ORDRE DES INGÉNIEURS DU QUÉBEC

NOVEMBER 2018 SESSION

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

14-IF-A1 ELECTRONICS

QUESTION 1 (20 points)

In the circuit of Figure 1, the Zener diode ($V_Z = 9\,V,\ R_Z = 0, I_{Zmin} = 0$) maintain a 9 V output voltage when the input V_S varying from 18 to 24 V and the current on the load I_L varying from 400 to 800 mA.

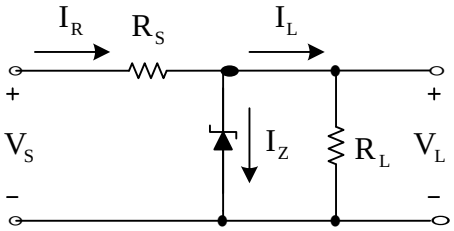

Figure 1

a. Determine the resistance R_S. (8 points)

b. Determine the maximal power of the diode Zener. (6 points)

c. Calculate the output voltage variation if $R_Z = 1\,\Omega$. (6 points)

QUESTION 2 (20 points)

For the circuit of Figure 2, $R_1 = 10\ k\Omega$, $R_2 = 10\ k\Omega$, $R_3 = 10\ k\Omega$, $V_D = 0.7\,V$ and $v_i = 10\sin(2\pi\frac{t}{T})\ V$:

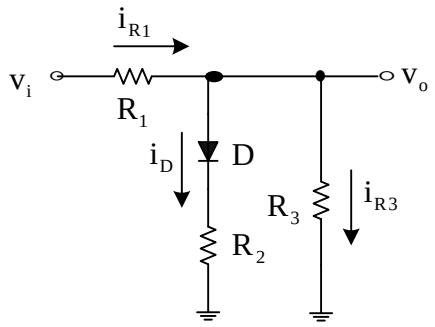

Figure 2

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, $R_1 = 10\ k\Omega$, $R_2 = 10\ k\Omega$, $R_3 = 10\ k\Omega$, $C_1 = 15\ nF$, $C_2 = 180\ pF$ and assuming ideal operational amplifier :

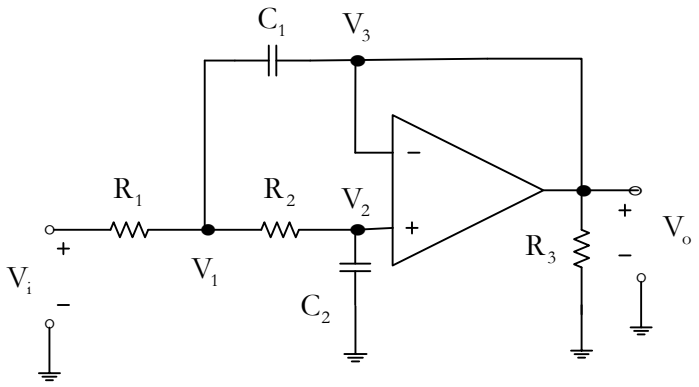

Figure 3

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

QUESTION 4 (20 points)

For the circuit in Figure 4, $R_B = 1\,k\Omega$, $R_E = 100\,\Omega$, $R_C = 1k\,\Omega$, $R_L = 1\,k\,\Omega$, $V_{CC} = 15\ V$, $V_{EE} = 1.7\ V$, $V_{BE} = 0.7\ V$, $\beta = 100$, $V_T = 26\ mV$ and $r_0 = \infty$:

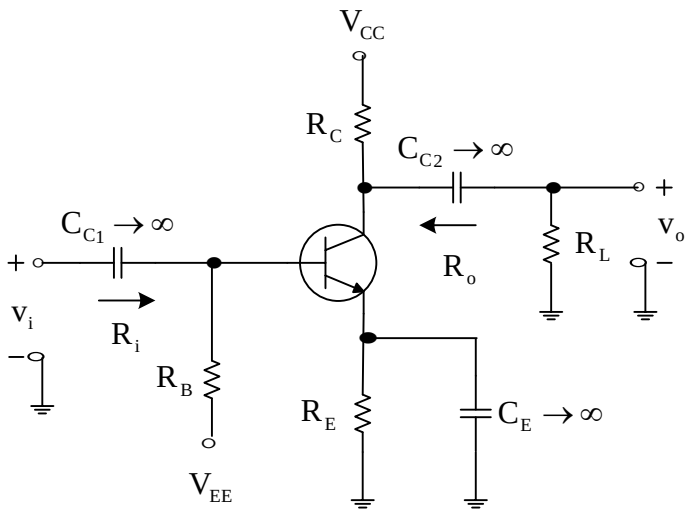

Figure 4

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

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

QUESTION 5 (20 points)

For the circuit in Figure 5, $R_{sig} = 100\,k\Omega$, $R_G = 1M\Omega$, $R_D = 4.7\,k\Omega$, $R_L = 3.3k\Omega$, $V_t = 1V$, $k_n = 0.4\,mA/V^2$, $V_A = 50\,V$ (NMOS) and $V_{DD} = 6\,V$:

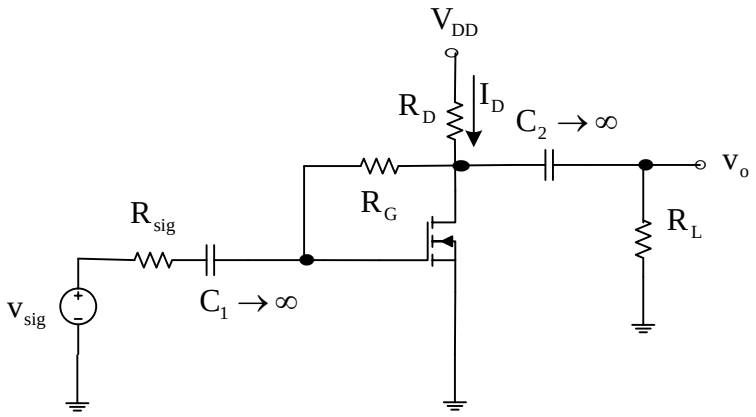

Figure 5

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

b. Determine the transconductance g_m. (4 points)

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