CH1. BASIC SEMICONDUCTOR DEVICES

20. Choose the statement **TRUE** among the following statements related to bipolar transistors:

[A] The transistor is the union of two diodes in opposition. ✗
[B] It is a symmetric three-terminal device, because you can swap the collector and emitter terminals. ✗
[C] The base terminal is serving as the control terminal. ✓

[A] 

Two diodes in opposition don't amplify. We need a narrow base and special configuration for do so.

[B] Changing E ⇆ C transistor enters in reverse active mode, and don't amplify.

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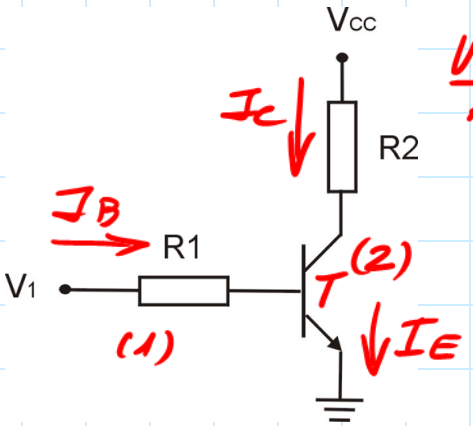
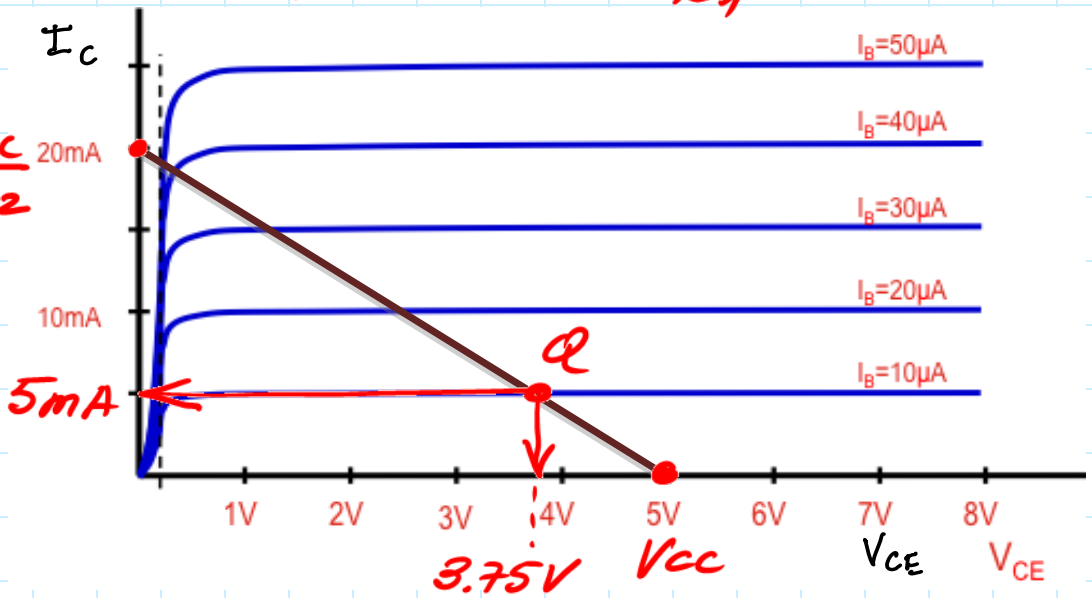
21. In the circuit with transistor of figure, and taking into account the following data, what will be the operating (quiescent) point of transistor?

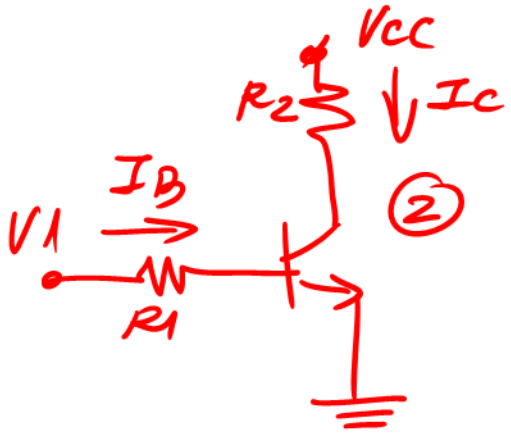
DATA: V_{BEON}=0.7V, V1= 2.7V, R1=200k, β = 500

[A] (V_{CE}=1.25V, I_C=15mA)
[B] (V_{CE}=2.5V, I_C=10mA)
[C] (V_{CE}=3.75V, I_C=5mA)
[D] (V_{CE}=2.5V, I_C=10mA)

- From curves: V_{CC} = 5V, V_{CC}/R_2 = 20mA
  $\Rightarrow R_2 = 0.25K$
- as $V_1 > V_{BE(ON)} \Rightarrow$ T is ON
- Input loop (1) $\Rightarrow I_B = \frac{V_1 - V_{BE(ON)}}{R_1} = 10\mu A$







Output loop:

Assuming active region:

$I_C = \beta I_B = 5mA$

$V_{CE} = V_{CC} - R_2 I_C = 5 - 0.25 \cdot 5 = 3.75V.$

As $V_{CE} > V_{CE(SAT)} = 0.2V \Rightarrow T$ is in active region $\Rightarrow$

$Q\ (I_B = 10\mu A;\ I_C = 5mA;\ V_{CE} = 3.75V)$

- We can also solve this exercise in a graphical form (see previous page)

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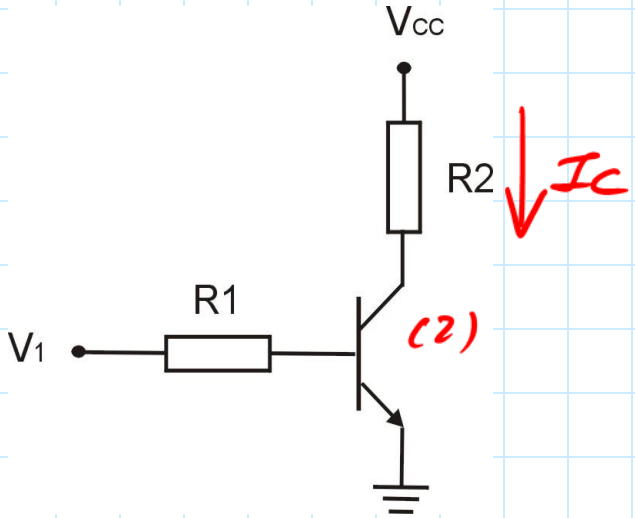
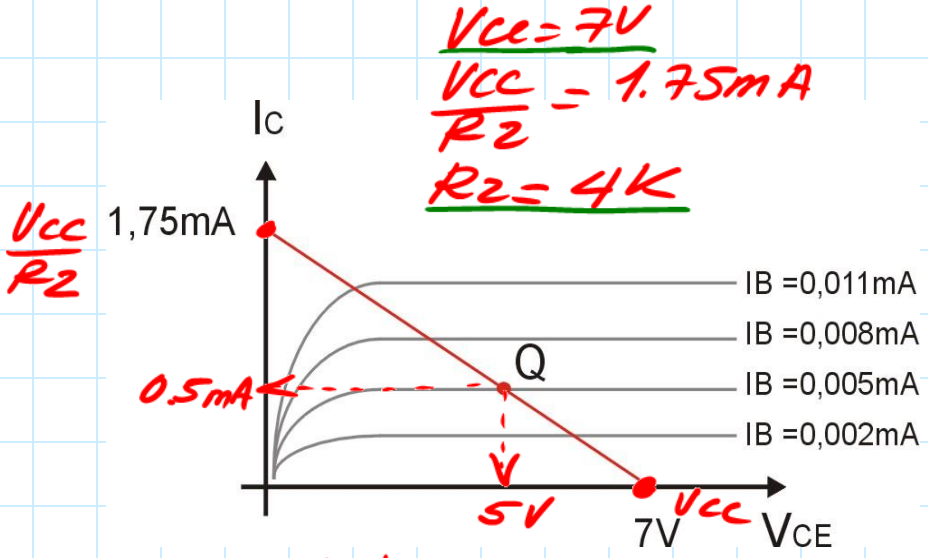
(22) Given the following circuit, the corresponding load line, operating point Q and characteristic curves of the transistor, which of the following statements is correct?

DATA: V_{CESAT} = 0,2V; V_{BEON} = 0,7V y β=100 ($I_B$is not negligible).





Vce=7V

Vcc/R2 = 1.75mA

R2=4K

[A]. The transistor is saturated. ✗

[B]. The $I_C$of transistor is 1,75mA. ✗

[C]. The $V_{CE}$of transistor is 5V.

[D]. The value of R2 is 3K. ✗

I_B = 0.005mA active region → $I_C = \beta I_B = 0.5mA$

(2) $V_{CE} = V_{cc} - I_C R_2 = 7 - 0.5 \cdot 4 = 5V$

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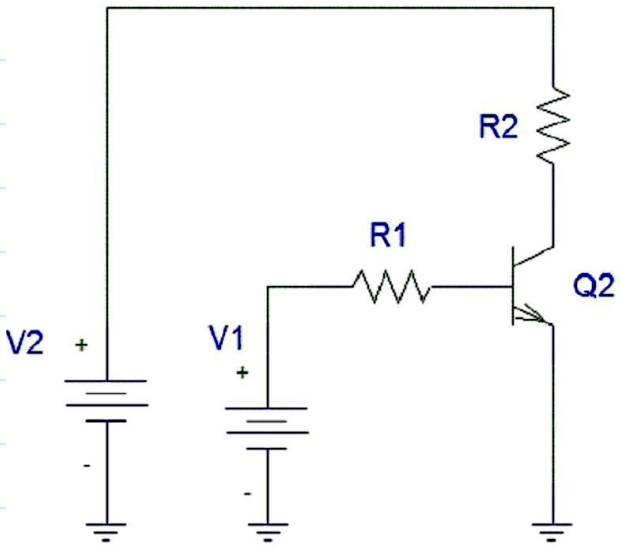
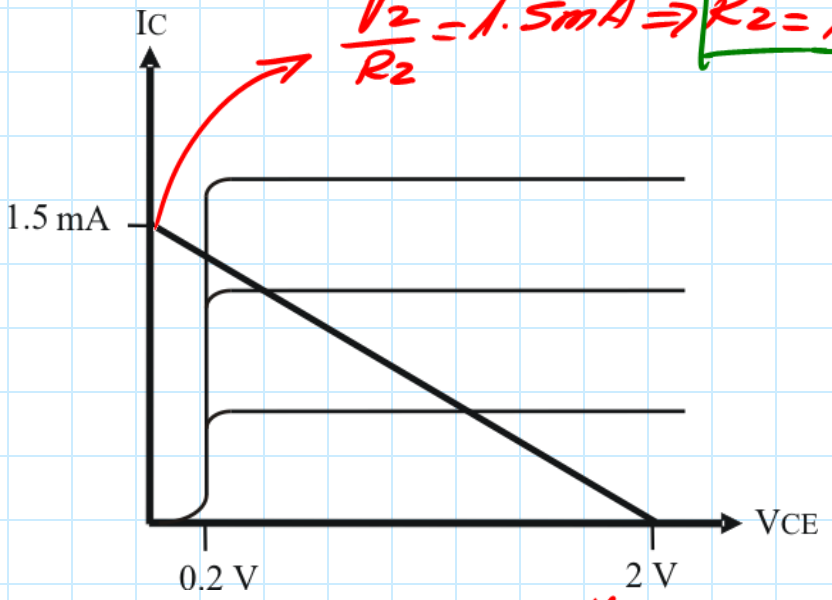
23.Indicate, using the attached figures, the value of resistance R2. (Data: β=100, $V_{CE(SAT)}$= 0.2V; $V_{BE\ (ON)}$ = 0.7V; V1= 6V; R1=100kΩ)





$\frac{V_2}{R_2} = 1.5mA \Rightarrow R_2 = 1.3k\Omega$

$V_2 = 2V$

[A] 1,33 kΩ
[B] 1,2 kΩ
[C] 0,87 kΩ
[D] Some data are missing.

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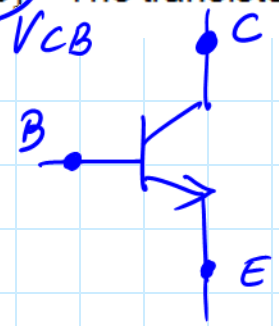
29. In a circuit based on a NPN bipolar transistor whose current gain β is 100, the following currents and DC voltages are measured:

$V_{BE} = 0.7V$	$I_B = 0.1mA$	$I_E = 3.5mA$

Taking into account these data, we can state that:

[A] The transistor is in cut-off mode.
[B] The transistor is in active region.
[C] The operating region cannot be known, because it is not know the value of V_{CE}.
[D] The transistor is saturated.



$V_{BE} = V_{BE_{ON}} \Rightarrow$ T is ON

$I_E = I_B + I_C \Rightarrow I_C = I_E - I_B = 3.4mA$

$\frac{I_C}{\beta} = 0.034mA$

As $I_B = 0.1mA > \frac{I_C}{\beta} = 0.034 \frac{}{mA} \Rightarrow$ T is SATURATED

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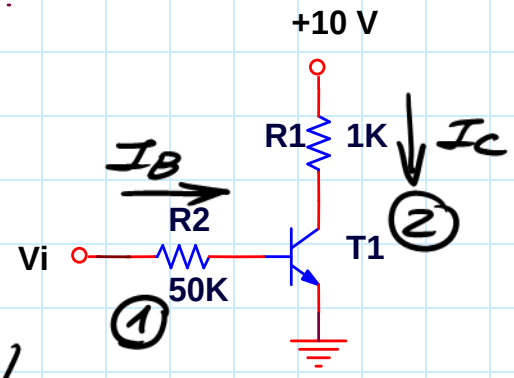
30. Given the circuit of the figure, where V_{BEON} = 0.7V, V_{CESAT} and β = 100; indicate the operating region of the transistor for:

[A] Vi = 0.7V
[B] Vi = 4V
[C] Vi = 6.7V



A) As $Vi = V_{BE(ON)}$

$I_B = \frac{Vi - V_{BE(ON)}}{R_2} = 0\,mA$ } Then T1 is in CUT-OFF reg.

but in the limit to ACTIVE Q(I_B=0, I_e=0, V_{CE}=10V)

B) $Vi > V_{BE(ON)} \Rightarrow$ T1 is ON

① $I_B = \frac{Vi - V_{BE(ON)}}{R_2} = \frac{4 - 0.7}{50K} = 0.066\,mA$

Assuming active region:

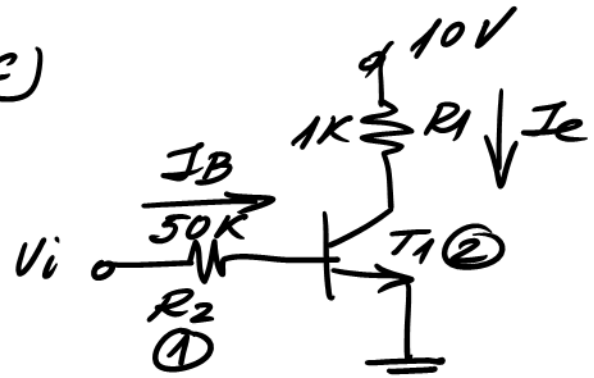
$I_C = \beta I_B = 6.6\,mA$

② $V_{CE} = V_{CC} - R_1 I_e = 10 - 1 \cdot 6.6 = 3.4V$

As $V_{CE} > V_{CE(SAT)} \Rightarrow$ T_1 is in ACTIVE region

Q ($I_B = 0.066mA$; $I_C = 6.6mA$; $V_{CE} = 3.4V$)

c)



$Vi > V_{BE(ON)} \Rightarrow T_1$ ON

① $I_B = \frac{Vi - 0.7}{R_2} = \frac{6}{50K} = 0.12mA$

Assuming ACTIVE region:

$I_C = \beta I_B = 12mA$

② $V_{CE} = 10 - R_1 I_C = 10 - 12 = -2V$, then T_1 is not in active region, then is saturated

$V_{CE} = V_{CE(SAT)} = 0.2V \Rightarrow$ ② $I_C = \frac{10 - V_{CE(SAT)}}{R_1} = \frac{10 - 0.2}{1}$

$I_C = 9.8mA$

Q ($I_B = 0.12mA$, $I_C = 9.8mA$, $V_{CE} = 0.2V$)

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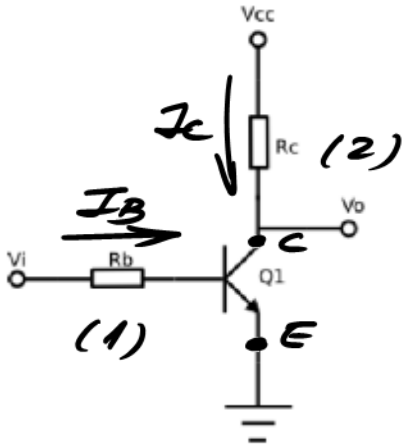
27. Indicate the working región of transistor of figure for an input voltaje Vi of 3.7 V:
(DATA: Vcc = 5V; Rb = 100 kΩ; Rc = 2 kΩ, Q1: $V_{BE(ON)}$ = 0.7V, $V_{CE(SAT)}$ = 0.2V, β = 100)

[A] Cutt-off
[B] Active
[C] En el límite entre Active and Saturation regions.
[D] Saturation



- As $V_i > V_{BE(ON)} \Rightarrow Q_1$ is ON

(1) $I_B = \frac{V_i - V_{BE(ON)}}{R_b} = \frac{3.7 - 0.7}{100K} = 0.03mA$

- Assuming linear region:

$I_C = \beta I_B = 3mA$

(2) $V_{CE} = V_{CC} - R_C I_C = 5 - 2 \cdot 3 = -1V$ (Impossible, then Q_1 is saturated $\Rightarrow V_{CE} = V_{CE(SAT)} = 0.2V$

(2) $I_C = I_{C(SAT)} = \frac{V_{CC} - V_{CE(SAT)}}{R_C} = \frac{5 - 0.2}{2K} = 2.4mA$

Q (I_B = 0.03mA, I_C = 2.4mA; V_{CE} = 0.2V) saturated