Recitation 4: Small signal amplifier using BJT

Exercise 1

Consider the circuit shown in Figure 1.

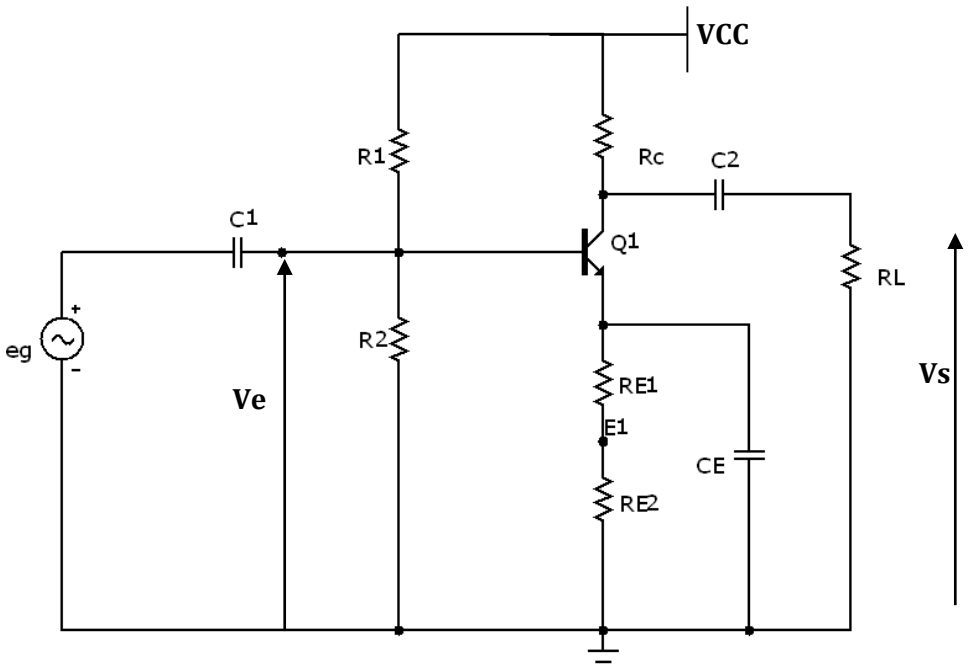

Figure 1

We give: C1=C2=100µF ; CE=220 µF.

We pose: RE=RE1+RE2 and RB=R1//R2.

The transistor has the following parameters: h_{11}=1000Ω ; h_{21}=100 ; $h_{22} = 10^{-5}$s ; h12=0, the resistors have the following values : RE=1K Ω, RC=4,7K Ω, RL=4,7K Ω, R1=180K Ω, R2=15K Ω.

1. Represent the equivalent model of the transistor alone.
2. The study frequency being f0=1KHz, calculate the modules of the impedances of the capacitors C1, C2, CE at this frequency.
3. Establish the small low frequency signal equivalent circuit of the complete stage.
4. Calculate the voltage amplification Av, the current amplification Ai as well as the input impedances Ze and output Zs of the stage.
5. The CE capacitor is connected to point E1.
   5.1. Give the new equivalent circuit by taking h22=0.
   5.2. Find the theoretical expression for the voltage gain.

Exercise 2

Consider the circuit shown in Figure 2.

RL=RE

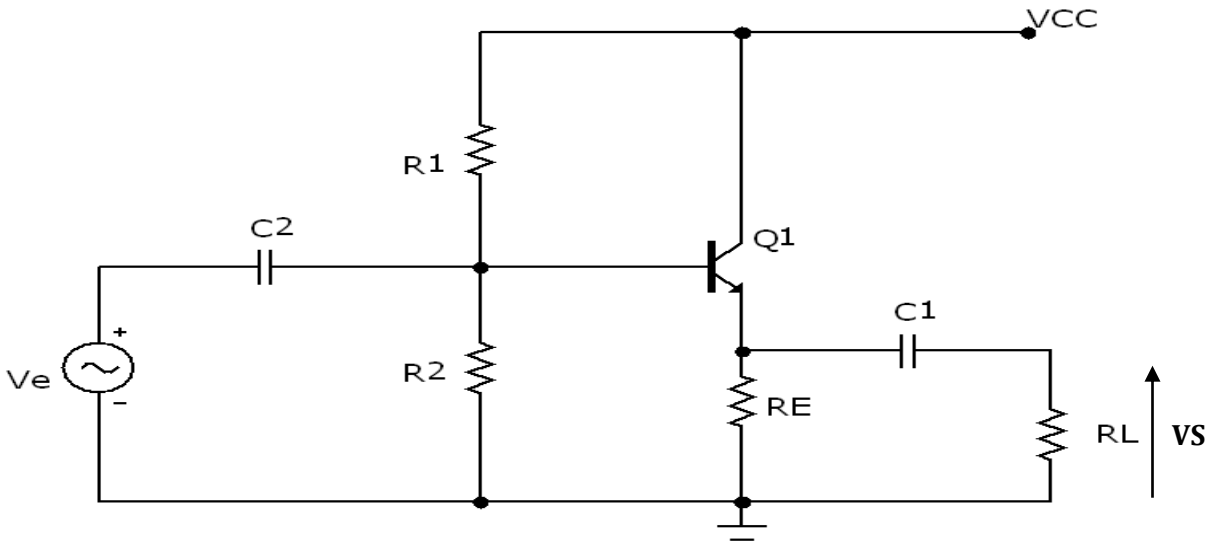

Figure 2

We give the common emitter hybrid parameters of the transistor Q1:
h_{11}=100Ω ; h_{21}=120 ; $\frac{1}{h_{22}} = \rho = 25K\Omega$; h12=0.

1. Draw the equivalent circuit of the complete stage.
2. Calculate Av, Ai, Ze, Zs.

Exercise 3

The amplifier is made with the following values :Vcc=12v, R_3=1KΩ, R_1=6.8KΩ, R_7=6.8KΩ, R_8=2.7KΩ, R_4=2.7KΩ, R_u=50Ω.

The two transistors Q1 and Q2 have the characteristics:

Q1 : I_{C1}=1mA ; V_{BE1}=0.7V ; ρ1 is infinite ; h_{11} =2.5KΩ et β1=100.

Q2 : I_{C2}=2mA ; V_{BE2}=0.7V ; ρ2=100kΩ; h_{11} =600Ω et β1=50.

I. Study of the stage in static regime

1. Give the equivalent static circuit.

2. Determine the voltages VCE1 and VCE2.

3. Determine the values of resistors R2 and R6.

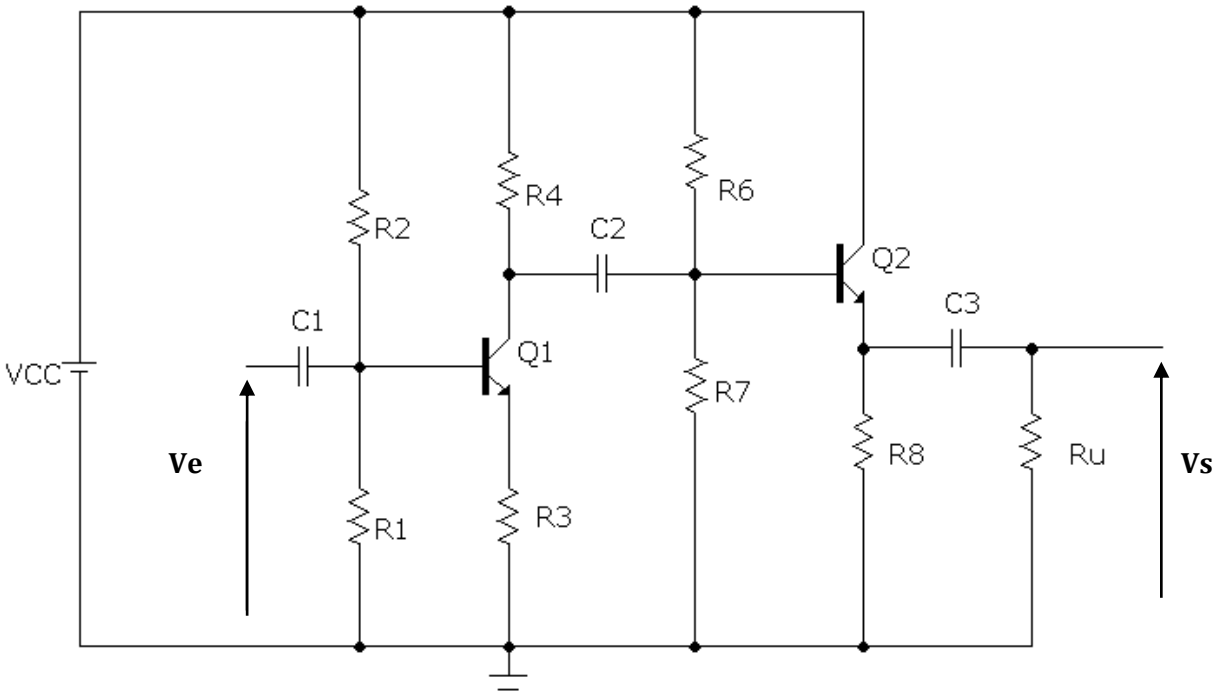

Figure 3

II. Study of the stage in dynamic regime

At working frequencies, all capacitors behave like short circuits.

1. Draw the dynamic equivalent circuit of this stage.
2. Calculate the input resistance:
    - 2.1. from the second stage.
    - 2.2. of the amplifier.
3. Calculate the voltage amplification
    - 3.1. from the first stage.
    - 3.2. from the second stage
    - 3.3. of the entire amplifier.
4. Calculate the current amplification
    - 4.1. from the first stage.
    - 4.2. from the second stage
    - 4.3. of the entire amplifier.
5. Calculate the output resistance:
    - 5.1. from the first stage.
    - 5.2. of the amplifier.