Name:	**Dr JBO**
Student ID Number:	**Model Answer**
Section: 01A/B	
Lecturer: Dr. Jamaludin Bin Omar	

EEEB273 - Quiz 1
SEMESTER 1, ACADEMIC YEAR 2016/2017
Date: 13 June 2016 Time: 15 minutes

Question:

For the basic two-transistor BJT current source in **Figure 1**, the transistor parameters are: β **= 50**, V_{BE}**(on) = 0.7 V**, and V_A **= 120 V**. The bias voltages are V^+ **= 7.5 V** and V^- **= -7.5 V**.
(a) **Design** the circuit such that I_O **= 0.5 mA** when V_{CE2} **= 0.7 V**. [5 marks]
(b) **Calculate** the **change in** I_O as V_{CE2} varies between **0.7 V to 7 V**? [5 marks]
Show clearly all calculations as marks are given according to this. All values must be given with their proper Units.

Answer:

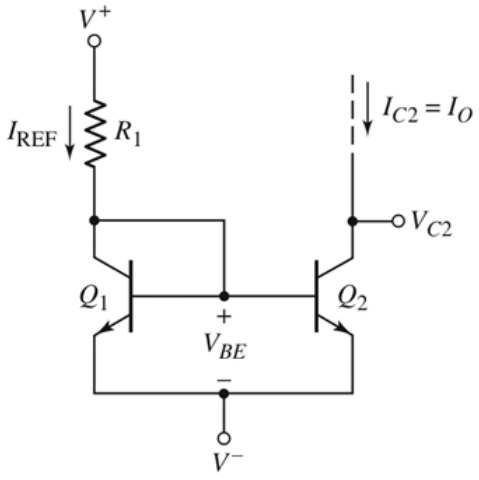

Figure 1

$$i_C = I_S e^{v_{BE}/V_T}\ ;\text{npn}$$
$$i_C = I_S e^{v_{EB}/V_T}\ ;\text{pnp}$$
$$i_C = \alpha i_E = \beta i_B$$
$$i_E = i_B + i_C$$
$$\alpha = \frac{\beta}{\beta+1}$$

;Small signal

$$\beta = g_m r_\pi$$
$$g_m = \frac{I_{CQ}}{V_T}$$
$$r_\pi = \frac{\beta V_T}{I_{CQ}}$$
$$r_o = \frac{V_A}{I_{CQ}}$$

(a)

I_{REF} $= I_O\,(1 + 2/\beta)$ [1]
$= (0.5\text{m})(1 + 2/50) \quad = 0.52$ mA [1, 0.5]

R_1 $= (V^+ - V_{BE} - V^-) / I_{REF}$ [1]
$= (7.5 - 0.7 - (-7.5)) / (0.52\text{m}) = 27.5$ kΩ [1, 0.5]

(b)

At $V_{CE2} = V_{BE}$**(on) = 0.7 V:**

R_O $= V_A / I_O$ [1]
$= 120 / 0.5\text{m} \quad = 240$ kΩ [1, 0.5]

R_O $= dV_{CE2} / dI_O$
dI_O $= dV_{CE2} / R_O$ [1]
$= (7 - 0.7) / (240\text{k}) \quad = 26.25$ uA [1, 0.5]

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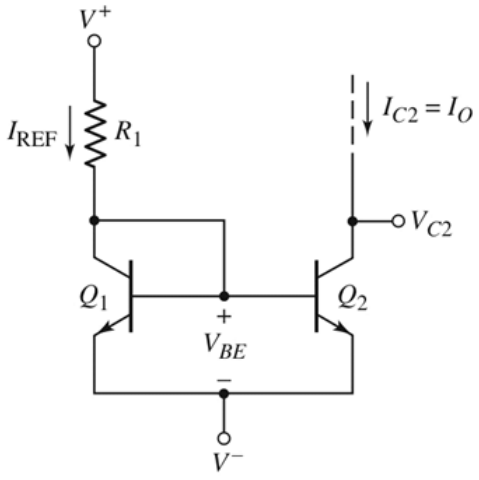
Question:

For the basic two-transistor BJT current source in **Figure 1**, the transistor parameters are: β **= 50**, V_{BE}**(on) = 0.7 V**, and V_A **= 110 V**. The bias voltages are V^+ **= 7.5 V** and V^- **= -7.5 V**.
(a) **Design** the circuit such that I_O **= 0.6 mA** when V_{CE2} **= 0.7 V**. [5 marks]
(b) **Calculate** the **change in** I_O as V_{CE2} varies between **0.7 V to 6 V**? [5 marks]
Show clearly all calculations as marks are given according to this. All values must be given with their proper Units.

Answer:



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$$\beta = g_m r_\pi$$
$$g_m = \frac{I_{CQ}}{V_T}$$
$$r_\pi = \frac{\beta V_T}{I_{CQ}}$$
$$r_o = \frac{V_A}{I_{CQ}}$$

(a)

I_{REF} **= I_O (1 + 2/β)** **[1]**
= (0.6m)(1 + 2/50) = 0.624 mA **[1, 0.5]**

R_1 **= (V^+ - V_{BE} - V^-) / I_{REF}** **[1]**
= (7.5 – 0.7 – (-7.5)) / (0.624m) = 22.92 kΩ **[1, 0.5]**

(b)

At V_{CE2} **= V_{BE}(on) = 0.7 V:**

R_O **= V_A / I_O** **[1]**
= 110 / 0.6m = 183.33 kΩ **[1, 0.5]**

R_O **= dV_{CE2} / dI_O**
dI_O **= dV_{CE2} / R_O** **[1]**
= (6 – 0.7) / (183.33k) = 28.9 uA **[1, 0.5]**

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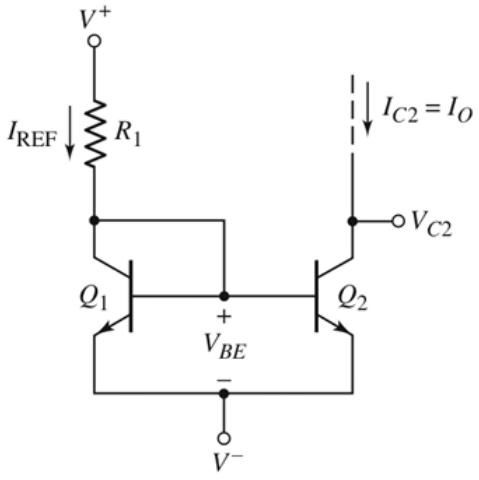
Date: 13 June 2016 Time: 15 minutes ;

Question:

For the basic two-transistor BJT current source in **Figure 1**, the transistor parameters are: β **= 50**, V_{BE}**(on) = 0.7 V**, and V_A **= 120 V**. The bias voltages are V^+ **= 7 V** and V^- **= -7 V**.
(a) **Design** the circuit such that I_O **= 0.5 mA** when V_{CE2} **= 0.7 V**. [5 marks]
(b) **Calculate** the **change in** I_O as V_{CE2} varies between **0.7 V to 5 V**? [5 marks]
Show clearly all calculations as marks are given according to this. All values must be given with their proper Units.

Answer:



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$$g_m = \frac{I_{CQ}}{V_T}$$
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$$r_o = \frac{V_A}{I_{CQ}}$$

(a)

I_{REF} $= I_O\,(1 + 2/\beta)$ [1]
$= (0.5\text{m})(1 + 2/50) \quad = 0.52$ mA [1, 0.5]

R_1 $= (V^+ - V_{BE} - V^-) / I_{REF}$ [1]
$= (7 - 0.7 - (-7)) / (0.52\text{m}) = 25.57$ kΩ [1, 0.5]

(b)
At $V_{CE2} = V_{BE}$**(on) = 0.7 V:**

R_O $= V_A / I_O$ [1]
$= 120 / 0.5\text{m} \quad = 240$ kΩ [1, 0.5]

R_O $= dV_{CE2} / dI_O$
dI_O $= dV_{CE2} / R_O$ [1]
$= (5 - 0.7) / (240\text{k}) \qquad = 17.92$ uA [1, 0.5]

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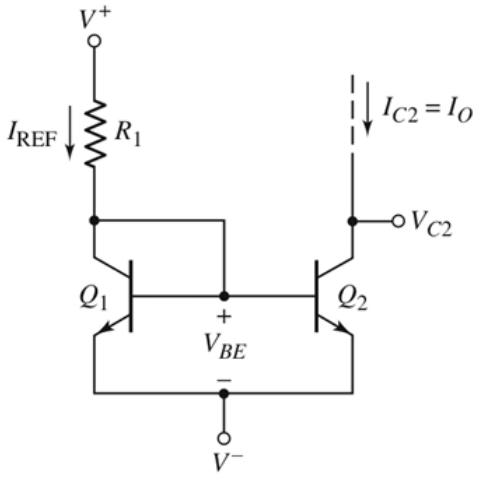
Date: 13 June 2016 Time: 15 minutes :

Question:

For the basic two-transistor BJT current source in **Figure 1**, the transistor parameters are: β = **50**, V_{BE}**(on) = 0.7 V**, and V_A **= 125 V**. The bias voltages are V^+ **= 7.5 V** and V^- **= -7.5 V**.
(a) **Design** the circuit such that I_O **= 0.7 mA** when V_{CE2} **= 0.7 V**. [5 marks]
(b) **Calculate** the **change in** I_O as V_{CE2} varies between **0.7 V to 6 V**? [5 marks]
Show clearly all calculations as marks are given according to this. All values must be given with their proper Units.

Answer:



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$$i_C = \alpha i_E = \beta i_B$$
$$i_E = i_B + i_C$$
$$\alpha = \frac{\beta}{\beta+1}$$

;Small signal

$$\beta = g_m r_\pi$$
$$g_m = \frac{I_{CQ}}{V_T}$$
$$r_\pi = \frac{\beta V_T}{I_{CQ}}$$
$$r_o = \frac{V_A}{I_{CQ}}$$

(a)

I_{REF} $= I_O\,(1 + 2/\beta)$ **[1]**
$= (0.7\text{m})(1 + 2/50) \quad = 0.728$ **mA** **[1, 0.5]**

R_1 $= (V^+ - V_{BE} - V^-) / I_{REF}$ **[1]**
$= (7.5 - 0.7 - (-7.5)) / (0.728\text{m}) = 19.64$ **kΩ** **[1, 0.5]**

(b)
At $V_{CE2} = V_{BE}$**(on) = 0.7 V:**

R_O $= V_A / I_O$ **[1]**
$= 125 / 0.7\text{m} \quad = 178.57$ **kΩ** **[1, 0.5]**

R_O $= dV_{CE2} / dI_O$
dI_O $= dV_{CE2} / R_O$ **[1]**
$= (6 - 0.7) / (178.57\text{k}) \quad = 29.68$ **uA** **[1, 0.5]**