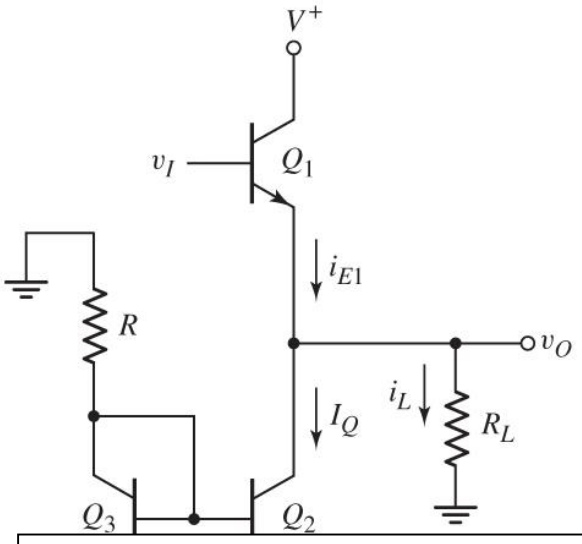
Name:	**Dr JBO**
Student ID Number:	**Model Answer**
Section:	01 A/B
Lecturer:	Dr. Jamaludin Bin Omar

EEEB273 - Quiz 5 .
SEMESTER 2, ACADEMIC YEAR 2017/2018
Date: 20 December 2017 Time: 15 minutes

Question:

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



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

;Small signal

$\beta = g_m r_\pi$

Answer:

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

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

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

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

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

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

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

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

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

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

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

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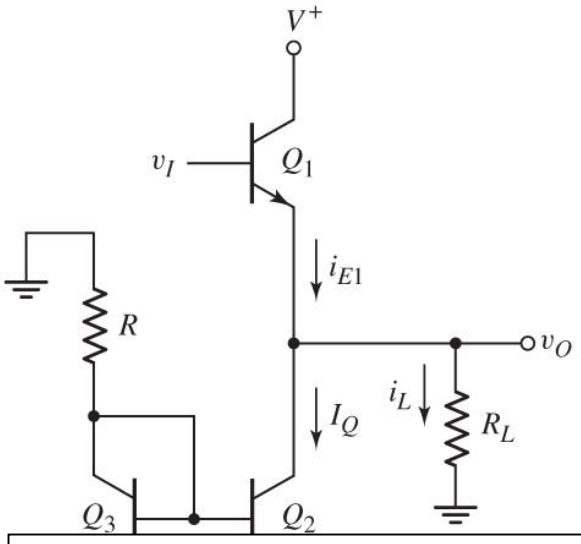
Question:

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}**(min) = 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]



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

$$\beta = g_m r_\pi \ ;\text{Small signal}$$

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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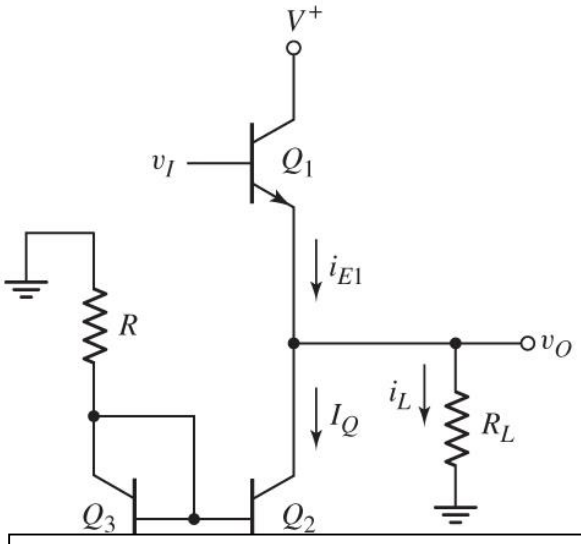
Question:

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}**(min) = 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]



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

;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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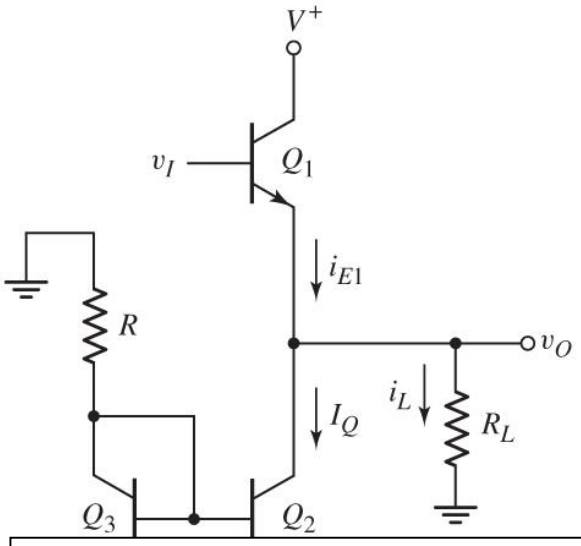
Question:

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 $R_L = 20\ \Omega$. The transistor parameters are $\beta = 40$ and V_{BE} **(on) = 0.7 V**. The minimum current in Q_1 is to be i_{E1}**(min) = 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]



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

;Small signal

$$\beta = g_m r_\pi$$

Answer:

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

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

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

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

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

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

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

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

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

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

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