Name:	Dr JBO
Student ID Number:	Model Answer
Section: 02 A/B	
Lecturer: Dr. Jamaludin Bin Omar	

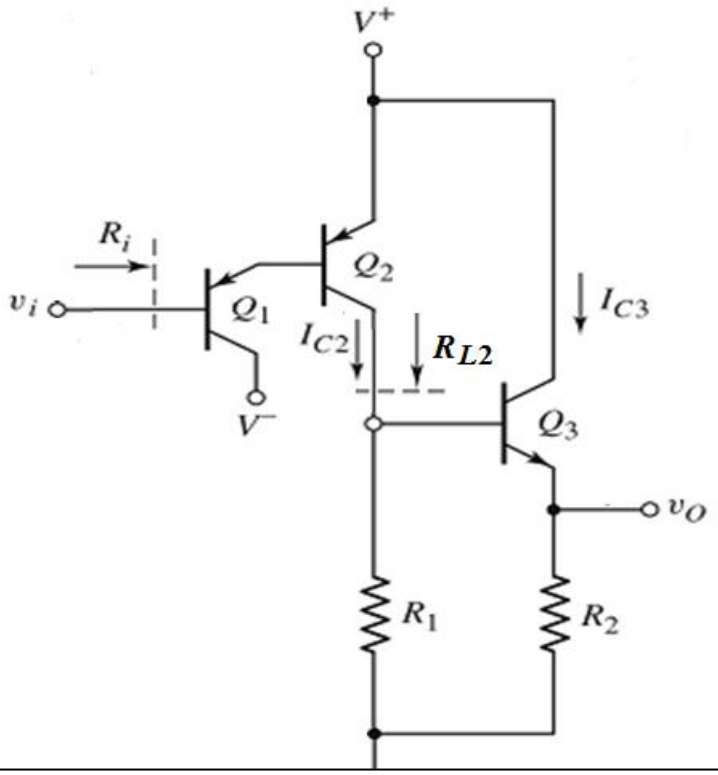
EEEB2014/EEEB273 - Quiz 3
SEMESTER 1, ACADEMIC YEAR 2019/2020
Date: 24 July 2019 Time: 15 minutes .

Question:

Study the gain stage and simple output stage circuit shown in **Figure 1** carefully. The transistor parameters are: β = **100** and V_A = **120 V**.

Let R_1 = **50 kΩ**, R_2 = **5 kΩ**, I_{C2} = **0.54 mA,** and I_{C3} = **1.2 mA**. **Determine** the **input resistance** (R_i) of the gain stage and the **equivalent load resistance** of the gain stage connected to the collector of Q_2, i.e. R_{L2} shown in the **Figure 1**. [10 marks]

Write your answer **using pen**, with **proper Units** for all the parameters.



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

;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_i	$= r_{\pi 1} + (1 + \beta)\, r_{\pi 2}$	[2]
$r_{\pi 2}$	$= (\beta V_T) / I_{C2}$ = (100 x 0.026) / 0.54m = 4.81 kΩ	[1]
I_{C1}	$= I_{C2} / (1 + \beta)$	[1]
$r_{\pi 1}$	$= (\beta V_T) / I_{C1} = (\beta(1 + \beta) V_T) / I_{C2}$ = (100x101x0.026) / 0.54m = 486.3 kΩ	[1]
R_i	$= r_{\pi 1} + (1 + \beta)\, r_{\pi 2}$ = 486.3k + (101)(4.81k) = 972.4 kΩ	[1]
R_{L2}	$= R_1 \,\|\| [\, r_{\pi 3} + (1 + \beta)\, R_2]$	[2]
$r_{\pi 3}$	$= (\beta V_T) / I_{C3}$ = (100 x 0.026) / 1.2m = 2.17 kΩ	[1]
R_{L2}	= (50k) || [2.17k + (1 + 100)(5k)] = 45.51 kΩ	[1]

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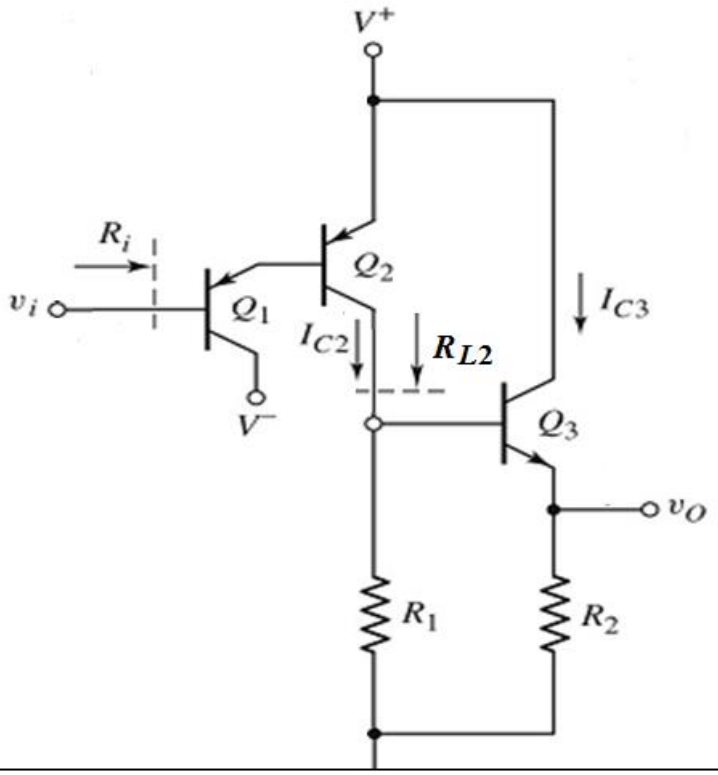
Question:

Study the gain stage and simple output stage circuit shown in **Figure 1** carefully. The transistor parameters are: β = **100** and V_A = **120 V**.

Let R_1 = **40 kΩ**, R_2 = **8 kΩ**, I_{C2} = **0.42 mA,** and I_{C3} = **1.3 mA**. **Determine** the **input resistance** (R_i) of the gain stage and the **equivalent load resistance** of the gain stage connected to the collector of Q_2, i.e. R_{L2} shown in the **Figure 1**. [10 marks]

Write your answer **using pen**, with **proper Units** for all the parameters.



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

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

$$i_E = i_B + i_C$$

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

;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_i	$= r_{\pi 1} + (1 + \beta)\, r_{\pi 2}$	[2]
$r_{\pi 2}$	$= (\beta\, V_T) / I_{C2}$ = (100 x 0.026) / 0.42m = 6.19 kΩ	[1]
I_{C1}	$= I_{C2} / (1 + \beta)$	[1]
$r_{\pi 1}$	$= (\beta\, V_T) / I_{C1} = (\beta(1 + \beta)\, V_T) / I_{C2}$ = (100x101x0.026) / 0.42m = 625.24 kΩ	[1]
R_i	$= r_{\pi 1} + (1 + \beta)\, r_{\pi 2}$ = 625.24k + (101)(6.19k) = 1250.43 kΩ	[1]
R_{L2}	$= R_1 \,\|\| [\, r_{\pi 3} + (1 + \beta)\, R_2]$	[2]
$r_{\pi 3}$	$= (\beta\, V_T) / I_{C3}$ = (100 x 0.026) / 1.3m = 2 kΩ	[1]
R_{L2}	= (40k) || [2k + (1 + 100)(8k)] = 38.12 kΩ	[1]

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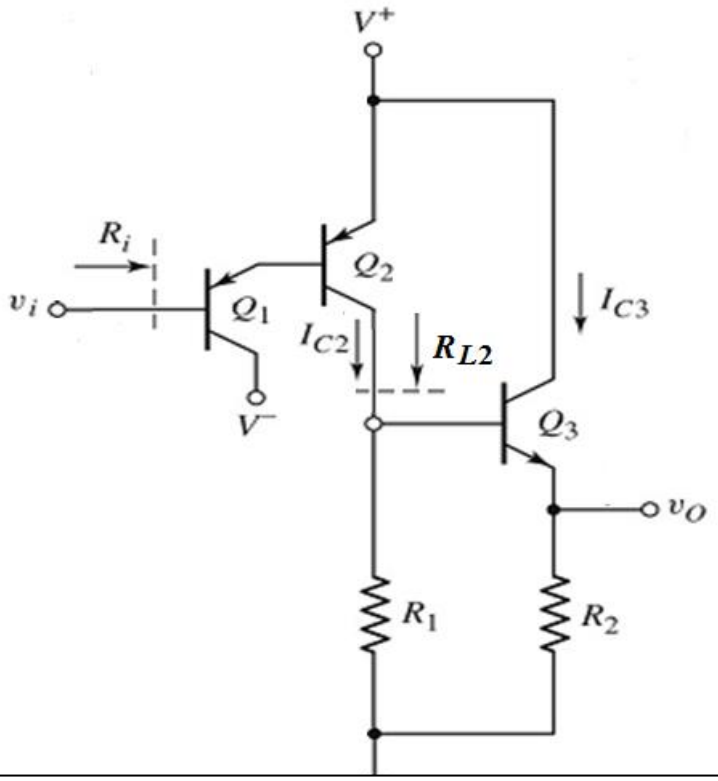
Question:

Study the gain stage and simple output stage circuit shown in **Figure 1** carefully. The transistor parameters are: β = **100** and V_A = **120 V**.

Let R_1 = **55 kΩ**, R_2 = **8 kΩ**, I_{C2} = **0.36 mA,** and I_{C3} = **1.4 mA**. **Determine** the **input resistance** (R_i) of the gain stage and the **equivalent load resistance** of the gain stage connected to the collector of Q_2, i.e. R_{L2} shown in the **Figure 1**. [10 marks]

Write your answer **using pen**, with **proper Units** for all the parameters.



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$$i_E = i_B + i_C$$

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;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_i	$= r_{\pi 1} + (1 + \beta)\, r_{\pi 2}$	[2]
$r_{\pi 2}$	$= (\beta V_T) / I_{C2}$ = (100 x 0.026) / 0.36m = 7.222 kΩ	[1]
I_{C1}	$= I_{C2} / (1 + \beta)$	[1]
$r_{\pi 1}$	$= (\beta V_T) / I_{C1} = (\beta(1 + \beta) V_T) / I_{C2}$ = (100x101x0.026) / 0.36m = 729.444 kΩ	[1]
R_i	$= r_{\pi 1} + (1 + \beta)\, r_{\pi 2}$ = 729.444k + (101)(7.222k) = 1458.88 kΩ	[1]
R_{L2}	$= R_1 \parallel [\, r_{\pi 3} + (1 + \beta)\, R_2]$	[2]
$r_{\pi 3}$	$= (\beta V_T) / I_{C3}$ = (100 x 0.026) / 1.4m = 1.86 kΩ	[1]
R_{L2}	= (55k) || [1.86k + (1 + 100)(8k)] = 51.5 kΩ	[1]

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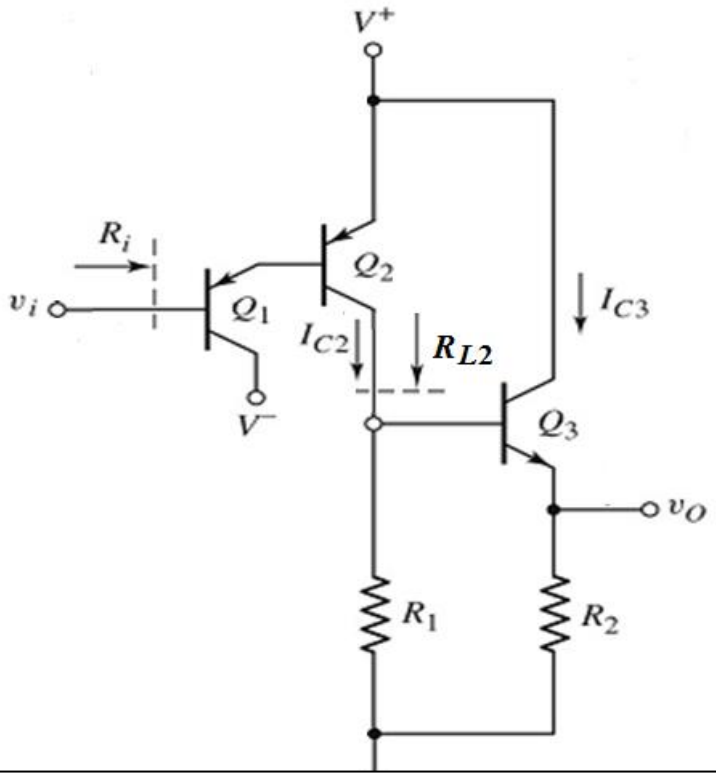
Question:

Study the gain stage and simple output stage circuit shown in **Figure 1** carefully. The transistor parameters are: β = **100** and V_A = **120 V**.

Let R_1 = **45 kΩ**, R_2 = **10 kΩ**, I_{C2} = **0.62 mA,** and I_{C3} = **1.5 mA**. **Determine** the **input resistance** (R_i) of the gain stage and the **equivalent load resistance** of the gain stage connected to the collector of Q_2, i.e. R_{L2} shown in the **Figure 1**. [10 marks]

Write your answer **using pen**, with **proper Units** for all the parameters.



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

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;Small signal

$$\beta = g_m r_\pi$$

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

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

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

R_i	= $r_{\pi 1}$ + (1 + β) $r_{\pi 2}$	[2]
$r_{\pi 2}$	= (β V_T) / I_{C2} = (100 x 0.026) / 0.62m = 4.193 kΩ	[1]
I_{C1}	= I_{C2} / (1 + β)	[1]
$r_{\pi 1}$	= (β V_T) / I_{C1} = (β(1 + β) V_T) / I_{C2} = (100x101x0.026) / 0.62m = 423.548 kΩ	[1]
R_i	= $r_{\pi 1}$ + (1 + β) $r_{\pi 2}$ = 423.548k + (101)(4.193k) = 847.04 kΩ	[1]
R_{L2}	= R_1 || [$r_{\pi 3}$ + (1 + β) R_2]	[2]
$r_{\pi 3}$	= (β V_T) / I_{C3} = (100 x 0.026) / 1.5m = 1.73 kΩ	[1]
R_{L2}	= (45k) || [1.73k + (1 + 100)(10k)] = 43.08 kΩ	[1]