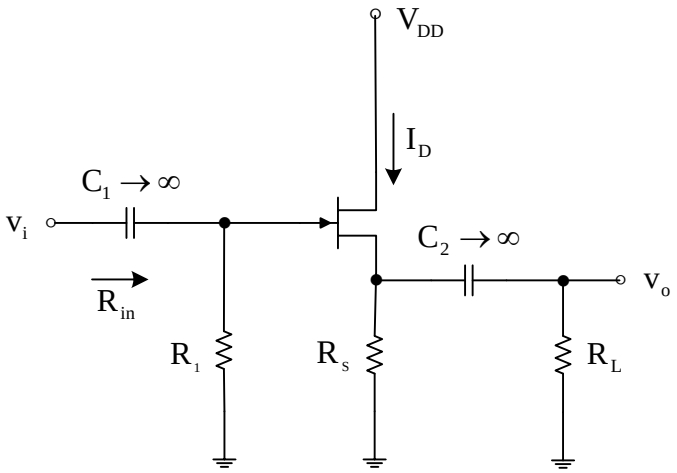

Figure 5

a. Determine I_D and V_{DS}. (8 points)

b. Determine the transconductance g_m. (4 points)

c. Determine $A_v = \frac{v_o}{v_i}$ and R_{in}. (8 points)