EEEB273/EEEB2014 - Quiz 2
SEMESTER 2, ACADEMIC YEAR 2018/2019
Date: 29 November 2019   .

Question:
Draw and label clearly a complete circuit diagram for a BJT differential amplifier that is biased with a **basic 3-transistor** current source at a constant current I_Q = **1.5 mA**. Your drawing **must include relevant values** for all components in the circuit and power supplies. The BJT diff amp has a differential gain for one-sided output A_d = **150**. Power supplies are V^+ = **+10 V** and V^- = **-10 V**. Assume β = **100** and V_{BE}(on) = **0.7 V** for all BJT in the circuit. *Hints: You are required to* ***determine*** *the value of* R_1 *in the* **basic 3-transistor** *current source and the value of* R_C *in the BJT differential amplifier that to be shown in your drawing.*   **[10 marks]**

Answer:

I_{REF} $= (V^+ - V_{BE3} - V_{BE5} - V^-) / (R_1) \acute{e} I_Q$ [0.5 mark]
R_1 $= (V^+ - V_{BE3} - V_{BE5} - V^-) / (I_Q)$ [0.5 mark]
         $= (10-0.7-0.7-(-10)) / (1.5m) = 12.4$ k   [0.5 mark]

A_d $= (g_m R_C)/2$
R_C $= (2 A_d)/ g_m$ [0.5 mark]
g_m $= I_Q / (2 V_T) = (1.5m)/(2x26m) = 28.846$ mA/V   [0.5 mark]
R_C $= (2x150)/(28.846m) = 10.4$ k   [0.5 mark]
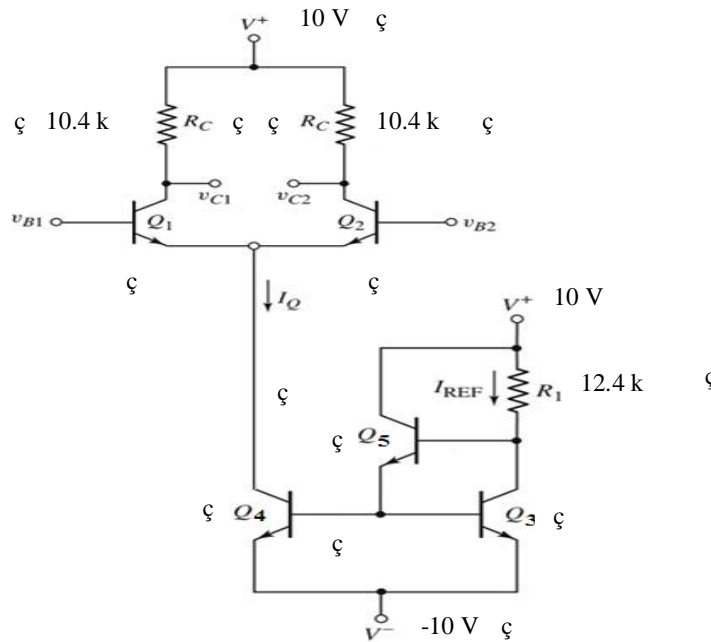
ç = ½ mark

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Question:

Draw and label clearly a complete circuit diagram for a BJT differential amplifier that is biased with a **basic 3-transistor** current source at a constant current $I_Q = 1.6$ **mA**. Your drawing **must include relevant values** for all components in the circuit and power supplies. The BJT diff amp has a differential gain for one-sided output $A_d = 150$. Power supplies are $V^+ = +11$ **V** and $V^- = -11$ **V**. Assume $\beta = 100$ and $V_{BE}(on) = 0.7$ **V** for all BJT in the circuit. *Hints: You are required to determine the value of R_1 in the basic 3-transistor current source and the value of R_C in the BJT differential amplifier that to be shown in your drawing.*   **[10 marks]**

Answer:

I_{REF}	$= (V^+ - V_{BE3} - V_{BE5} - V^-) / (R_1) \approx I_Q$	[0.5 mark]
R_1	$= (V^+ - V_{BE3} - V_{BE5} - V^-) / (I_Q)$	[0.5 mark]
	$= (11-0.7-0.7-(-11)) / (1.6m) = 12.875$ k	[0.5 mark]
A_d	$= (g_m R_C)/2$	
R_C	$= (2 A_d)/ g_m$	[0.5 mark]
g_m	$= I_Q / (2V_T) = (1.6m)/(2 \times 26m) = 30.769$ mA/V	[0.5 mark]
R_C	$= (2 \times 150)/(30.769m) = 9.75$ k	[0.5 mark]
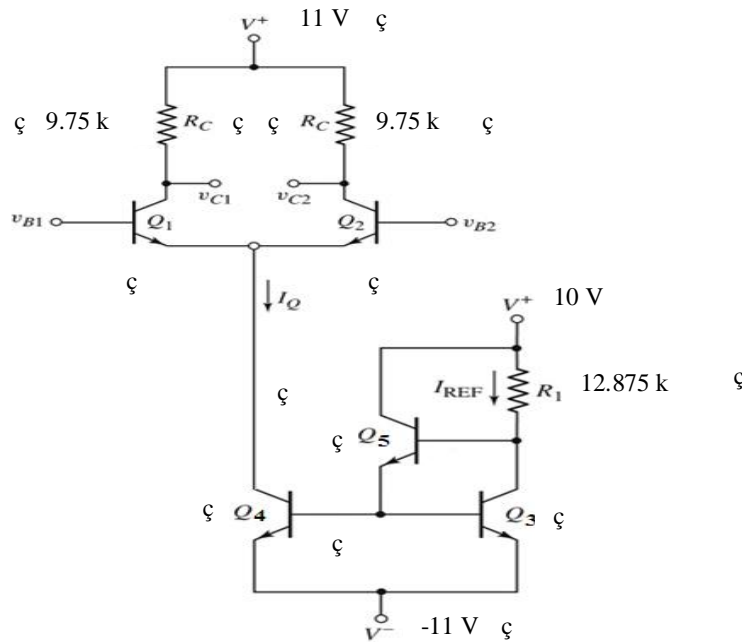
ç = ½ mark

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Date: 29 November 2019 ;

Question:
Draw and label clearly a complete circuit diagram for a BJT differential amplifier that is biased with a **basic 3-transistor** current source at a constant current I_Q = **1.3 mA**. Your drawing **must include relevant values** for all components in the circuit and power supplies. The BJT diff amp has a differential gain for one-sided output A_d = **160**. Power supplies are V^+ = **+12 V** and V^- = **-12 V**. Assume β = **100** and V_{BE}(**on**) = **0.7 V** for all BJT in the circuit. *Hints: You are required to* **determine** *the value of* R_1 *in the* **basic 3-transistor** *current source and the value of* R_C *in the BJT differential amplifier that to be shown in your drawing.* **[10 marks]**

Answer:

I_{REF} = $(V^+ - V_{BE3} - V_{BE5} - V^-) / (R_1)$ é I_Q [0.5 mark]
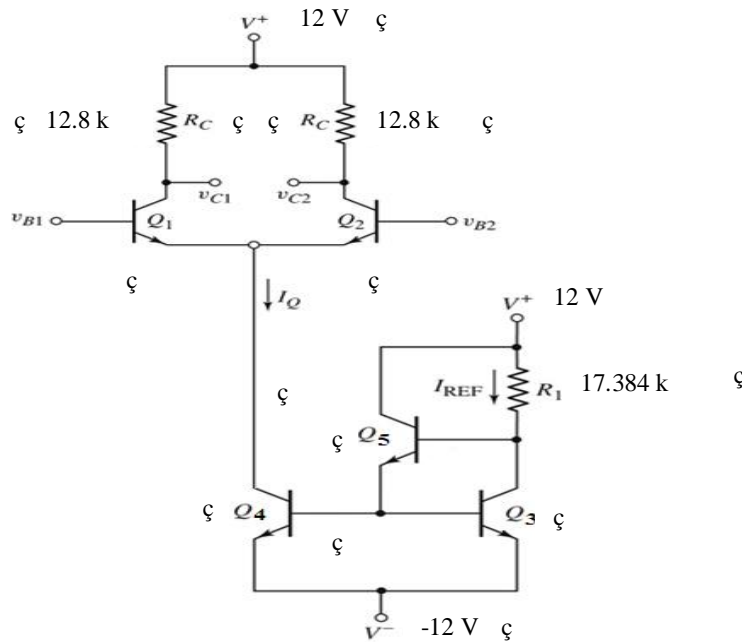R_1 = $(V^+ - V_{BE3} - V_{BE5} - V^-) / (I_Q)$ [0.5 mark]
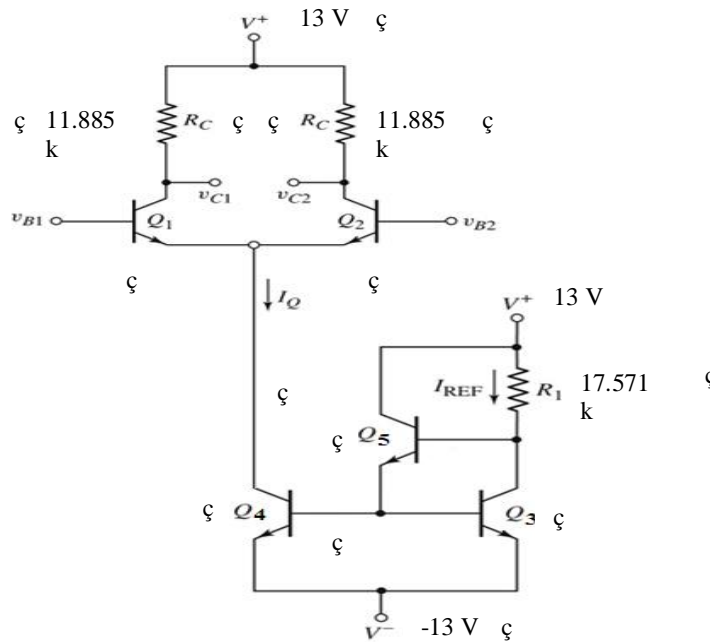   = (12-0.7-0.7-(-12)) / (1.3m) = 17.384 k   [0.5 mark]

A_d = $(g_m R_C)/2$
R_C = $(2 A_d)/ g_m$ [0.5 mark]
g_m = $I_Q / (2V_T)$ = (1.3m)/(2x26m) = 25 mA/V   [0.5 mark]
R_C = (2x160)/(25m) = 12.8 k   [0.5 mark]

ç = ½ mark

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Question:
Draw and label clearly a complete circuit diagram for a BJT differential amplifier that is biased with a **basic 3-transistor** current source at a constant current I_Q = **1.4 mA**. Your drawing **must include relevant values** for all components in the circuit and power supplies. The BJT diff amp has a differential gain for one-sided output A_d = **160**. Power supplies are V^+ = **+13 V** and V^- = **-13 V**. Assume β = **100** and V_{BE}(on) = **0.7 V** for all BJT in the circuit. *Hints: You are required to* ***determine*** *the value of R_1 in the* ***basic 3-transistor*** *current source and the value of R_C in the BJT differential amplifier that to be shown in your drawing.* **[10 marks]**

Answer:

I_{REF}	$= (V^+ - V_{BE3} - V_{BE5} - V^-) / (R_1)$ é I_Q	[0.5 mark]
R_1	$= (V^+ - V_{BE3} - V_{BE5} - V^-) / (I_Q)$	[0.5 mark]
	$= (13-0.7-0.7-(-13)) / (1.4m) = 17.571$ k	[0.5 mark]

A_d	$= (g_m R_C)/2$	
R_C	$= (2 A_d)/ g_m$	[0.5 mark]
g_m	$= I_Q / (2V_T) = (1.4m)/(2x26m) = 26.923$ mA/V	[0.5 mark]
R_C	$= (2x160)/(26.923m) = 11.885$ k	[0.5 mark]

ç = ½ mark