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

EEEB273 - Quiz 1
SEMESTER 1, ACADEMIC YEAR 2017/2018
Date: 30 May 2017 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**. [6 marks]
(b) **Calculate** output resistance (R_O) of the current source. [4 marks]
Show clearly all calculations as marks are given according to this. All values must be given with their proper Units.

Answer:

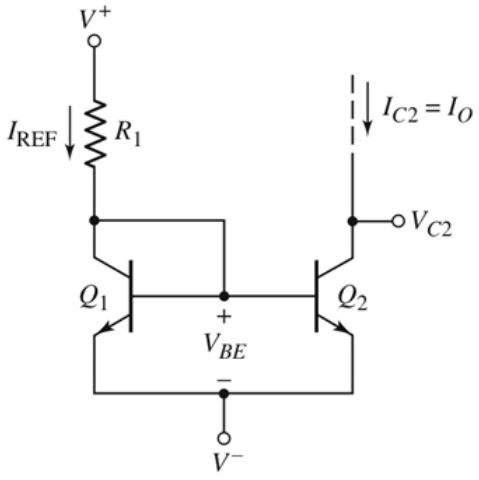

Figure 1

(a)

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

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

(b)

R_O $= r_{o2} \quad = V_A / I_O$ [1, 1]
$= 120 / 0.5\text{m} \quad = 240$ kΩ [1, 1]

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

$$;\text{Small signal}$$
$$\beta = g_m r_\pi$$
$$g_m = \frac{I_{CQ}}{V_T}$$
$$r_\pi = \frac{\beta V_T}{I_{CQ}}$$
$$r_o = \frac{V_A}{I_{CQ}}$$

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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**. [6 marks]
(b) **Calculate** output resistance (R_O) of the current source. [4 marks]
Show clearly all calculations as marks are given according to this. All values must be given with their proper Units.

Answer:

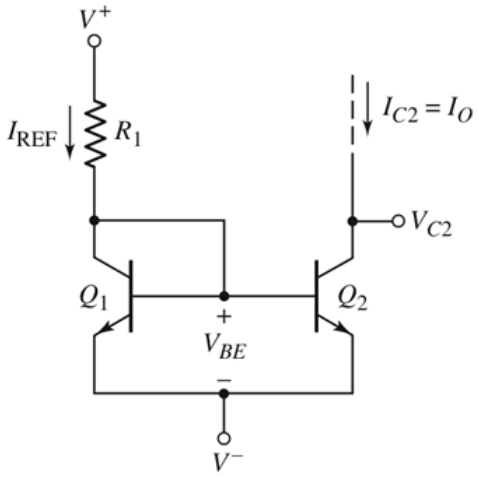

Figure 1

(a)

I_{REF} $= I_O\,(1 + 2/\beta)$ [1]
$= (0.6\text{m})(1 + 2/50) \quad = 0.624$ mA [1, 1]

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

(b)

R_O $= r_{o2} \quad = V_A / I_O$ [1, 1]
$= 110 / 0.6\text{m} \quad = 183.33$ kΩ [1, 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

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

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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 **= 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**. [6 marks]
(b) **Calculate** output resistance (R_O) of the current source. [4 marks]
Show clearly all calculations as marks are given according to this. All values must be given with their proper Units.

Answer:

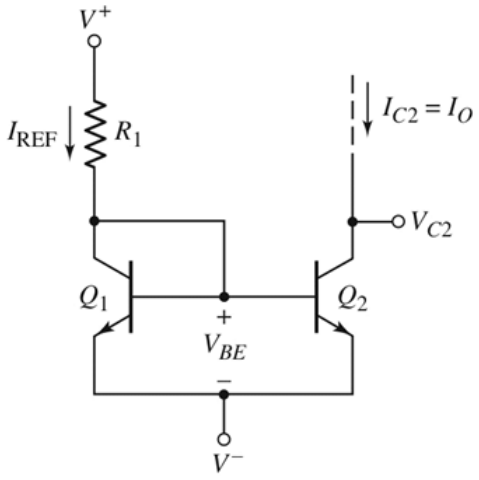

Figure 1

(a)

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

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

(b)

R_O $= r_{o2} \quad = V_A / I_O$ [1, 1]
$= 120 / 0.5\text{m} \quad = 240$ kΩ [1, 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

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

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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 **= 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**. [6 marks]
(b) **Calculate** output resistance (R_O) of the current source. [4 marks]
Show clearly all calculations as marks are given according to this. All values must be given with their proper Units.

Answer:

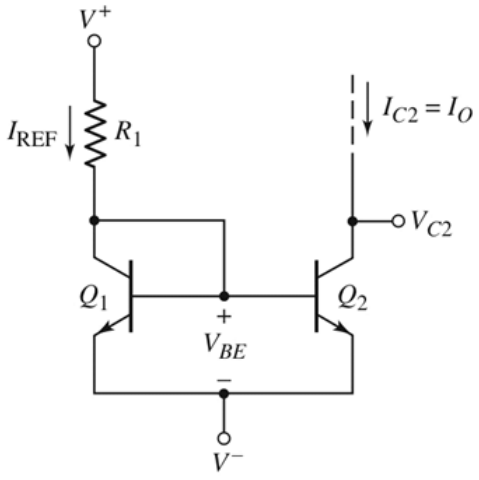

Figure 1

(a)

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

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

(b)

R_O $= r_{o2} \quad = V_A / I_O$ [1, 1]
$= 125 / 0.7\text{m} \quad = 178.57$ kΩ [1, 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

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