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

EEEB273 - Quiz 3 ṡ ṡ
SEMESTER 2, ACADEMIC YEAR 2014/2015
Date: 8 January 2015 Time: 15 minutes

Question:

Study the simple output stage circuit shown in **Figure 1** carefully. Let R_1 = **50 kΩ**, R_2 = **5 kΩ**, I_{C2} = **0.5 mA,** and I_{C3} = **1 mA**. The transistor parameters are: β = **100** and V_A = **120 V**. Neglect base currents.

Determine the output resistance (R_O) of the emitter follower Q_3. [10 marks]

Write your answer **using pen,** in 4 decimal points, with **proper Units** for all the parameters.

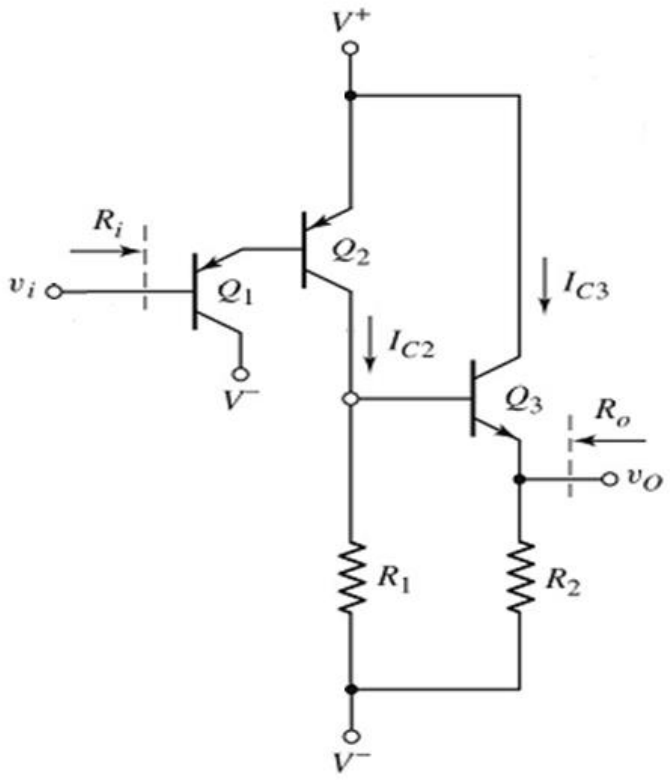

Figure 1

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

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

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

$$i_E = i_B + i_C$$

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

; Small signal

$$\beta = g_m r_\pi$$

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

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

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

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

R_O	= R_2 || [($r_{\pi 3}$ + Z) / (1 + β)]	[1.5]
Z	= R_1 || R_{c2}	[1]
R_{c2}	= r_{O2} = V_A / I_{C2}	[2]
	= (120 V)/(0.5 mA) = 240 kΩ	[1]
Z	= (50 kΩ) || (240 kΩ) = 41.379 kΩ	[1]
$r_{\pi 3}$	= (β V_T) / I_{C3} = (100 x 0.026) / 1m = 2.6 kΩ	[2]
R_O	= (5 kΩ) || [(2.6 kΩ + 41.379 kΩ) / (1 + 100)]	[1]
	= 400.55 Ω	[0.5]

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Question:

Study the simple output stage circuit shown in **Figure 1** carefully. Let R_1 = **40 kΩ**, R_2 = **8 kΩ**, I_{C2} = **0.4 mA,** and I_{C3} = **1 mA**. The transistor parameters are: β = **100** and V_A = **120 V**. Neglect base currents.

Determine the output resistance (R_O) of the emitter follower Q_3. [10 marks]

Write your answer **using pen,** in 4 decimal points, with **proper Units** for all the parameters.

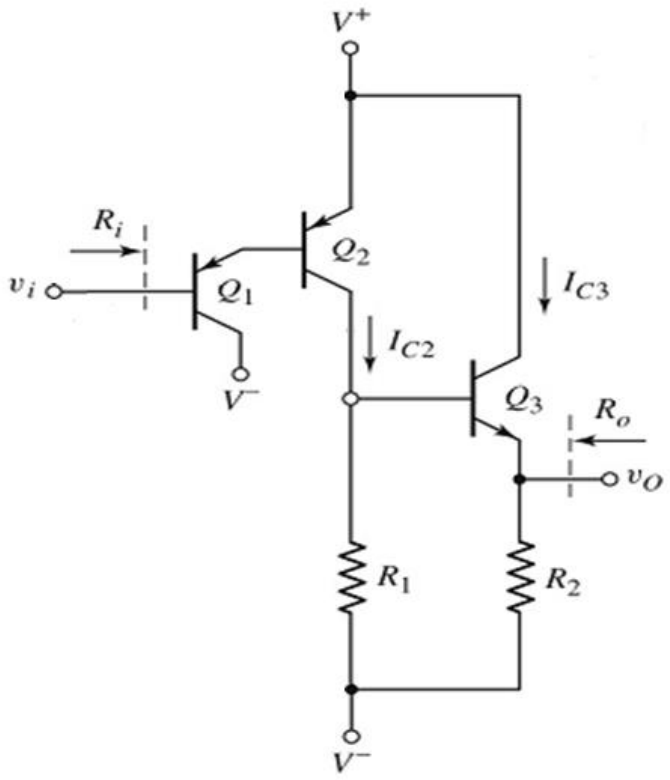

Figure 1

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

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

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

$$i_E = i_B + i_C$$

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

; Small signal

$$\beta = g_m r_\pi$$

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

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

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

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

R_O	= R_2 || [($r_{\pi 3}$ + Z) / (1 + β)]	[1.5]
Z	= R_1 || R_{c2}	[1]
R_{c2}	= r_{O2} = V_A / I_{C2}	[2]
	= (120 V)/(0.4 mA) = 300 kΩ	[1]
Z	= (40 kΩ) || (300 kΩ) = 35.294 kΩ	[1]
$r_{\pi 3}$	= (β V_T) / I_{C3} = (100 x 0.026) / 1m = 2.6 kΩ	[2]
R_O	= (8 kΩ) || [(2.6 kΩ + 35.294 kΩ) / (1 + 100)]	[1]
	= 358.38 Ω	[0.5]

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Date: 8 January 2015 Time: 15 minutes

Question:

Study the simple output stage circuit shown in **Figure 1** carefully. Let R_1 = **55 kΩ**, R_2 = **8 kΩ**, I_{C2} = **0.3 mA,** and I_{C3} = **1 mA**. The transistor parameters are: β = **100** and V_A = **120 V**. Neglect base currents.

Determine the output resistance (R_O) of the emitter follower Q_3. [10 marks]

Write your answer **using pen,** in 4 decimal points, with **proper Units** for all the parameters.

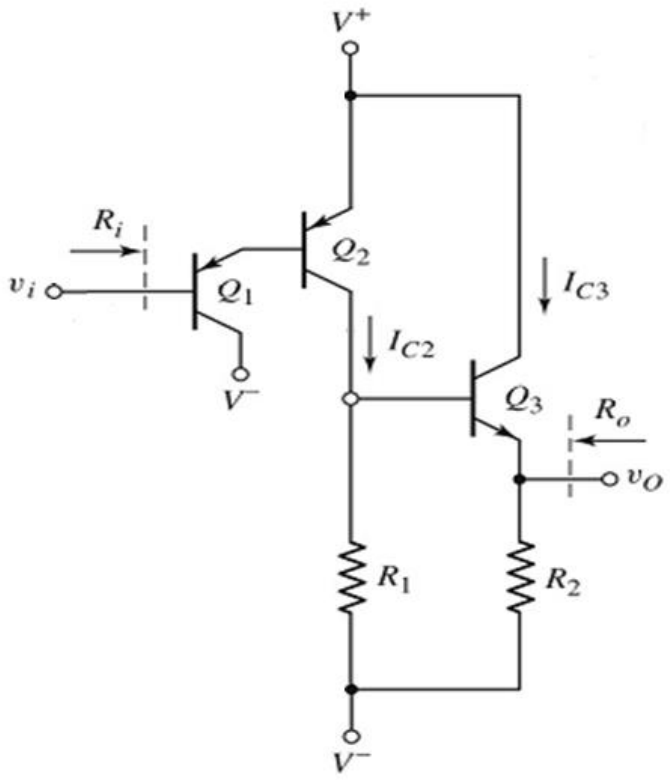

Figure 1

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

; Small signal

$$\beta = g_m r_\pi$$
$$r_\pi = \frac{\beta V_T}{I_{CQ}}$$
$$g_m = \frac{I_{CQ}}{V_T}$$
$$r_o = \frac{V_A}{I_{CQ}}$$
$$V_T = 26\,\text{mV}$$

R_O	$= R_2 \parallel [(r_{\pi 3} + Z) / (1 + \beta)]$	[1.5]
Z	$= R_1 \parallel R_{c2}$	[1]
R_{c2}	$= r_{O2} = V_A / I_{C2}$	[2]
	$= (120\text{ V})/(0.3\text{ mA}) = 400\text{ k}\Omega$	[1]
Z	$= (55\text{ k}\Omega) \parallel (400\text{ k}\Omega) = 48.351\text{ k}\Omega$	[1]
$r_{\pi 3}$	$= (\beta V_T) / I_{C3} = (100 \times 0.026) / 1\text{m} = 2.6\text{ k}\Omega$	[2]
R_O	$= (8\text{ k}\Omega) \parallel [(2.6\text{ k}\Omega + 48.351\text{ k}\Omega) / (1 + 100)]$	[1]
	$= 474.55\ \Omega$	[0.5]

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Question:

Study the simple output stage circuit shown in **Figure 1** carefully. Let R_1 = **45 kΩ**, R_2 = **10 kΩ**, I_{C2} = **0.6 mA**, and I_{C3} = **1 mA**. The transistor parameters are: β = **100** and V_A = **120 V**. Neglect base currents.

Determine the output resistance (R_O) of the emitter follower Q_3. [10 marks]

Write your answer **using pen,** in 4 decimal points, with **proper Units** for all the parameters.

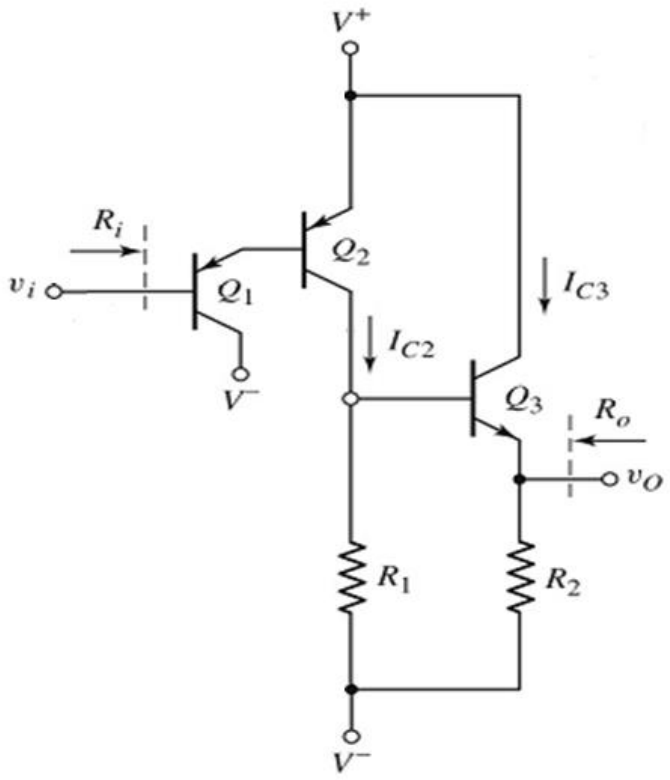

Figure 1

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

; Small signal

$$\beta = g_m r_\pi$$
$$r_\pi = \frac{\beta V_T}{I_{CQ}}$$
$$g_m = \frac{I_{CQ}}{V_T}$$
$$r_o = \frac{V_A}{I_{CQ}}$$
$$V_T = 26\,\text{mV}$$

R_O	$= R_2 \parallel [(r_{\pi 3} + Z) / (1 + \beta)]$	[1.5]
Z	$= R_1 \parallel R_{c2}$	[1]
R_{c2}	$= r_{O2} = V_A / I_{C2}$	[2]
	$= (120\text{ V})/(0.6\text{ mA}) = 200\text{ k}\Omega$	[1]
Z	$= (45\text{ k}\Omega) \parallel (200\text{ k}\Omega) = 36.735\text{ k}\Omega$	[1]
$r_{\pi 3}$	$= (\beta V_T) / I_{C3} = (100 \times 0.026) / 1\text{m} = 2.6\text{ k}\Omega$	[2]
R_O	$= (10\text{ k}\Omega) \parallel [(2.6\text{ k}\Omega + 36.735\text{ k}\Omega) / (1 + 100)]$	[1]
	$= 374.85\ \Omega$	[0.5]