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

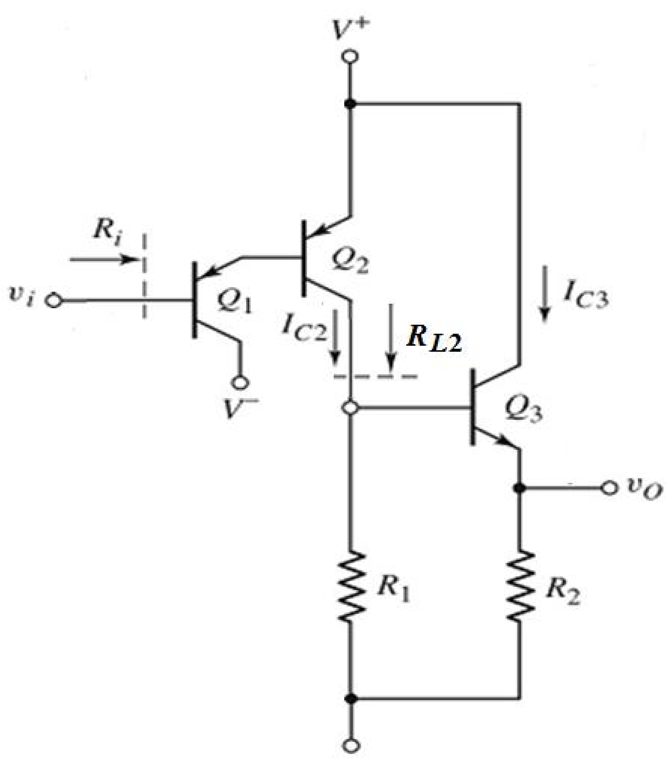
EEEB273/EEEB2014 - Quiz 3
SEMESTER 2, ACADEMIC YEAR 2018/2019
Date: 20 December 2018 Time: 15 minutes .

Question:

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

Let R_1 **= 50 kΩ,** R_2 **= 5 kΩ,** I_{C2} **= 0.5 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.



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

;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	$= r_{\pi1} + (1+\beta)\, r_{\pi2}$	[2]
$r_{\pi2}$	$= (\beta V_T) / I_{C2}$ = (120 x 0.026) / 0.5m = 6.24 kΩ	[1]
I_{C1}	$= (\beta I_{E1})/(1+\beta) = (\beta I_{B2})/(1+\beta) = (\beta I_{C2}/\beta)/(1+\beta)$	
	$= I_{C2} / (1+\beta)$	[1]
$r_{\pi1}$	$= (\beta V_T) / I_{C1} = (\beta V_T)(1+\beta) / I_{C2}$	
	= (120x121x0.026) / 0.5m = 755.04 kΩ	[1]
R_i	$= r_{\pi1} + (1+\beta)\, r_{\pi2}$	
	= 755.04k + (121)(6.24k) = 1510.8 kΩ	[1]
R_{L2}	$= R_1 \,\|\, [\, r_{\pi3} + (1+\beta) R_2]$	[2]
$r_{\pi3}$	$= (\beta V_T) / I_{C3}$ = (120 x 0.026) / 1.4m = 2.23 kΩ	[1]
R_{L2}	= (50k) ‖ [2.23k + (1 + 120)(5k)] = 46.2 kΩ	[1]

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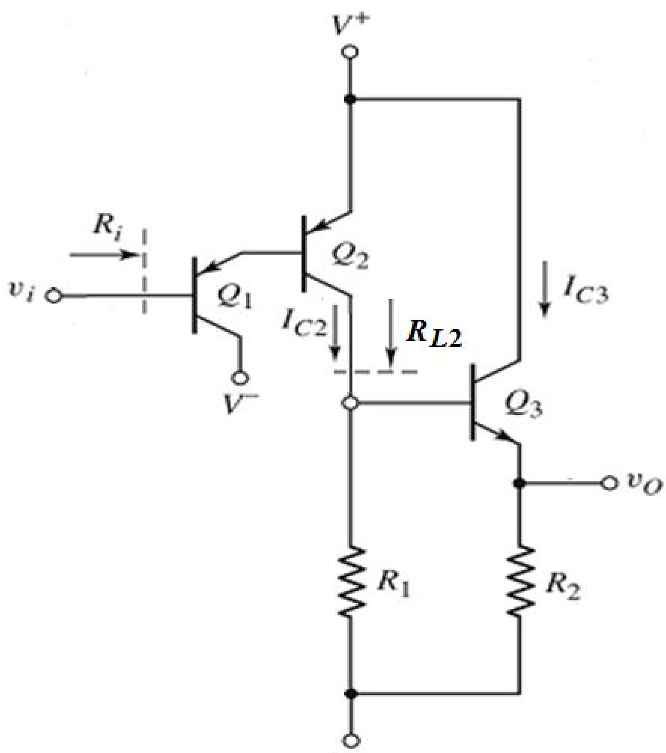
Question:

Study the gain stage and simple output stage circuit shown in **Figure 1** carefully. The transistor parameters are: $\boldsymbol{\beta}$ **= 120** and $\boldsymbol{V_A}$ **= 120 V**. Neglect base currents.

Let $\boldsymbol{R_1}$ **= 40 kΩ,** $\boldsymbol{R_2}$ **= 8 kΩ,** $\boldsymbol{I_{C2}}$ **= 0.4 mA,** and $\boldsymbol{I_{C3}}$ **= 1.3 mA**. **Determine** the **input resistance (**$\boldsymbol{R_i}$**)** of the gain stage and the **equivalent load resistance** of the gain stage connected to the collector of $\boldsymbol{Q_2}$, i.e. $\boldsymbol{R_{L2}}$ 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	$= r_{\pi1} + (1+\beta)\, r_{\pi2}$	[2]
$r_{\pi2}$	$= (\beta V_T) / I_{C2}$ = (120 x 0.026) / 0.4m = 7.8 kΩ	[1]
I_{C1}	$= (\beta I_{E1})/(1+\beta) = (\beta I_{B2})/(1+\beta) = (\beta I_{C2}/\beta)/(1+\beta)$	
	$= I_{C2} / (1+\beta)$	[1]
$r_{\pi1}$	$= (\beta V_T) / I_{C1} = (\beta V_T)(1+\beta) / I_{C2}$	
	= (120x121x0.026) / 0.4m = 943.8 kΩ	[1]
R_i	$= r_{\pi1} + (1+\beta)\, r_{\pi2}$	
	= 943.8k + (121)(7.8k) = 1887.6 kΩ	[1]
R_{L2}	$= R_1 \parallel [\, r_{\pi3} + (1+\beta)\, R_2]$	[2]
$r_{\pi3}$	$= (\beta V_T) / I_{C3}$ = (120 x 0.026) / 1.3m = 2.4 kΩ	[1]
R_{L2}	= (40k) ‖ [2.4k + (1 + 120)(8k)] = 38.42 kΩ	[1]

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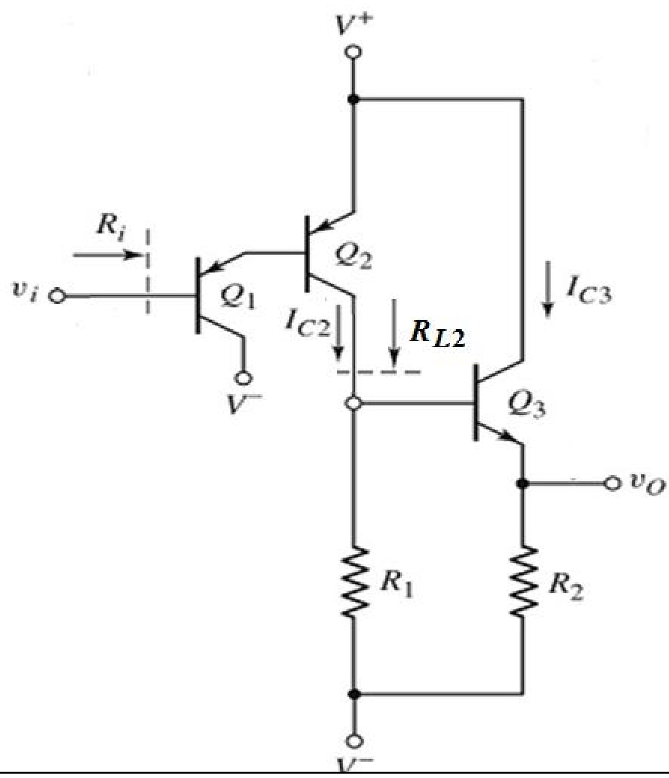
Question:

Study the gain stage and simple output stage circuit shown in **Figure 1** carefully. The transistor parameters are: $\boldsymbol{\beta = 120}$ and $\boldsymbol{V_A = 120}$ **V**. Neglect base currents.

Let $\boldsymbol{R_1 = 55}$ **kΩ,** $\boldsymbol{R_2 = 8}$ **kΩ,** $\boldsymbol{I_{C2} = 0.3}$ **mA,** and $\boldsymbol{I_{C3} = 1.2}$ **mA. Determine** the **input resistance (**$\boldsymbol{R_i}$**)** of the gain stage and the **equivalent load resistance** of the gain stage connected to the collector of $\boldsymbol{Q_2}$, i.e. $\boldsymbol{R_{L2}}$ shown in the **Figure 1**. **[10 marks]**

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



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$$\beta = g_m r_\pi$$

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

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

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

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

$\boldsymbol{R_i}$	$= r_{\pi 1} + (1+\beta)\, r_{\pi 2}$	[2]
$\boldsymbol{r_{\pi 2}}$	$= (\beta V_T) / I_{C2} = (120 \times 0.026) / 0.3\text{m} = 10.4$ kΩ	[1]
$\boldsymbol{I_{C1}}$	$= (\beta I_{E1})/(1+\beta) = (\beta I_{B2})/(1+\beta) = (\beta I_{C2}/\beta)/(1+\beta)$	
	$= I_{C2} / (1+\beta)$	[1]
$\boldsymbol{r_{\pi 1}}$	$= (\beta V_T) / I_{C1} = (\beta V_T)(1+\beta) / I_{C2}$	
	$= (120 \times 121 \times 0.026) / 0.3\text{m} = 1258.4$ kΩ	[1]
$\boldsymbol{R_i}$	$= r_{\pi 1} + (1+\beta)\, r_{\pi 2}$	
	$= 1258.4\text{k} + (121)(10.4\text{k}) = 2516.8$ kΩ [1]	
$\boldsymbol{R_{L2}}$	$= R_1 \,\|\, [\, r_{\pi 3} + (1+\beta) R_2]$	[2]
$\boldsymbol{r_{\pi 3}}$	$= (\beta V_T) / I_{C3} = (120 \times 0.026) / 1.2\text{m} = 2.6$ kΩ	[1]
$\boldsymbol{R_{L2}}$	$= (55\text{k}) \,\|\, [2.6\text{k} + (1+120)(8\text{k})] = 52.05$ kΩ	[1]

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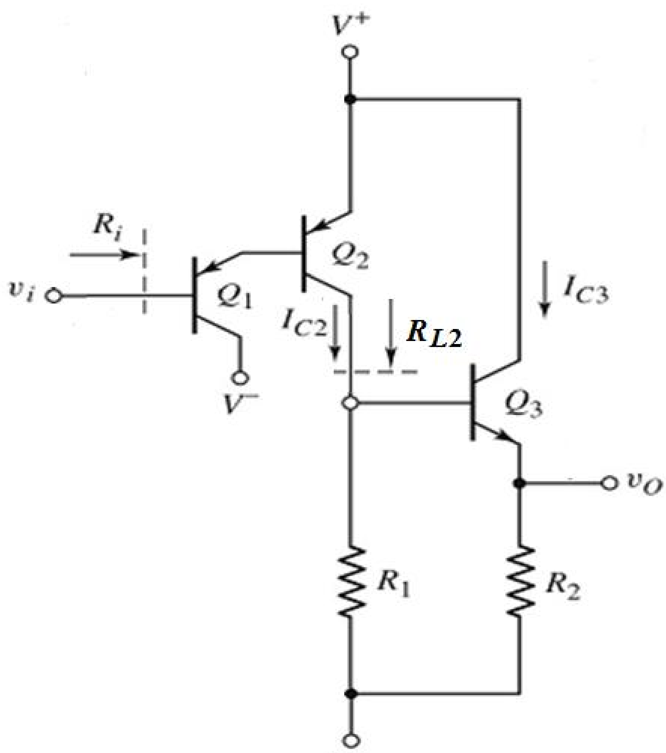
Question:

Study the gain stage and simple output stage circuit shown in **Figure 1** carefully. The transistor parameters are: $\beta = 120$ and $V_A = 120$ V. Neglect base currents.

Let $R_1 = 45$ kΩ, $R_2 = 10$ kΩ, $I_{C2} = 0.6$ mA, and $I_{C3} = 1.1$ 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	$= r_{\pi1} + (1+\beta)\, r_{\pi2}$	[2]
$r_{\pi2}$	$= (\beta V_T) / I_{C2} = (120 \times 0.026) / 0.6\text{m} = 5.2\ \text{k}\Omega$	[1]
I_{C1}	$= (\beta I_{E1})/(1+\beta) = (\beta I_{B2})/(1+\beta) = (\beta I_{C2}/\beta)/(1+\beta)$	
	$= I_{C2} / (1+\beta)$	[1]
$r_{\pi1}$	$= (\beta V_T) / I_{C1} = (\beta V_T)(1+\beta) / I_{C2}$	
	$= (120 \times 121 \times 0.026) / 0.6\text{m} = 629.2\ \text{k}\Omega$	[1]
R_i	$= r_{\pi1} + (1+\beta)\, r_{\pi2}$	
	$= 629.2\text{k} + (121)(5.2\text{k}) = 1258.4\ \text{k}\Omega$	[1]
R_{L2}	$= R_1 \parallel [\, r_{\pi3} + (1+\beta) R_2]$	[2]
$r_{\pi3}$	$= (\beta V_T) / I_{C3} = (120 \times 0.026) / 1.1\text{m} = 2.84\ \text{k}\Omega$	[1]
R_{L2}	$= (45\text{k}) \parallel [2.84\text{k} + (1+120)(10\text{k})] = 43.39\ \text{k}\Omega$	[1]