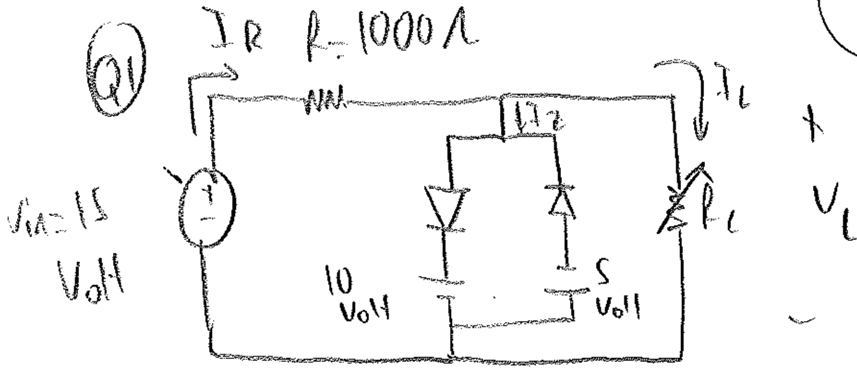
MECE 246
Midterm
2018-2019 spring
Midterm (Make-up) solution

Q1)



* when $R_L=0$ $I_Z=0$ $I_R=I_L=\frac{V_{in}}{R+R_L}=\frac{V_{in}}{1000+0}=\frac{15}{1000}=15mA$

$V_L=R_LI_L=0$ Volt

* when $0<R_L<R_{Lcritical}$ $I_Z=0$ $I_R=I_L$

→ to find $R_{Lcritical}$; at $R_L=R_{Lcritical}$ $V_L=10$ Volt and $I_R=I_L$

$I_R=I_L \Rightarrow \frac{V_{in}-V_{Lcritical}}{R}=\frac{V_{Lcritical}}{R_{Lcritical}}$ ← $10=V_{Lcritical}$ (3)

$I_L=5mA=\frac{15-10}{1000}=\frac{10}{R_{Lcritical}}$ (3) $R_{Lcritical}=\frac{10000}{5}=2000\Omega$ (4)

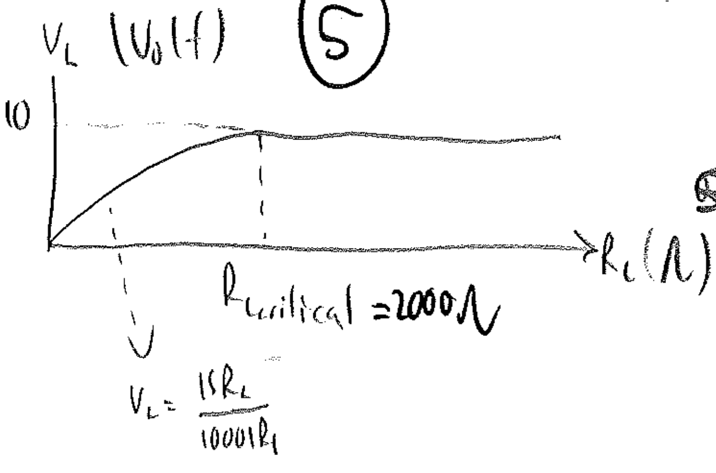
hence

when $0<R_L<R_{Lcritical}=2000$ $I_R=I_L=\frac{V_{in}}{R+R_L}=\frac{15}{1000+R_L}$ (3) ; $V_L=R_LI_L=\frac{15R_L}{1000+R_L}$

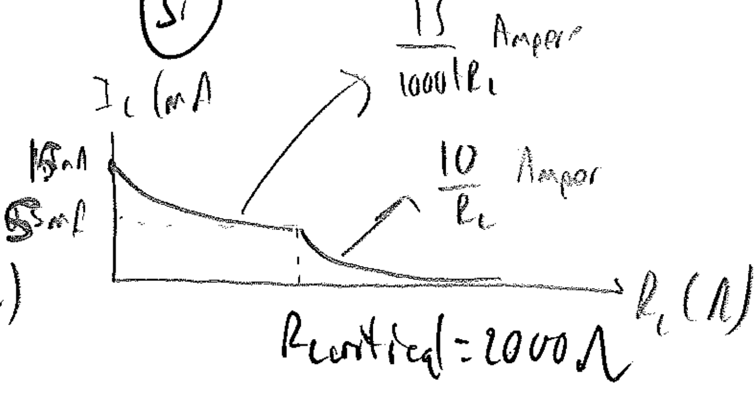
* when $R_L>R_{Lcritical}=2000\Omega$ (3)

$V_L=V_{Lcritical}=10$ Volt $I_L=\frac{V_L}{R_L}=\frac{10}{R_L}$ (4)

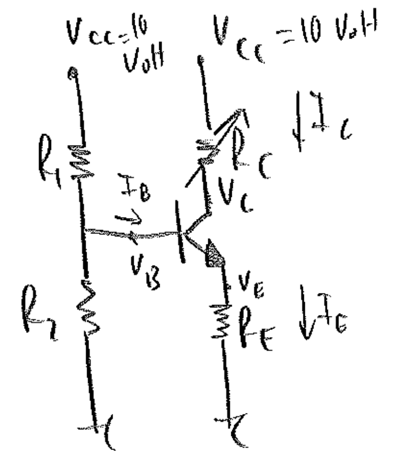
(5)



(5)



(Q2)



$V_{cc} = 10$ Volt

$\beta = 99$

$R_E = 100\,\Omega$

$R_1 = R_2 = 10000\,\Omega$

$V_{cc} = 10$ Volt

$V_{BE_{active}} = 0.8$

$V_{BE_{sat}} = 0.8$

$V_{CE_{sat}} = 0.8$

(8)

$$\frac{V_{cc} - V_B}{R_1} = \frac{V_B}{R_2} + I_B \qquad I_B = \frac{V_B - V_{BE_{sat}}}{R_E(\beta+1)}$$

(8)

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$$\frac{V_{cc} - V_B}{R_1} = \frac{V_B}{R_2} + \frac{V_B - V_{BE_{active}}}{R_E(\beta+1)}$$

(1)

$$\frac{V_{cc}}{R_1} + \frac{V_{BE_{active}}}{R_E(\beta+1)} = V_B\left[\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_E(\beta+1)}\right]$$

$$\frac{10}{10000} + \frac{0.8}{10000} = V_B\left[\frac{1}{10000} + \frac{1}{10000} + \frac{1}{10000}\right]$$

$$V_B = \frac{\frac{10.8}{10000}}{\frac{3}{10000}} \Rightarrow V_B = 3.6 \text{ Volt}$$

(2)

(1) $V_E = 2.8$ Volt

$$I_B = \frac{V_B - V_{BE_{active}}}{R_E(\beta+1)}$$

$$I_B = \frac{3.6 - 0.8}{10000} = \frac{2.8}{10000} = 0.28\text{ mA}$$

(1)

if transistor is in sat region $V_{BE_{sat}} = V_{CE_{sat}}$ $\quad V_{B_{sat}} = V_{C_{sat}} = 3.6$ Volt (3 Quan)

$$V_C = V_{cc} - R_C I_C$$

(5)

$$V_C = 10 - R_C \beta I_B$$

$$V_C = 10 - R_C \times 99 \times 0.28 \times 10^{-3}$$

$$3.6 = 10 - R_C \times 99 \times 0.28 \times 10^{-3}$$

$$6.4 = R_C \times 99 \times 0.28 \times 10^{-3}$$

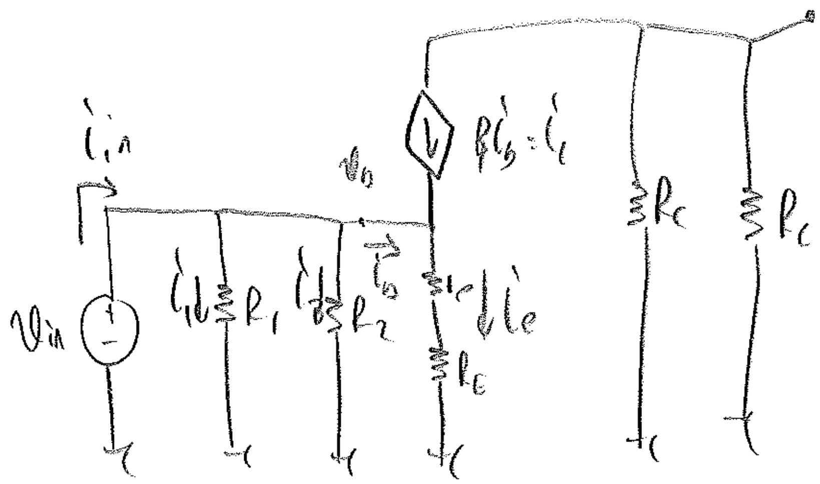
(2)

$$R_C = \frac{6.4}{99 \times 0.28 \times 10^{-3}}$$

$$\boxed{R_C = \frac{6400}{99 \times 0.28} = R_{C\,max}}$$

(Q3)

(a)



$$Gain = -\frac{99}{100}\,\frac{(R_C \| R_L)}{(r_e + R_E)} = -\frac{99}{100}\,\frac{R_C \| R_L}{200}$$ (3)

~~$Gain = -10 \le -\frac{99}{20000}\, R_C \| R_L$~~

~~$\frac{20000}{99} = R_C \| R_L$~~

$$10 \le \frac{99}{20000}\, R_C \| R_L$$

$$\frac{200000}{99} < R_C \| R_L$$

$$2020 < R_C \| R_L$$ (1)

~~$R_C = 1000$~~

~~$R_C = 2100 \quad R_L = 2100 \quad R_C \| R_L = 1050$~~

if $R_L = R_C$ let $R_L = R_C = 4500$ $R_C \| R_L = 2250$

(1) seçim