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

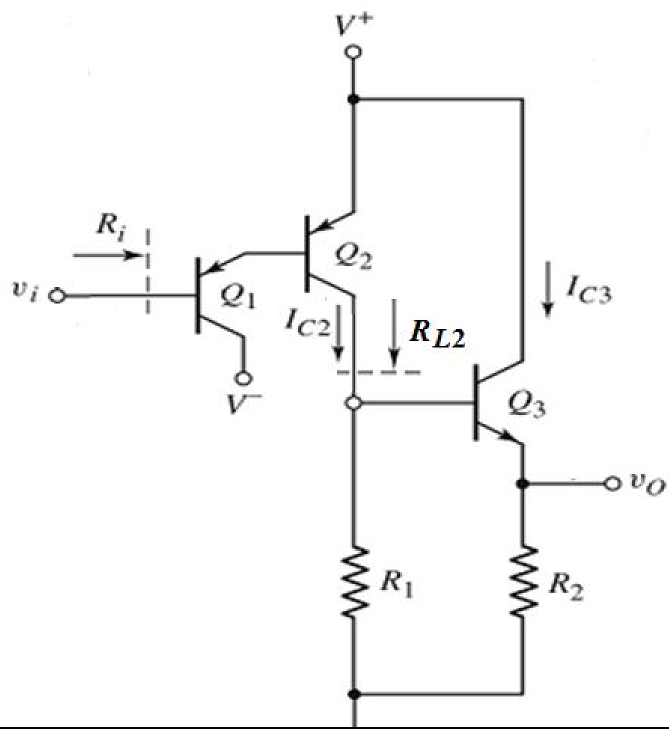
EEEB273 - Quiz 5
SEMESTER 2, ACADEMIC YEAR 2016/2017
Date: 29 December 2016 Time: 15 minutes .

Question:

Study the gain stage and simple output stage circuit shown in **Figure 1** carefully. The transistor parameters are: $\beta = 100$ and $V_A = 120$ V. Neglect base currents.

Let $R_1 = 50$ kΩ, $R_2 = 5$ kΩ, $I_{C2} = 0.5$ mA, and $I_{C3} = 1$ 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) / 0.5m = 5.2 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) / 0.5m = 525.2 kΩ	[1]
R_i	$= r_{\pi 1} + (1+\beta)\, r_{\pi 2}$	
	= 525.2k + (101)(5.2k) = 1050.4 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) / 1m = 2.6 kΩ	[1]
R_{L2}	= (50k) ‖ [2.6k + (1 + 100)(5k)] = 45.51 kΩ	[1]

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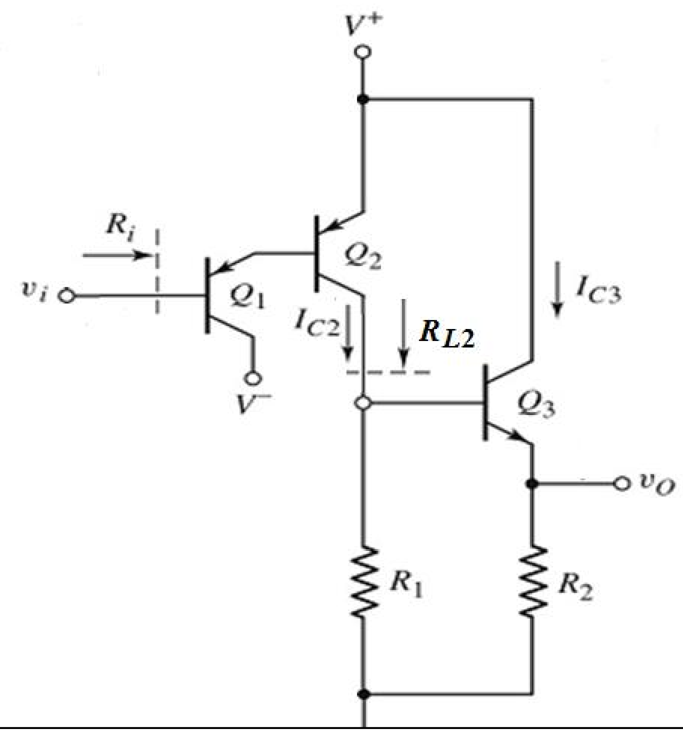
Question:

Study the gain stage and simple output stage circuit shown in **Figure 1** carefully. The transistor parameters are: $\boldsymbol{\beta = 100}$ 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 $\boldsymbol{I_{C3} = 1}$ **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]
$r_{\pi2}$	$= (\beta V_T) / I_{C2}$ = (100 x 0.026) / 0.4m = 6.5 kΩ		[1]
I_{C1}	$= I_{C2} / (1+\beta)$		[1]
$r_{\pi1}$	$= (\beta V_T) / I_{C1} = (\beta(1+\beta) V_T) / I_{C2}$		
	= (100x101x0.026) / 0.4m	= 656.5 kΩ	[1]
R_i	$= r_{\pi1} + (1+\beta)\, r_{\pi2}$		
	= 656.5k + (101)(6.5k)	= 1313 kΩ	[1]
R_{L2}	$= R_1 \parallel [\, r_{\pi3} + (1+\beta) R_2]$		[2]
$r_{\pi3}$	$= (\beta V_T) / I_{C3}$ = (100 x 0.026) / 1m	= 2.6 kΩ	[1]
R_{L2}	= (40k) ‖ [2.6k + (1 + 100)(8k)]	= 38.12 kΩ	[1]

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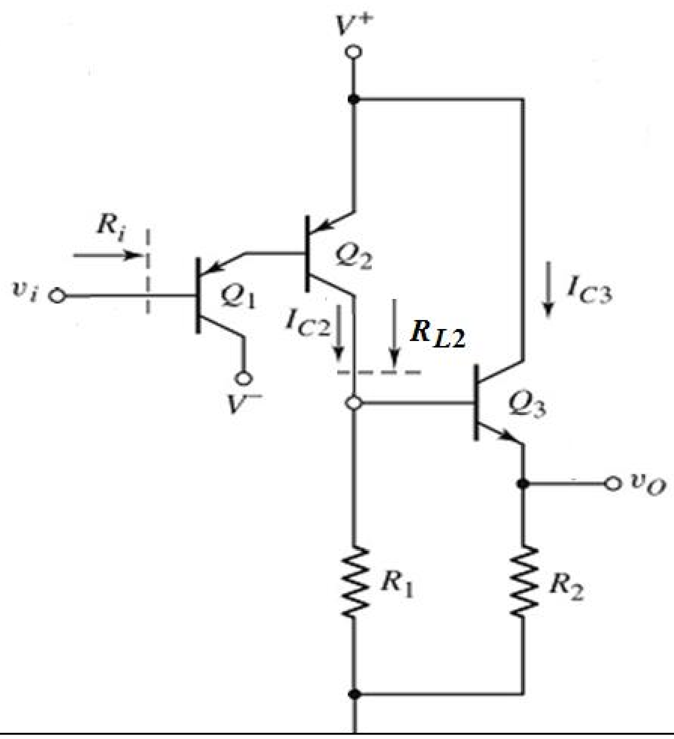
Date: 29 December 2016 Time: 15 minutes ;

Question:

Study the gain stage and simple output stage circuit shown in **Figure 1** carefully. The transistor parameters are: $\boldsymbol{\beta = 100}$ 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 $\boldsymbol{I_{C3} = 1}$ **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.



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

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

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

$$i_E = i_B + i_C$$

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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]
$r_{\pi 2}$	$= (\beta V_T) / I_{C2} = (100 \times 0.026) / 0.3\text{m} = 8.667\ \text{k}\Omega$	[1]
I_{C1}	$= I_{C2} / (1+\beta)$	[1]
$r_{\pi 1}$	$= (\beta V_T) / I_{C1} = (\beta(1+\beta) V_T) / I_{C2}$	
	$= (100 \times 101 \times 0.026) / 0.3\text{m} = 875.333\ \text{k}\Omega$	[1]
R_i	$= r_{\pi 1} + (1+\beta)\, r_{\pi 2}$	
	$= 875.333\text{k} + (101)(8.667\text{k}) = 1750.666\ \text{k}\Omega$	[1]
R_{L2}	$= R_1 \parallel [\, r_{\pi 3} + (1+\beta) R_2]$	[2]
$r_{\pi 3}$	$= (\beta V_T) / I_{C3} = (100 \times 0.026) / 1\text{m} = 2.6\ \text{k}\Omega$	[1]
R_{L2}	$= (55\text{k}) \parallel [2.6\text{k} + (1+100)(8\text{k})] = 51.5\ \text{k}\Omega$	[1]

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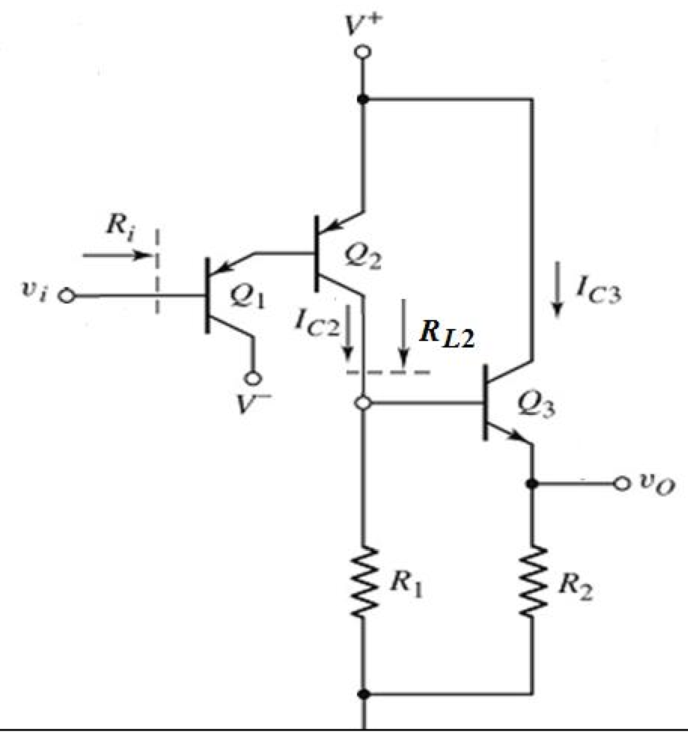
Question:

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**. Neglect base currents.

Let R_1 **= 45 kΩ,** R_2 **= 10 kΩ,** I_{C2} **= 0.6 mA,** and I_{C3} **= 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.



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

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

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

$$i_E = i_B + i_C$$

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$$\beta = g_m r_\pi$$

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

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

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

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

R_i	$= r_{\pi1} + (1+\beta)\, r_{\pi2}$	[2]
$r_{\pi2}$	$= (\beta V_T) / I_{C2}$ = (100 x 0.026) / 0.6m = 4.333 kΩ	[1]
I_{C1}	$= I_{C2} / (1+\beta)$	[1]
$r_{\pi1}$	$= (\beta V_T) / I_{C1} = (\beta(1+\beta) V_T) / I_{C2}$	
	= (100x101x0.026) / 0.6m = 437.667 kΩ	[1]
R_i	$= r_{\pi1} + (1+\beta)\, r_{\pi2}$	
	= 437.667k + (101)(4.333k) = 875.333 kΩ	[1]
R_{L2}	$= R_1 \,\|\, [\, r_{\pi3} + (1+\beta) R_2]$	[2]
$r_{\pi3}$	$= (\beta V_T) / I_{C3}$ = (100 x 0.026) / 1m = 2.6 kΩ	[1]
R_{L2}	= (45k) ǁ [2.6k + (1 + 100)(10k)] = 43.08 kΩ	[1]