

Question:

Refer to **Figure 1**. All transistors are matched.

The circuit parameters are: $V^+ = 7.5 \text{ V}$ and $V^- = -7.5 \text{ V}$.

The transistor parameters are: $V_{BE}(\text{on}) = 0.6 \text{ V}$, $V_A = 150 \text{ V}$, and $\beta = 50$.

DESIGN a two-transistor BJT current source similar to the **Figure 1** using all the parameters given above so that **its output resistance (R_O) is 200 k Ω** . **Show clearly all calculations** as marks are given according to this.

[10 marks]

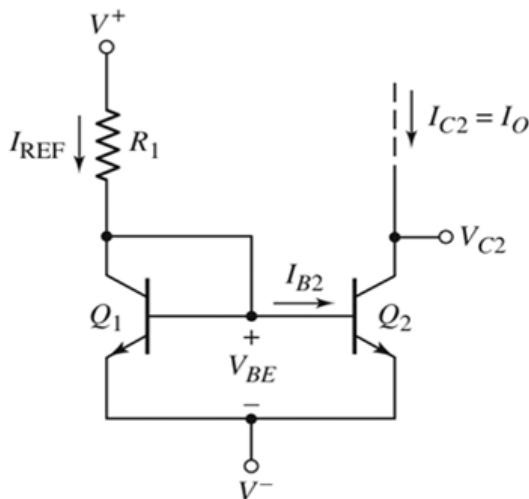


Figure 1

Answer:

R_O	$= r_{O2} = V_A / I_O$	[2]
I_O	$= V_A / R_O$	[1]
	$= (150) / (200\text{k})$	[0.5]
	$= 0.75 \text{ mA}$	[0.5]
I_{REF}	$= I_O (1 + 2/\beta)$	[2]
	$= (0.75\text{m})(1 + 2/50)$	[0.5]
	$= 0.78 \text{ mA}$	[0.5]
R_1	$= (V^+ - V_{BE} - V^-) / I_{REF}$	[2]
	$= (7.5 - 0.6 - (-7.5)) / (0.78\text{m})$	[0.5]
	$= 18.4615 \text{ k}\Omega$	[0.5]

$$i_C = I_S e^{v_{BE}/V_T}; \text{ npn}$$

$$i_C = I_S e^{v_{EB}/V_T}; \text{ pnp}$$

$$i_C = \alpha i_E = \beta i_B$$

$$i_E = i_B + i_C$$

$$\alpha = \frac{\beta}{\beta + 1}$$

; Small signal

$$\beta = g_m r_\pi$$

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

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

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

$$V_T = 26 \text{ mV}$$

Question:

Refer to **Figure 1**. All transistors are matched.

The circuit parameters are: $V^+ = 8\text{ V}$ and $V^- = -8\text{ V}$.

The transistor parameters are: $V_{BE}(\text{on}) = 0.6\text{ V}$, $V_A = 160\text{ V}$, and $\beta = 50$.

DESIGN a two-transistor BJT current source similar to the **Figure 1** using all the parameters given above so that **its output resistance (R_o) is 200 k Ω** . Show clearly all calculations as marks are given according to this.

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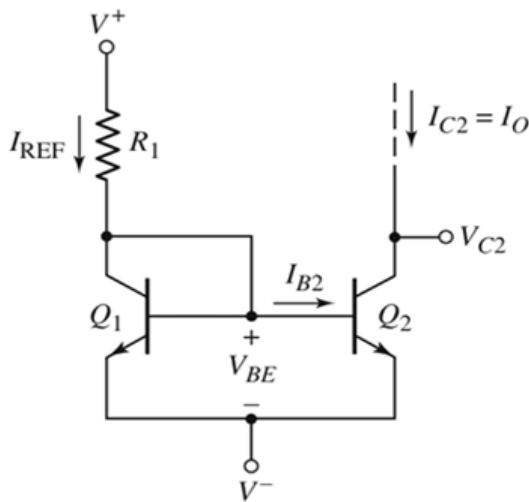


Figure 1

Answer:

R_o	$= r_{o2} = V_A / I_O$	[2]
I_O	$= V_A / R_o$	[1]
	$= (160) / (200\text{k})$	[0.5]
	$= 0.80\text{ mA}$	[0.5]
I_{REF}	$= I_O (1 + 2/\beta)$	[2]
	$= (0.80\text{m})(1 + 2/50)$	[0.5]
	$= 0.832\text{ mA}$	[0.5]
R_1	$= (V^+ - V_{BE} - V^-) / I_{REF}$	[2]
	$= (8 - 0.6 - (-8)) / (0.832\text{m})$	[0.5]
	$= 18.509\text{ k}\Omega$	[0.5]

$$i_C = I_S e^{v_{BE}/V_T}; \text{npn}$$

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$$i_C = \alpha i_E = \beta i_B$$

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Refer to **Figure 1**. All transistors are matched.

The circuit parameters are: $V^+ = 7.5 \text{ V}$ and $V^- = -7.5 \text{ V}$.

The transistor parameters are: $V_{BE}(\text{on}) = 0.6 \text{ V}$, $V_A = 150 \text{ V}$, and $\beta = 80$.

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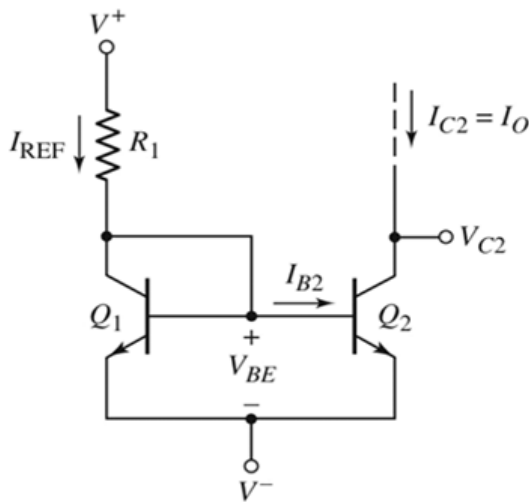


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I_O	$= V_A / R_o$	[1]
	$= (150) / (200\text{k})$	[0.5]
	$= 0.75 \text{ mA}$	[0.5]
I_{REF}	$= I_O (1 + 2/\beta)$	[2]
	$= (0.75\text{m})(1 + 2/80)$	[0.5]
	$= 0.76875 \text{ mA}$	[0.5]
R_1	$= (V^+ - V_{BE} - V^-) / I_{REF}$	[2]
	$= (7.5 - 0.6 - (-7.5)) / (0.76875\text{m})$	[0.5]
	$= 18.7317 \text{ k}\Omega$	[0.5]

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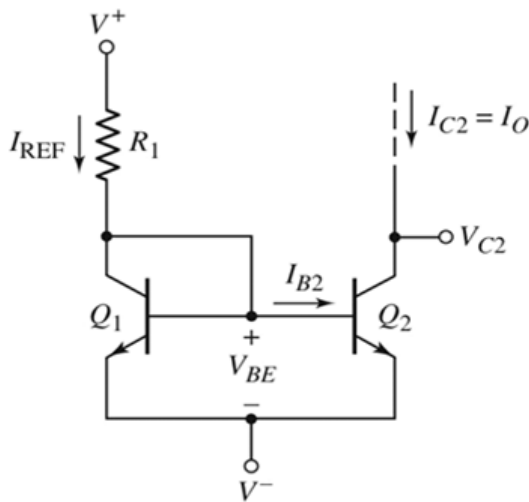


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	$= 0.82\text{ mA}$	[0.5]
R_1	$= (V^+ - V_{BE} - V^-) / I_{REF}$	[2]
	$= (8 - 0.6 - (-8)) / (0.82\text{m})$	[0.5]
	$= 18.78\text{ k}\Omega$	[0.5]

$$i_C = I_S e^{v_{BE}/V_T}; \text{npn}$$

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