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

EEEB273 - Quiz 5 .
SEMESTER 1, ACADEMIC YEAR 2017/2018
Date: 8 August 2017 Time: 15 minutes

Question:

Study the simple output stage circuit shown in **Figure 1** carefully. Let $R_1 = 50\ k\Omega$, $R_2 = 5\ k\Omega$, $I_{C2} = 0.5\ mA$, and $I_{C3} = 1\ mA$. The transistor parameters are: $\beta = 100$ 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** with **proper Units** for all the parameters. **Show clearly** all formula used in finding the solution.

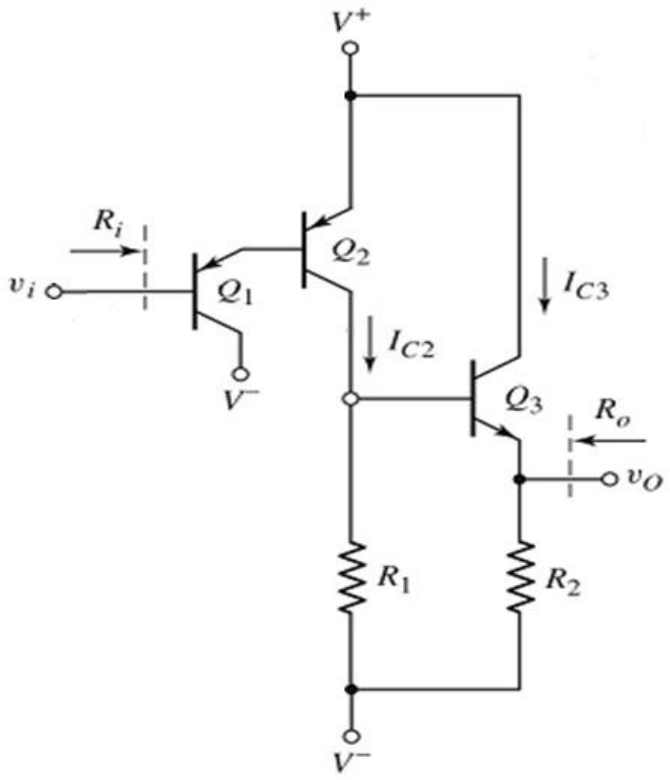

Figure 1

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

;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]
	$= (120\ V)/(0.5\ mA) = 240\ k\Omega$	[1]
Z	$= (50\ k\Omega) \parallel (240\ k\Omega) = 41.379\ k\Omega$	[1]
$r_{\pi 3}$	$= (\beta V_T) / I_{C3} = (100 \times 0.026) / 1m = 2.6\ k\Omega$	[2]
R_O	$= (5\ k\Omega) \parallel [(2.6\ k\Omega + 41.379\ k\Omega) / (1 + 100)]$	[1]
	$= 400.55\ \Omega$	[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** with **proper Units** for all the parameters. **Show clearly** all formula used in finding the solution.

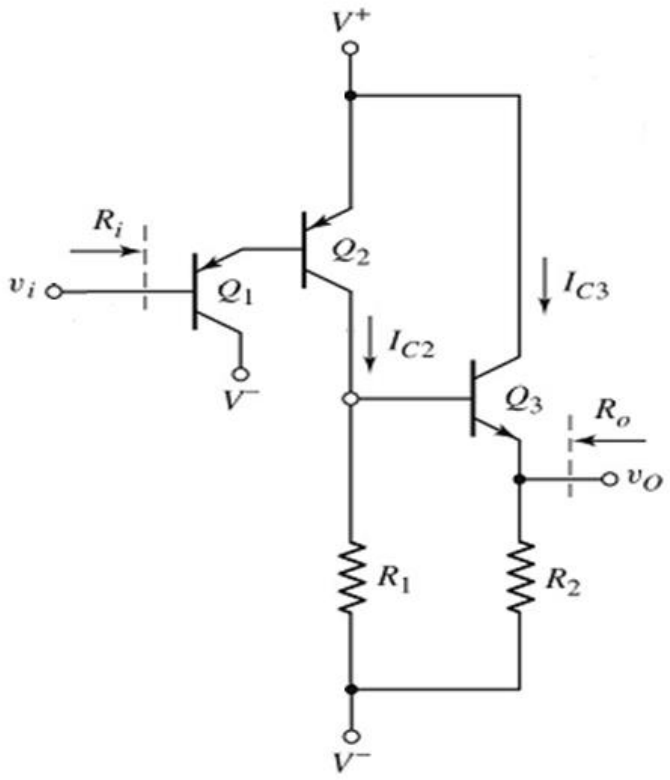

Figure 1

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

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

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

$$i_E = i_B + i_C$$

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

;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]
	$= (120\text{ V})/(0.4\text{ mA}) = 300\text{ k}\Omega$	[1]
Z	$= (40\text{ k}\Omega) \parallel (300\text{ k}\Omega) = 35.294\text{ k}\Omega$	[1]
$r_{\pi 3}$	$= (\beta V_T) / I_{C3} = (100 \times 0.026) / 1\text{m} = 2.6\text{ k}\Omega$	[2]
R_O	$= (8\text{ k}\Omega) \parallel [(2.6\text{ k}\Omega + 35.294\text{ k}\Omega) / (1+100)]$	[1]
	$= 358.38\ \Omega$	[0.5]

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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** with **proper Units** for all the parameters. **Show clearly** all formula used in finding the solution.

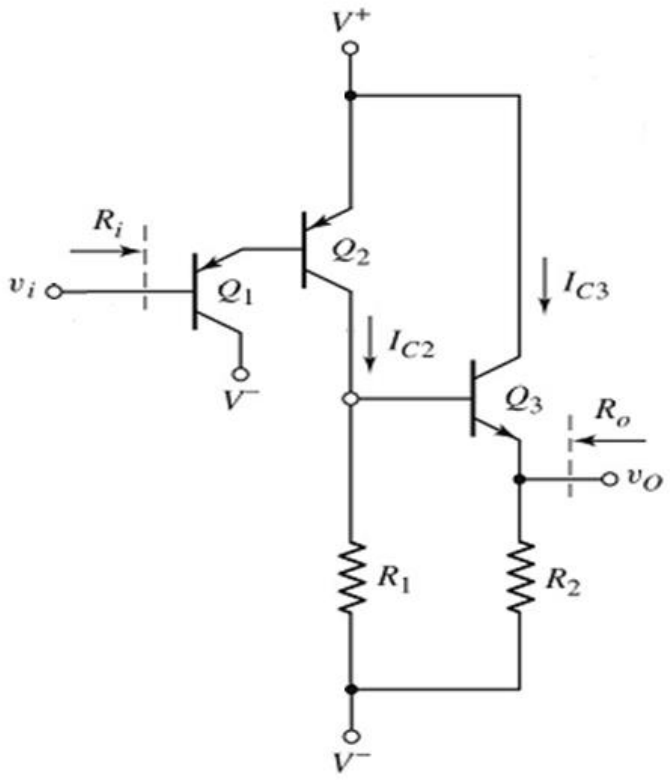

Figure 1

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

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

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

$$i_E = i_B + i_C$$

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

;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** with **proper Units** for all the parameters. **Show clearly** all formula used in finding the solution.

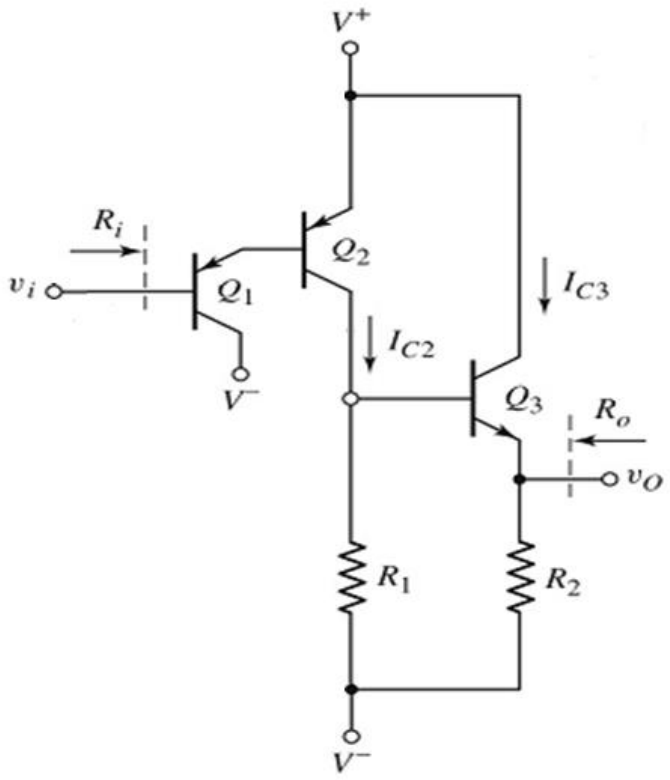

Figure 1

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

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

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

$$i_E = i_B + i_C$$

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

; 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]