Electronics exam – Bipolar Transistors

[SI-S4-ELEC-2-TB]

Calculators and documents are forbidden. Scoring scale is given as a guide

Answers exclusively on the subject. If you need more space, you can use the back of the pages.

Exercise 1. MCQ (3 points – no negative score)

Q1. In active (or linear) mode, the base emitter junction operates in:

a. Reverse mode
b. Direct mode

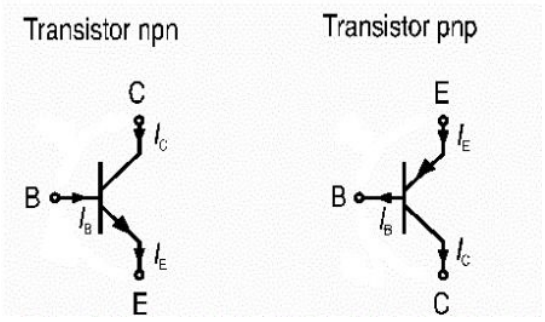
Q2. In saturation mode, the base emitter junction operates in:

c. Reverse mode
d. Direct mode

Q3. In active mode (or linear):

a. $I_B = \beta . I_C$
b. $I_B > \frac{I_{C_{Sat}}}{\beta}$
c. $V_{CE} > 0$
d. $V_{BC} = 0{,}6V$

Q4. In active mode, what is the correct relation between these intensities:



a. $I_B + I_C + I_E = 0$
b. $I_B = I_C + I_E$
c. $I_B + I_C = I_E$
d. Node's law depends on the transistor type, therefore, none of the laws above can be applied both for NPN and PNP transistors.

Q5. When a NPN bipolar transistor operates in saturation mode, then: (1 or more correct choices)

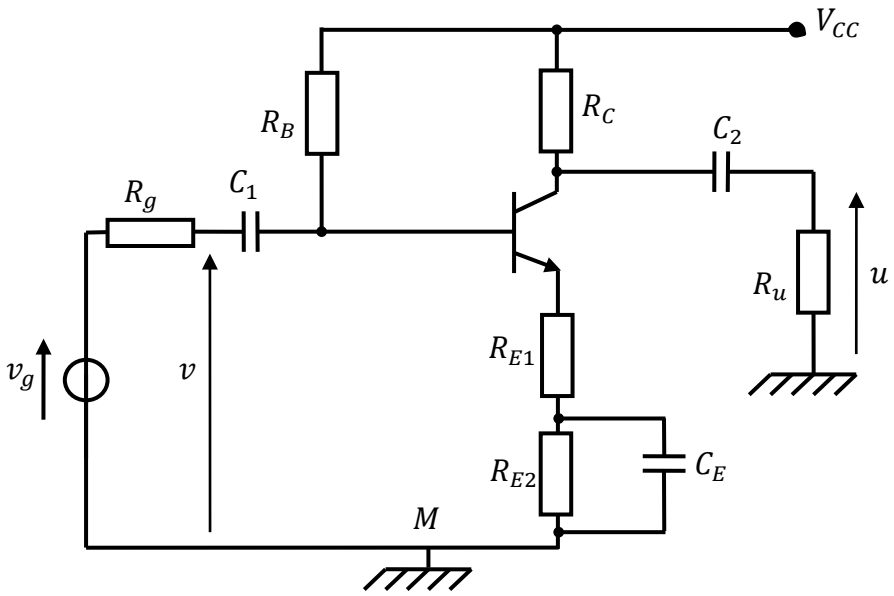
a. No current is flowing through the transistor
b. The transistor behaves like a closed switch between the collector and the emitter.
c. The transistor behaves like an open switch between the collector and the emitter.
d. The collector current reaches the maximum value fixed by the circuit (i.e. power supplies, resistors…)

Q6. Cutoff and saturation modes of a bipolar transistor are used to design logic gates

a. TRUE
b. FALSE

Exercise 2. Amplifier (10 points)

Consider the diagram below:



Capacitors C_1 and C_2 are called « link capacitors ». Capacitor C_E is a decoupling capacitor.

We set:

$$R_B = 150k\Omega\ , R_C = 1k\Omega, R_{E1} = 500\Omega, R_{E2} = 1k\Omega,\ V_{cc} = 10V, V_{BE} = 0{,}7V \text{ et } \beta = 100.$$

A. Bias study (DC signals)

1. Draw the bias scheme.

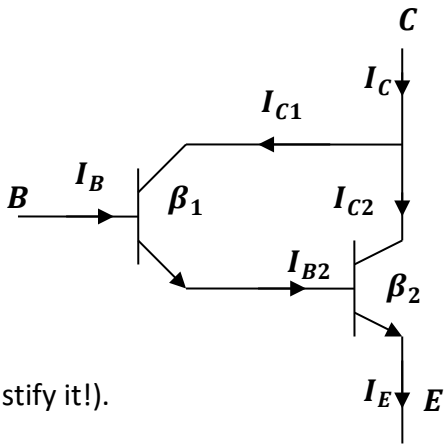
2. Determine the currents I_B and I_C as well as the voltage V_{CE}. We assume the transistor operating in active mode (no need to justify the operation mode) and that $1 + \beta \approx \beta$.

B. Small signal study (AC signals)

1. Draw the small signal equivalent scheme from the diagram above.

2. Determine the expression of voltage amplification A_v. (We assume $1 + \beta \approx \beta$ and we neglect the transistor output resistance ρ) – (give the expression of v and u in terms of i_b.)

Exercise 3. Darlington setup (2 points)



Consider the diagram on the opposite.

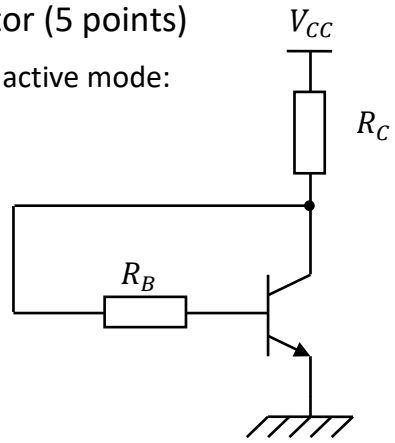
β_1 is the transfer coefficient of the base current (also called Current gain) of the transistor on the left and β_2 represents the same coefficient for the transistor on the right. Determine the current gain β of the transistor equivalent to this association, in terms of β_1 and β_2.

We assume both transistors operating in active mode (no need to justify it!).

Indication: Determine I_C in terms of I_B.

Exercise 4. Polarization (bias) by feedback to the the collector (5 points)

Consider the scheme on the opposite where the transistor operates in active mode:



Determine the polarization (bias) point of the transistor (i.e. the expressions of the currents I_B, I_C and I_E, as well as the voltages V_{BC} and V_{CE}. Express your results in terms of V_{cc}, R_C, R_B et, V_{BE}).

We assume $\beta + 1 \approx \beta$ and $V_{BE} = 0{,}7V$.