Course of **Analog Electronics** – 2022-2023

Prof. Simone Buso

Xmas Homework #1

Exercise 1

Consider the two-stage amplifier in Fig. 1. The circuit parameters, at T = 25°C, are the following:

V_{CC} = 15 V, R_g = 10 kΩ, R_B = 1.8 MΩ, R_C = 10 kΩ, R_E = 1.2 kΩ; R_D = 6.8 kΩ, R_S = 1 kΩ, R_L = 100 kΩ, R_F = 2.2 kΩ, C_g = 10 nF, C_L = 1 μF, C_F = 1 μF.

Q_1: V_{BE} = -0.7 V; β_F = 100; β_0 = 100; $r_0 = +\infty$;
Q_2: V_t = 2 V; $I_{DSS} = k_n \frac{W}{L} V_t^2$ = 0.2 mA ; $r_0 = +\infty$;

V_T = 25 mV.

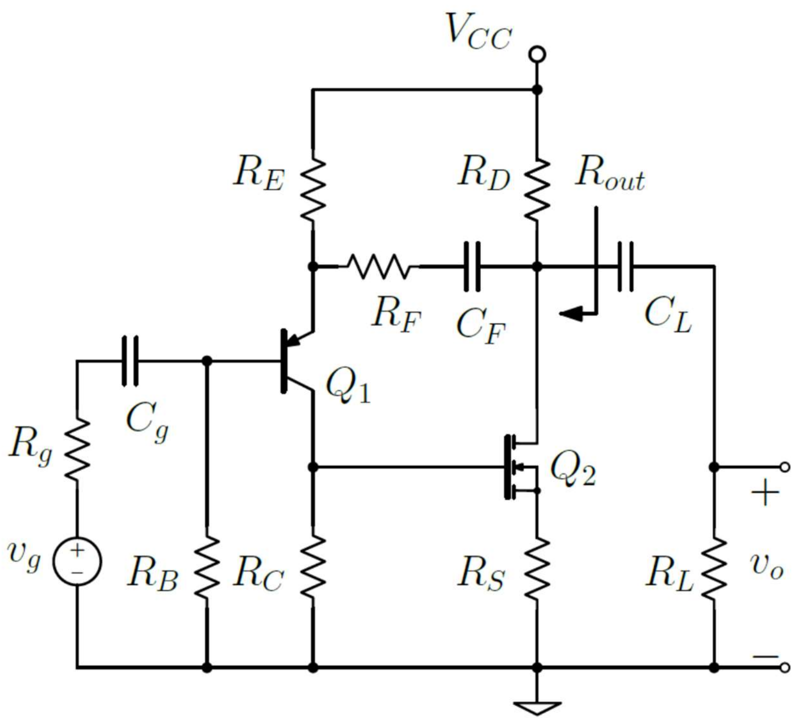


Fig. 1 – Two stage amplifier with feedback.

Considering all capacitors to be equivalent to open circuits, determine:

1. the operating points *(V_{CE}, I_C)* of *Q_1* and (V_{DS}, I_D) of *Q_2*.

Assuming all capacitors to be equivalent to *short circuits* at the frequencies of interest, determine also:

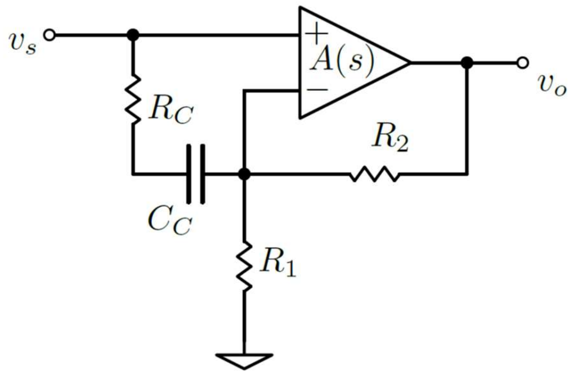
2. the voltage gain $A_v = v_o/v_g$ of the amplifier;
3. the output resistance indicated in the figure;
4. the low frequency bandwidth limit of the amplifier.

Exercise 2

Consider the operational amplifier configuration shown in Fig. 2. The circuit parameters are the following:

$R_1 = 18\ k\Omega$; $R_2 = 56\ k\Omega$.

$A(s) = \dfrac{A_0}{\left(1+\frac{s}{\omega_{p1}}\right)\left(1+\frac{s}{\omega_{p2}}\right)}$ [V/V], with $A_0 = 10^5$ [V/V]; $\omega_{p1} = 10^2$ rad/s; $\omega_{p2} = 5\cdot10^5$ rad/s.



Determine:

1. an estimation of the circuit *phase* margin with $R_C = +\infty$;
2. a block diagram representation of the amplifier;
3. the expression of the closed loop gain of the compensated amplifier, assuming $|T>>1|$;
4. the values of R_C and C_C that yield a +45° phase margin (hint: place the crossover frequency of loop gain T *exactly a decade lower than* ω_{p2}, and place the compensation network zero *at the same frequency).*