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

EEEB273 - Quiz 1 .
SEMESTER 2, ACADEMIC YEAR 2017/2018
Date: 24 October 2017 Time: 15 minutes

Question:

Refer to a two-transistor BJT current source shown in **Figure 1**. All transistors are matched.
The circuit parameters are: $V^+ = 7.5$ **V** and $V^- = -7.5$ **V**.
The transistor parameters are: V_{BE} **(on) = 0.6 V**, $V_A = 150$ **V**, and $\beta = 50$.
Output resistance (R_O) of the two-transistor BJT current source is **200 kΩ**.

DESIGN the two-transistor BJT current source shown in the **Figure 1** using all the parameters given above. **Show clearly all calculations** as marks are given according to this.

[10 marks]

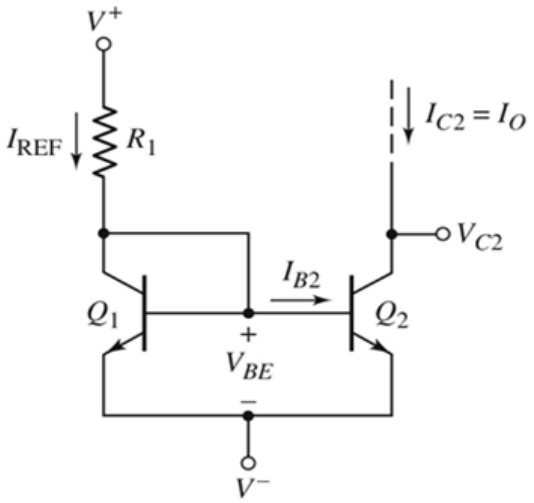

Figure 1

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

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

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

$$i_E = i_B + i_C$$

$$;\text{Small signal}$$

$$\beta = g_m r_\pi$$

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

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

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

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

Answer:

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

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Question:

Refer to a two-transistor BJT current source shown in **Figure 1**. All transistors are matched.
The circuit parameters are: $V^+ = 8$ V and $V^- = -8$ V.
The transistor parameters are: V_{BE} **(on)** $= 0.6$ V, $V_A = 160$ V, and $\beta = 50$.
Output resistance (R_O) of the two-transistor BJT current source is **200 kΩ**.

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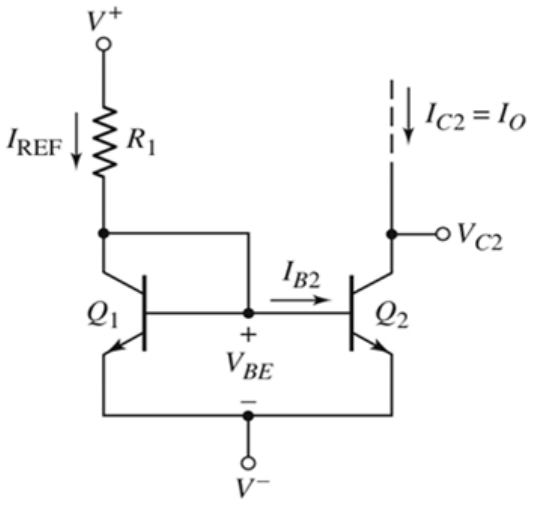

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Answer:

R_O	$= r_{O2}$	$= V_A / I_O$	[2]
I_O		$= V_A / R_O$	[1]
		= (160) / (200k)	[0.5]
		= 0.80 mA	[0.5]
I_{REF}		$= I_O (1 + 2/\beta)$	[2]
		= (0.80m)(1 + 2/50)	[0.5]
		= 0.832 mA	[0.5]
R_1		$= (V^+ - V_{BE} - V^-) / I_{REF}$	[2]
		= (8 – 0.6 – (-8)) / (0.832m)	[0.5]
		= 18.509 kΩ	[0.5]

;Small signal

$$\beta = g_m r_\pi$$

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

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

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

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

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Question:

Refer to a two-transistor BJT current source shown in **Figure 1**. All transistors are matched.
The circuit parameters are: $V^+ = 7.5$ **V** and $V^- = -7.5$ **V**.
The transistor parameters are: V_{BE} **(on) = 0.6 V**, $V_A = 150$ **V**, and $\beta = 80$.
Output resistance (R_O) of the two-transistor BJT current source is **200 kΩ**.

DESIGN the two-transistor BJT current source shown in the **Figure 1** using all the parameters given above. **Show clearly all calculations** as marks are given according to this.

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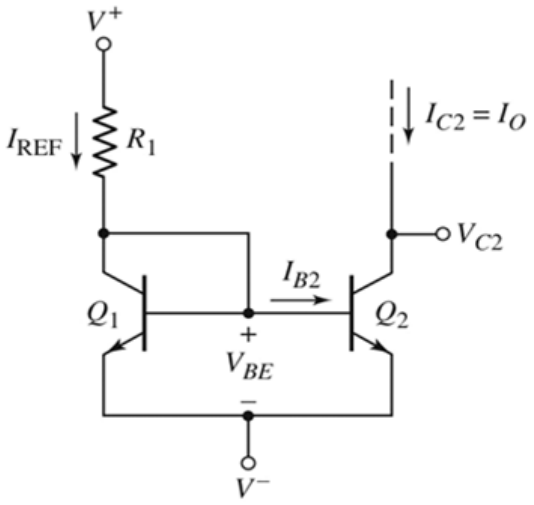

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Answer:

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

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The circuit parameters are: $V^+ = 8$ V and $V^- = -8$ V.
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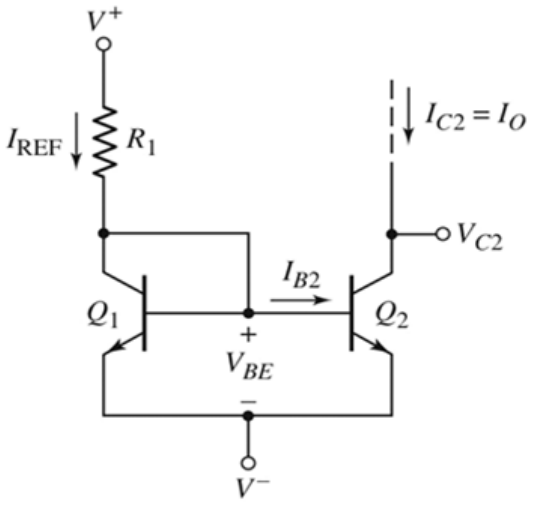

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		= (160) / (200k)	[0.5]
		= 0.80 mA	[0.5]
I_{REF}		$= I_O (1 + 2/\beta)$	[2]
		= (0.80m)(1 + 2/80)	[0.5]
		= 0.82 mA	[0.5]
R_1		$= (V^+ - V_{BE} - V^-) / I_{REF}$	[2]
		= (8 – 0.6 – (-8)) / (0.82m)	[0.5]
		= 18.78 kΩ	[0.5]