

18/05/20

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QUESTION ONE

A) (i) Resistance of the circuit R_T

$$R_{12} = \frac{1}{R_1} = \frac{1}{6} + \frac{1}{12} = 4\Omega$$

$$R_{123} = R_{12} + R_3 = 4 + 4 = 8\Omega$$

$$R_{45} = R_4 + R_5 = 8\Omega$$

$$R_T = \frac{1}{R_T} = \frac{1}{R_{123}} + \frac{1}{R_{45}} = \frac{1}{8} + \frac{1}{8} = \underline{4\Omega}$$

$$(iii) \text{ Total Power } P_T = \frac{V^2}{R} = \frac{12^2}{4} = \frac{144}{4} = \underline{36W}$$

$$(ii) \text{ Total Current } = I_T = \frac{V}{R} = \frac{12}{4} = \underline{3A}$$

(iv) Current through R_4 (3Ω)

$$I_4 = \frac{V_4}{R_4} = \frac{9}{3} = 3A \quad I_T = 3A$$

$$R_{123} = R_{34} \therefore I_4 = \frac{3}{2} = \underline{1.5A}$$

(v) Voltage across R_5 (5Ω)

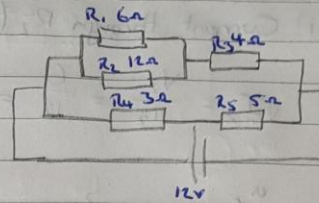
$$V_5 = I_5 \times R_5 = 1.5 \times 5 = \underline{7.5V}$$

$$I_5 = I_4 = 1.5A$$

(vi) Voltage across R_1 (6Ω)

$$V_1 = I_1 \times R_1 = 1 \times 6 = 6V$$

$$I_1 = 1.5$$



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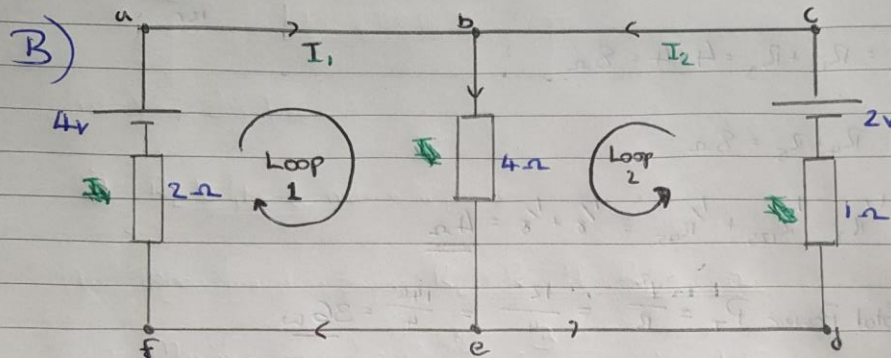
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(vii) Current through R_2 (12Ω)

$$I_2 = \frac{V_2}{R_2} = \frac{6}{12} = \underline{0.5A}$$

$$V_2 = V_1 = 6V$$



Loop 1 abef

Loop 2 cbde

$$2(I_1 + I_2) + 2I_1 + 4 = 0$$

$$4(I_1 + I_2) + 1I_2 - 2 = 0$$

$$4I_1 + 4I_2 + 2I_1 - 4 = 0$$

$$4I_1 + 4I_2 + I_2 - 2 = 0$$

$$6I_1 + 4I_2 = 4 \quad (1)$$

$$4I_1 + 5I_2 = 2 \quad (2)$$

$$(1) \quad 6I_1 + 4I_2 = 4 \quad \times 4$$

$$6I_1 + 4(-0.286) = 16$$

$$(2) \quad 4I_1 + 5I_2 = 2 \quad \times 6$$

$$6I_1 + 1.144 = 16$$

$$6I_1 = 16 + 1.144$$

$$6I_1 = 17.144$$

$$I_1 = \frac{17.144}{6}$$

$$\underline{I_1 = 2.857}$$

$$24I_1 + 16I_2 = 16$$

$$24I_1 + 30I_2 = 12$$

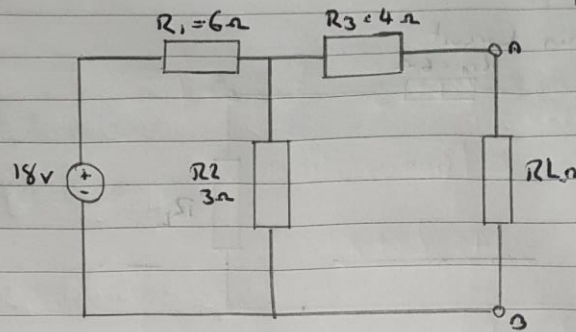
$$-14I_2 = 4$$

$$-14I_2 = 4$$

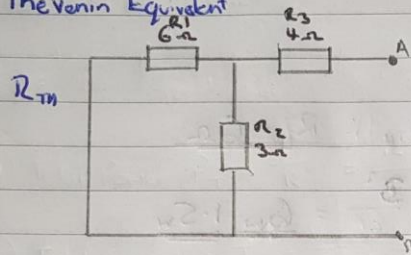
$$I_2 = \frac{4}{-14}$$

$$\underline{I_2 = -0.286}$$

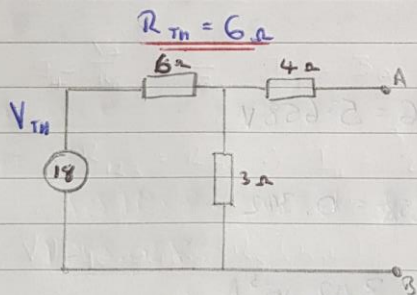
QUESTION 2



(i) Thevenin Equivalent



$$R_{TH} = (R_1 \times R_3) / (R_1 + R_3) + R_2 = (6 \times 4) / (6 + 4) + 3 = 6 \Omega$$



$$V_{TH} = \frac{(V)(R_3)}{R_3 + R_1} = \frac{(18)(4)}{4 + 6} = 6V$$

$$\underline{V_{TH} = 6V}$$

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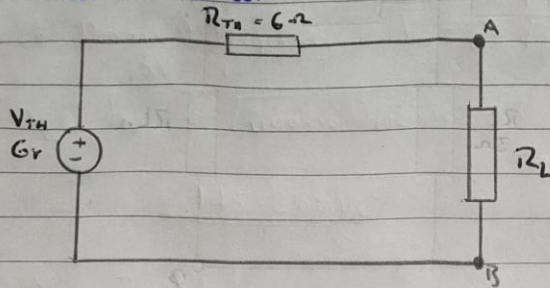
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Thevenin Circuit

(ii) R_L to provide maximum power

When maximum power $R_L = R_{TH} \therefore \underline{R_L = 6\Omega}$

(iii) Maximum power = $P = \frac{V_L^2}{R} = \frac{3^2}{6} = \underline{\underline{1.5W}}$

(iv) $R_L = 100\Omega$ $I_{RL} = \frac{V_{RL}}{R_L}$

$V_S = I_T = 0.943A$

$V_{RTH} = I_T \times R_{TH} = 0.943 \times 6 = 5.658V$

$V_{RL} = V_T - V_{RTH} = 6 - 5.658 = 0.342$

$I_{RL} = \frac{V_{RL}}{R_L} = \frac{0.342}{100} = \underline{\underline{3.42 \times 10^{-3} A}}$

or $\underline{\underline{3420\mu A}}$

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QUESTION 3

A) (i) Circuit Impedance

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$X_L = 2\pi fL$$

$$= 2\pi(100)(80 \times 10^{-3})$$

$$X_L = 50.265 \Omega$$

$$X_C = \frac{1}{2\pi fC}$$

$$= \frac{1}{2\pi(100)(40 \times 10^{-6})}$$

$$X_C = 39.789 \Omega$$

$$Z = \sqrt{8^2 + (50.265 - 39.789)^2}$$

$$= \sqrt{64 + 109.747}$$

$$Z = 13.181 \Omega$$

$$(ii) \text{ Current Flowing } = I_T = \frac{V}{Z} = \frac{200}{13.181} = 15.173 \text{ A}$$

$$(iii) \text{ Voltage across coil } = V_C = I_T \times R_C = 15.173 \times 8 = 121.384 \text{ V}$$

$$(iv) \text{ Voltage across Capacitor } = V_{cap} = I_T \times R_{cap} = 15.173 \times 39.789 = 603.718 \text{ V}$$

$$R_{cap} = X_C$$

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B) (i) Resonant Frequency $f_0 = \frac{1}{2\pi\sqrt{LC}}$

$$X \quad f_0 = \frac{1}{2\pi\sqrt{(100 \times 10^{-3})(12 \times 10^{-6})}}$$

$$= \underline{145.288 \text{ Hz}}$$

$$(ii) X_L = 2\pi fL$$

$$= \underline{91.287 \Omega}$$

$$(iii) X_L = X_C \text{ at resonance} \therefore X_C = \underline{91.287 \Omega}$$

$$(iv) \text{Current} = I = \frac{V}{Z} = \frac{200}{25} = \underline{8 \text{ A}}$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$= \sqrt{25^2 + (91.287 - 91.287)^2}$$

$$= 25$$

$$(v) \text{Voltage across capacitor } V = I \times X_C = 8 \times 91.287$$

$$= \underline{730.296 \text{ V}}$$

$$(vi) X_L = X_C \quad V = I \times X_L = 8 \times 91.287 = \underline{730.296 \text{ V}}$$

$$(vii) \frac{730.296}{200} = \underline{3.651} \text{ greater}$$

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QUESTION 4

Assume voltage of diode = 0.7V

$$a) (i) 5 - 0.7 = 4.3$$

$$I = \frac{V}{R} = \frac{4.3}{50} = 0.086A$$

(ii) No current would pass as the diode is positively biased

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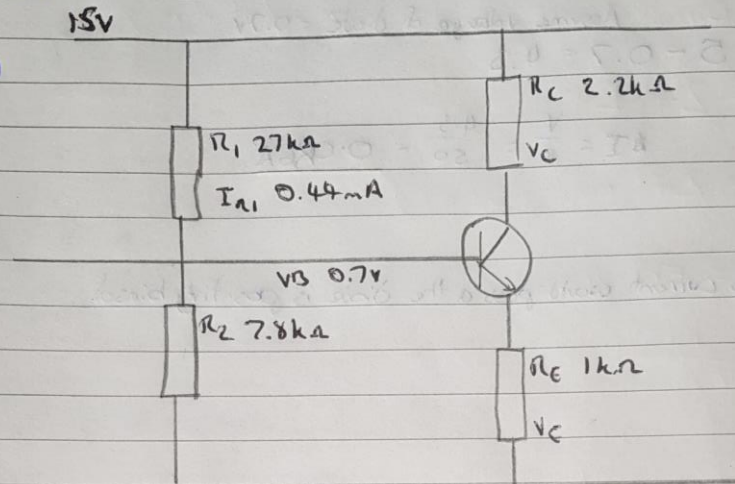
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QUESTION 4

b) (i)

Current through R_2 Rule of thumb I_{R1} is 10 times bigger than I_B I_{R2} is 10 times bigger than I_B

$$I_B = \frac{I_{R1}}{11} = \frac{I_{R2}}{11} = \frac{0.44 \times 10^{-3}}{11} = 4 \times 10^{-5} \text{ A} \text{ or } 0.4 \text{ mA}$$

$$I_{R2} = (4 \times 10^{-5}) \times 10 = 4 \times 10^{-4} \text{ or } 40 \text{ nA}$$

$$(i) V_{R1} = I_{R1} \times R_1 = (27 \times 10^3) \times (0.44 \times 10^{-3}) = 11.88 \text{ V}$$

$$V_{R2} = V_{CC} - V_{R1} = 15 - 11.88 = 3.12 \text{ V}$$

$$I_{R2} = \frac{V_{R2}}{R_2} = \frac{3.12}{7800} = 4 \times 10^{-4} \text{ or } 40 \text{ nA}$$

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(ii) $I_{nc} \approx I_{ec}$ V_c Assumed $7.5V$ $\left(\frac{15}{2} = 7.5\right)$

$$I_{ec} = \frac{V_c}{R_c} = \frac{7.5}{2200} = 3.4 \times 10^{-3} A \text{ or } \underline{3.4mA}$$

(iii) $\text{Gain} = \frac{V_c}{V_e} = \frac{7.5}{3.4} = \underline{2.2 \text{ gain}}$

$$V_e = I_e \times R_e = (3.4 \times 10^{-3}) \times 1000 = 3.4V$$