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

EEEB273 - Quiz 5
SEMESTER 1, ACADEMIC YEAR 2015/2016
Date: 13 August 2015 Time: 15 minutes

1

Question:

A **class-A** emitter follower biased with a constant current source is shown in **Figure 1**. Assume circuit parameters of $\boldsymbol{V^+ = 10}$ **V**, $\boldsymbol{V^- = -10}$ **V**, and $\boldsymbol{R_L = 20\ \Omega}$. The transistor parameters are $\boldsymbol{\beta = 40}$ and $\boldsymbol{V_{BE}}$ **(on) = 0.7 V**. The minimum current in $\boldsymbol{Q_1}$ is to be $\boldsymbol{i_{E1}}$ **= 50 mA** and the minimum collector- emitter voltage is to be $\boldsymbol{v_{CE}}$ **(min) = 0.7 V**.

Determine the value of $\boldsymbol{R}$ that will produce the maximum possible output voltage swing. **What** is the value of $\boldsymbol{I_Q}$? What is the maximum value of $\boldsymbol{i_{E1}}$? [10 marks]

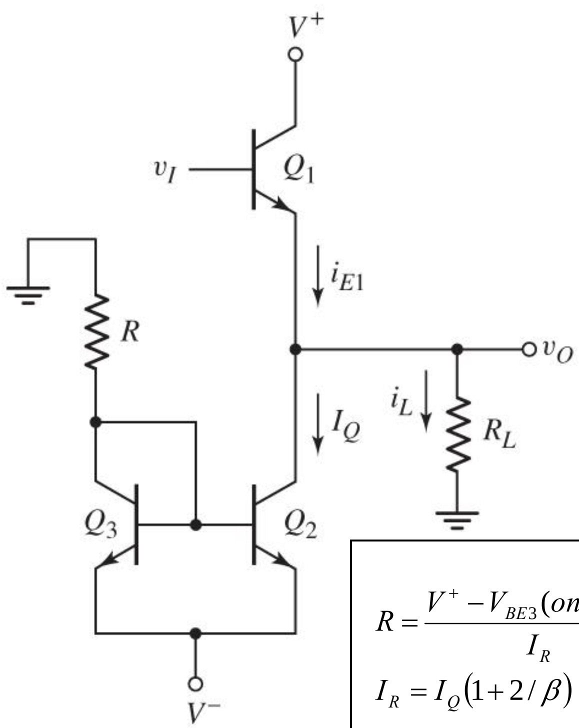

Figure 1

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

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

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

$$i_E = i_B + i_C$$

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

;Small signal

$\beta = g\ r$

Answer:

$$R = \frac{V^+ - V_{BE3}(on) - V^-}{I_R} = \frac{0 - 0.7 - (-10)}{I_R} = \frac{9.3}{I_R}\ [1]$$

$$I_R = I_Q(1 + 2/\beta)\ [1]$$

$$i_{E1} = I_Q + i_L$$

$$i_{E1}(\min) = I_Q + i_L(\min)\ [1]$$

$$i_L(\min) = \frac{v_O(\min)}{R_L} = \frac{V^- + v_{CE2}(\min)}{R_L} = \frac{-10 + 0.7}{20} = -465mA\ [1]$$

$$I_Q = i_{E1}(\min) - i_L(\min) = 50mA - (-465mA) = 515mA\ [1]$$

$$I_R = (515mA)(1 + 2/40) = 540.75mA\ [1]$$

$$R = (9.3V)/(540.75mA) = 17.198\,\Omega\ [1]$$

$$i_{E1}(\max) = I_Q + i_L(\max)\ [1]$$

$$i_L(\max) = \frac{v_O(\max)}{R_L} = \frac{V^+ - v_{CE1}(\min)}{R_L} = \frac{10 - 0.7}{20} = 465mA\ [1]$$

$$i_{E1}(\max) = I_Q + i_L(\max) = 515mA + 465mA = 980mA\ [1]$$

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Question:

A **class-A** emitter follower biased with a constant current source is shown in **Figure 1**. Assume circuit parameters of $V^+ = 11$ V, $V^- = -11$ V, and $R_L = 15\ \Omega$. The transistor parameters are $\beta = 40$ and V_{BE} **(on) = 0.7 V**. The minimum current in Q_1 is to be i_{E1} **= 50 mA** and the minimum collector- emitter voltage is to be v_{CE} **(min) = 0.7 V**.

Determine the value of R that will produce the maximum possible output voltage swing. **What** is the value of I_Q? What is the maximum value of i_{E1}? [10 marks]

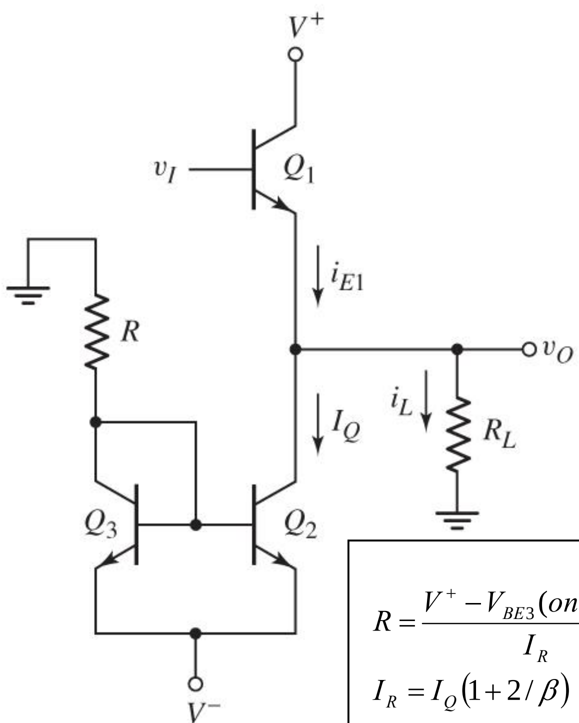

Figure 1

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

;Small signal

$\beta = g\;r$

Answer:

$$R = \frac{V^+ - V_{BE3}(on) - V^-}{I_R} = \frac{0 - 0.7 - (-11)}{I_R} = \frac{10.3}{I_R}\ [1]$$
$$I_R = I_Q(1 + 2/\beta)\ [1]$$
$$i_{E1} = I_Q + i_L$$
$$i_{E1}(\min) = I_Q + i_L(\min)\ [1]$$
$$i_L(\min) = \frac{v_O(\min)}{R_L} = \frac{V^- + v_{CE2}(\min)}{R_L} = \frac{-11 + 0.7}{15} = -686.7mA\ [1]$$
$$I_Q = i_{E1}(\min) - i_L(\min) = 50mA - (-686.7mA) = 736.7mA\ [1]$$
$$I_R = (736.7mA)(1 + 2/40) = 773.5mA\ [1]$$
$$R = (10.3V)/(773.5mA) = 13.316\,\Omega\ [1]$$
$$i_{E1}(\max) = I_Q + i_L(\max)\ [1]$$
$$i_L(\max) = \frac{v_O(\max)}{R_L} = \frac{V^+ - v_{CE1}(\min)}{R_L} = \frac{11 - 0.7}{15} = 686.7mA\ [1]$$
$$i_{E1}(\max) = I_Q + i_L(\max) = 736.7mA + 686.7mA = 1423.4mA\ [1]$$

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Question:

A **class-A** emitter follower biased with a constant current source is shown in **Figure 1**. Assume circuit parameters of $V^+ = 11$ V, $V^- = -11$ V, and $R_L = 25\ \Omega$. The transistor parameters are $\beta = 40$ and V_{BE} **(on)** = **0.7 V**. The minimum current in Q_1 is to be i_{E1} = **50 mA** and the minimum collector- emitter voltage is to be v_{CE} **(min)** = **0.7 V**.

Determine the value of R that will produce the maximum possible output voltage swing. **What** is the value of I_Q? What is the maximum value of i_{E1}? [10 marks]

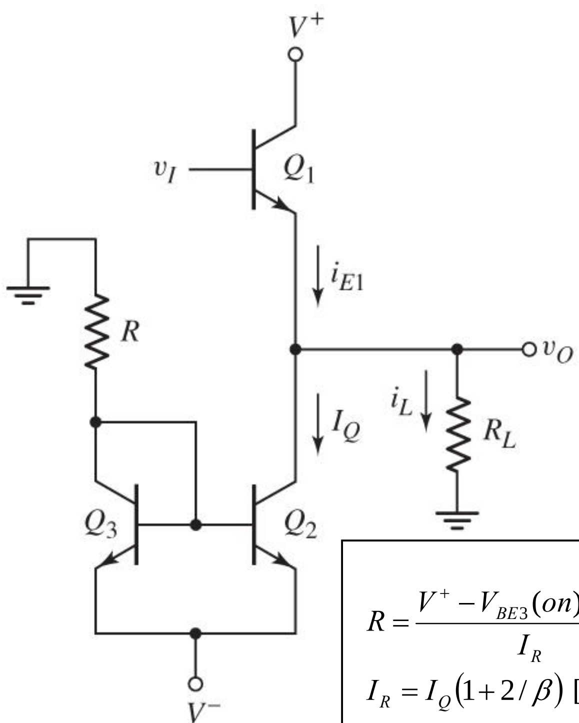

Figure 1

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

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

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

$$i_E = i_B + i_C$$

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

;Small signal

$\beta = g_m r_\pi$

Answer:

$$R = \frac{V^+ - V_{BE3}(on) - V^-}{I_R} = \frac{0 - 0.7 - (-11)}{I_R} = \frac{10.3}{I_R}\ [1]$$

$$I_R = I_Q(1 + 2/\beta)\ [1]$$

$$i_{E1} = I_Q + i_L$$

$$i_{E1}(\min) = I_Q + i_L(\min)\ [1]$$

$$i_L(\min) = \frac{v_O(\min)}{R_L} = \frac{V^- + v_{CE2}(\min)}{R_L} = \frac{-11 + 0.7}{25} = -412mA\ [1]$$

$$I_Q = i_{E1}(\min) - i_L(\min) = 50mA - (-412mA) = 462mA\ [1]$$

$$I_R = (462mA)(1 + 2/40) = 485.1mA\ [1]$$

$$R = (10.3V)/(485.1mA) = 21.232\,\Omega\ [1]$$

$$i_{E1}(\max) = I_Q + i_L(\max)\ [1]$$

$$i_L(\max) = \frac{v_O(\max)}{R_L} = \frac{V^+ - v_{CE1}(\min)}{R_L} = \frac{11 - 0.7}{25} = 412mA\ [1]$$

$$i_{E1}(\max) = I_Q + i_L(\max) = 462mA + 412mA = 874mA\ [1]$$

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Question:

A **class-A** emitter follower biased with a constant current source is shown in **Figure 1**. Assume circuit parameters of V^+ **= 9 V**, V^- **= −9 V**, and R_L **= 20 Ω**. The transistor parameters are β **= 40** and V_{BE} **(on) = 0.7 V**. The minimum current in Q_1 is to be i_{E1} **= 50 mA** and the minimum collector- emitter voltage is to be v_{CE} **(min) = 0.7 V**.

Determine the value of R that will produce the maximum possible output voltage swing. **What** is the value of I_Q? What is the maximum value of i_{E1}? [10 marks]

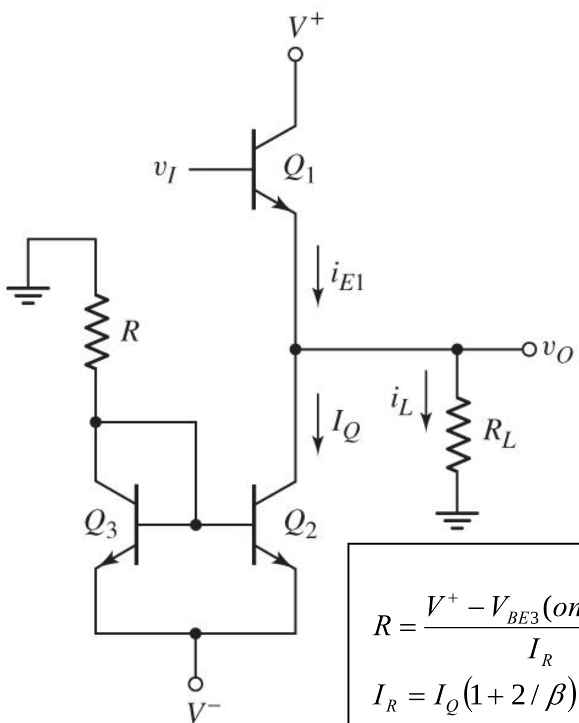

Figure 1

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

;Small signal

$$\beta = g_m r_\pi$$

Answer:

$$R = \frac{V^+ - V_{BE3}(on) - V^-}{I_R} = \frac{0 - 0.7 - (-9)}{I_R} = \frac{8.3}{I_R} \text{ [1]}$$

$$I_R = I_Q(1 + 2/\beta) \text{ [1]}$$

$$i_{E1} = I_Q + i_L$$

$$i_{E1}(\min) = I_Q + i_L(\min) \text{ [1]}$$

$$i_L(\min) = \frac{v_O(\min)}{R_L} = \frac{V^- + v_{CE2}(\min)}{R_L} = \frac{-9 + 0.7}{20} = -415mA \text{ [1]}$$

$$I_Q = i_{E1}(\min) - i_L(\min) = 50mA - (-415mA) = 465mA \text{ [1]}$$

$$I_R = (465mA)(1 + 2/40) = 488.25mA \text{ [1]}$$

$$R = (8.3V)/(488.25mA) = 16.999\,\Omega \text{ [1]}$$

$$i_{E1}(\max) = I_Q + i_L(\max) \text{ [1]}$$

$$i_L(\max) = \frac{v_O(\max)}{R_L} = \frac{V^+ - v_{CE1}(\min)}{R_L} = \frac{9 - 0.7}{20} = 415mA \text{ [1]}$$

$$i_{E1}(\max) = I_Q + i_L(\max) = 465mA + 415mA = 880mA \text{ [1]}$$