ORDRE DES INGÉNIEURS DU QUÉBEC

NOVEMBER 2017 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, $V_{D1} = V_{D2} = 0.7\ V$, $V_1 = 5\ V$ and $V_2 = 5\ V$.

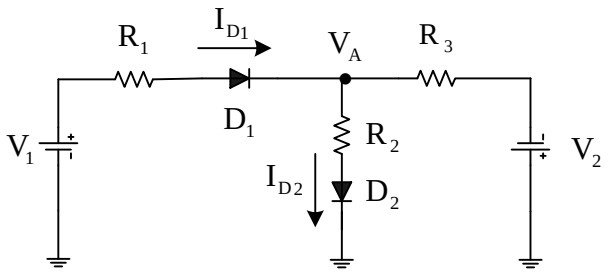

Figure 1

Find the values of V_A, I_{D1} and I_{D2}:

a. When $R_1 = 10\ k\Omega$, $R_2 = 5\ k\Omega$ and $R_3 = 5\ k\Omega$. (10 points)

b. When $R_1 = 5\ k\Omega$, $R_2 = 5\ k\Omega$ and $R_3 = 10\ k\Omega$. (10 points)

QUESTION 2 (20 points)

For the circuit of Figure 2, $V = 3V$, $R_1 = 10\ k\Omega$, $R_2 = 10\ k\Omega$, $V_D = 0.7\,V$ and $v_i = 15\sin(2\pi\frac{t}{T})\ V$:

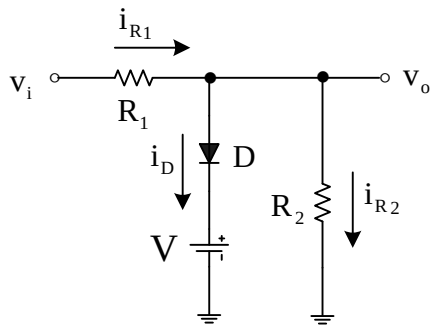

Figure 2

a. Find and sketch the voltage v_o for $0 \le t \le T$. (10 points)

b. Find and sketch the current i_D for $0 \le t \le T$. (10 points)

QUESTION 3 (20 points)

For the circuit in Figure 3, $R_1 = 10\ k\Omega$, $R_2 = 10\ k\Omega$, $R_3 = 5\ k\Omega$, $R_4 = 0.5\ k\Omega$, $R_5 = 9.5\ k\Omega$, $C_1 = 0.1\ \mu F$, $C_2 = 0.1\ \mu F$, $C_3 = 0.2\ \mu F$ and assuming ideal operational amplifiers :

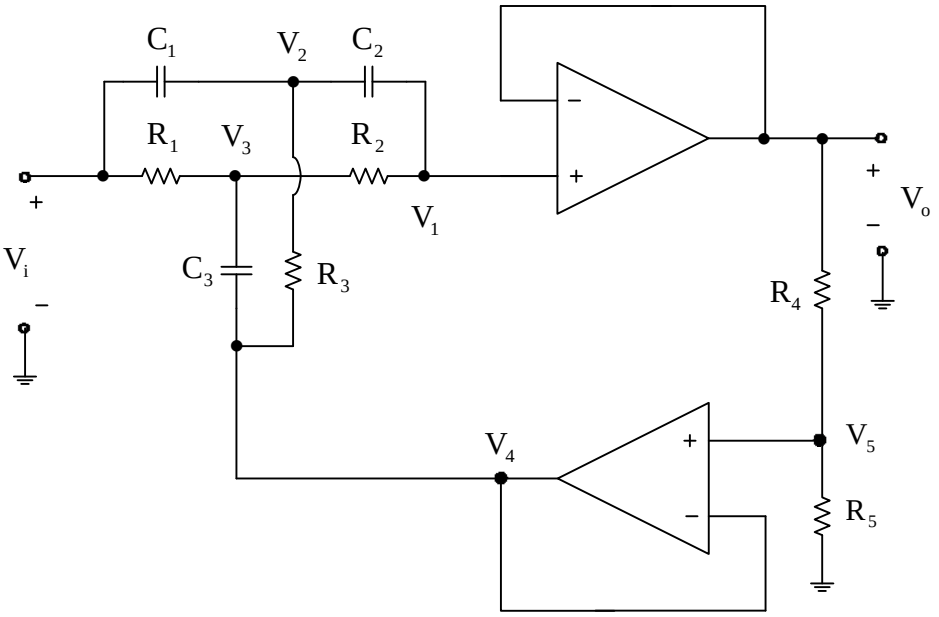

Figure 3

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

QUESTION 4 (20 points)

For the circuit in Figure 4, $R_1 = 47\ k\Omega$, $R_2 = 82\ k\Omega$, $R_E = 1.5 k\Omega$, $R_L = 1.5 k\Omega$, $R_S = 10\ k\Omega$, $V_{CC} = 12\ V$, $V_{EB} = 0.7\ V$, $\beta = 100$, $V_T = 26\ mV$ and $r_0 = \infty$:

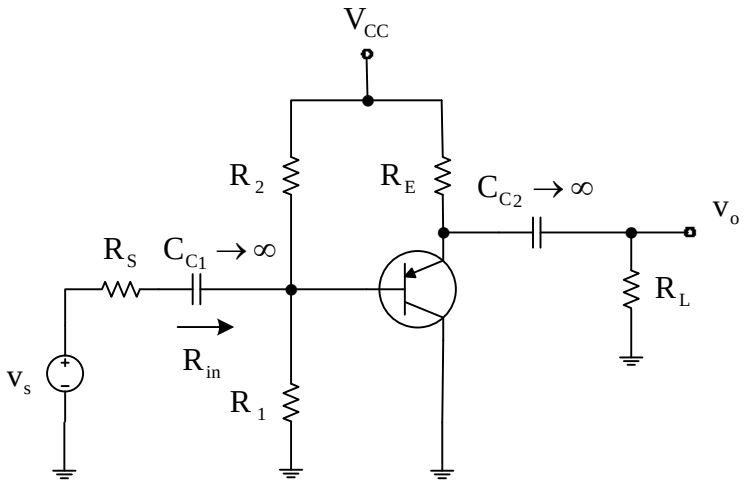

Figure 4

a. Determine I_C and V_{EC}. (8 points)

b. Determine R_{in} and $A_v = \frac{v_o}{v_s}$. (12 points)

QUESTION 5 (20 points)

For the circuit in Figure 5, $R_{sig} = 100\,k\Omega$, $R_1 = 2\,M\Omega$, $R_2 = 1\,M\Omega$, $R_D = 150\ \Omega$, $R_L = 1k\Omega$, $V_t = 0.8\,V$, $k_n = 12\,mA/V^2$ (NMOS 2N7000) and $V_{DD} = 9\,V$:

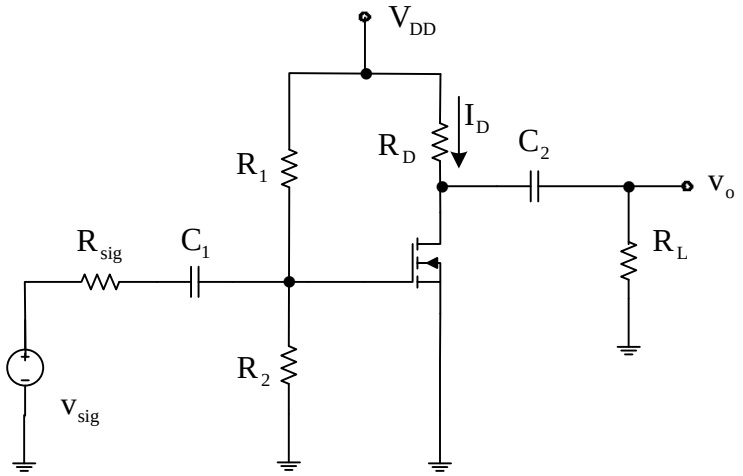

Figure 5

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

b. Determine the transconductance g_m. (4 points)

c. Determine $A_v = \frac{v_o}{v_{sig}}$. (8 points)