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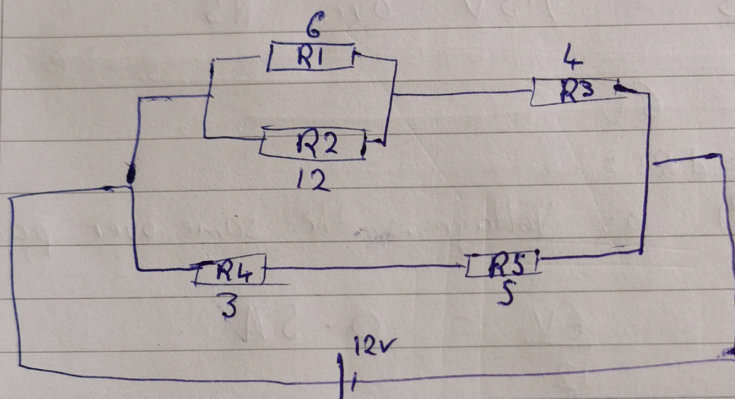
Electrical Principles

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Question 1



$$i) \frac{1}{R_{1+2}} = \frac{1}{6} + \frac{1}{12} = \frac{1}{4} = 0.25 \quad R_{1+2} = \frac{1}{0.25} = 4$$

$$4 + 4 = 8$$
$$3 + 5 = 8$$

$$\frac{1}{R_T} = \frac{1}{8} + \frac{1}{8}$$

$$\frac{1}{R_T} = 0.25 \quad R_T = 4 \Omega$$

$$ii) I = \frac{V}{R} = \frac{12}{4} = 3 A$$

$$iii) P = I^2 R = 3^2 \times 4 = 36 W$$

~~$$iii) \frac{12}{8} = 1.5 \times 3 = 2.25 V \text{ over } R_4$$~~

~~$$I = \frac{V}{R} = \frac{2.25}{3} = 0.75 A$$~~

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$$vi) \frac{6}{8} = 0.75 \times 5 = 3.75V \text{ over } R_5$$

$$vii) \frac{12}{8} = 1.5 \times 3 = 4.5V \text{ over } R_6$$

$$I = \frac{V}{R} = \frac{4.5}{3} = 1.5A$$

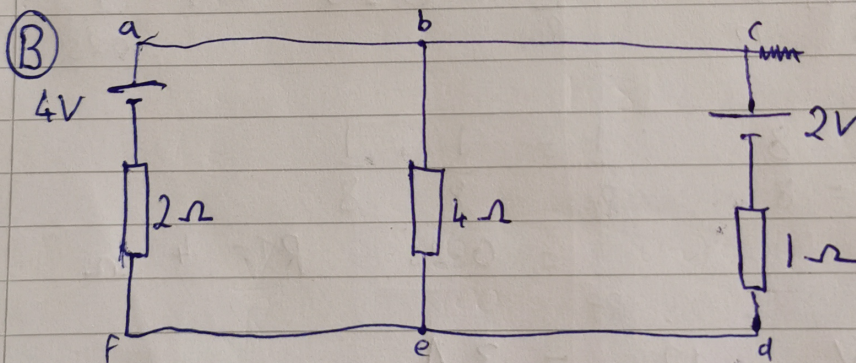
$$v) 12 - 4.5 = 7.5V \text{ over } R_5$$

$$vi) 12 \div 2 = 6V$$

as $R_1 + R_2$ and $R_3 = 4\Omega$

6V over R_1 as Voltage is the same over parallel

$$vii) I = \frac{V}{R} = \frac{6V}{12} = 0.5A$$



abef

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

$$bcde \quad -4 + 4I_1 + 4I_2 + 2I_1 = 0$$

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

$$-4 + 6I_1 + 4I_2 = 0 \quad \text{--- (1)}$$

bcde

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

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

$$2 + 5I_2 + 4I_1 = 0 \quad \text{--- (2)}$$

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$$\textcircled{1} \times 2 \quad -8 + 12I_1 + 8I_2 = 0 \quad \text{---} \quad \textcircled{3}$$

$$\textcircled{2} \times 3 \quad 6 + 15I_2 + 12I_1 = 0 \quad \text{---} \quad \textcircled{4}$$

$$\textcircled{4} - \textcircled{3} \quad 14 + 7I_2 = 0$$

$$7I_2 = -14$$

$$I_2 = \frac{-14}{7}$$

$$I_2 = -2A \quad \text{minus because opposite direction}$$

$$I_2 = 2A \text{ in } \textcircled{2}$$

$$2 + 5(2) + 4I_1 = 0$$

$$2 + 10 + 4I_1 = 0$$

$$12 + 4I_1 = 0$$

$$4I_1 = -12$$

$$I_1 = \frac{-12}{4}$$

$$I_1 = -3A$$

Question 2

$$i) V_{AB} = \frac{V_1 R_3}{R_1 + R_3} = \frac{18 \times 3}{6 + 3} = 6V$$

$$R_{TH} = R_3 + \frac{R_1 \times R_2}{R_1 + R_2} = 4 + \frac{6 \times 3}{6 + 3}$$

$$= 4 + 2$$

$$= 6\Omega = R_L$$

$$V_x = \frac{6 \times 6}{6 + 6} = \frac{36}{12} = 3V$$

Question 3

ii) $P = I^2 R_L$

$$I = \frac{V}{R_{TH} + R_L} = \frac{3}{6+6} = 0.5 A$$

$$P = I^2 R_L$$

$$= 3^2 \times 6 = 0.5^2 \times 6$$

$$= 54 W = 1.5 W$$

$$iii) \frac{dP_L}{dR_L} = \frac{V_{TH}^2 (R_{TH} + R_L)^2 \times 1 - R_L \times 2 (R_{TH} + R_L)}{(R_{TH} + R_L)^4} = 0$$

$$P_{max} = V_{TH}^2 \left(\frac{R_{TH}}{(R_{TH} + R_{TH})^2} \right)$$

$$= V_{TH}^2 \frac{R_{TH}}{4 R_{TH}^2}$$

$$= \frac{V_{TH}^2}{4 R_{TH}}$$

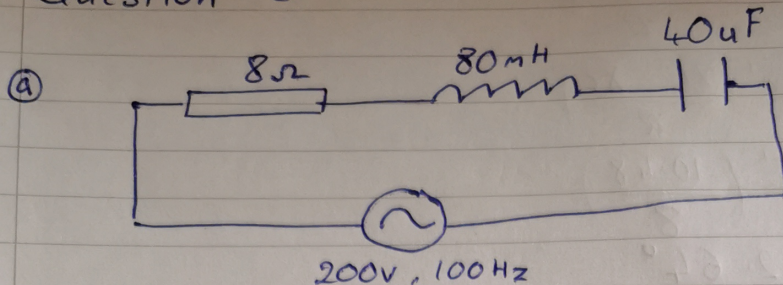
$$= \frac{6^2}{4(6)} = \frac{36}{24} = 1.5 V$$

iv) $I = \frac{V}{R} = \frac{6}{100} = 0.06 A$

$$= 60 mA$$

~~scribble~~

Question 3



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

$$\begin{aligned} X_L &= 2\pi fL \\ &= 2\pi \times 100 \times 80 \times 10^{-3} \\ &= \cancel{628.39} \ 50.27 \end{aligned}$$

$$\cancel{X_C} = \frac{1}{2\pi fC} = \frac{1}{2\pi \times 100 \times 40 \times 10^{-6}} = 39.79$$

$$\begin{aligned} Z &= \sqrt{8^2 + (50.27 - 39.79)^2} \\ &= \sqrt{64 + (10.48)^2} \\ &= \sqrt{64 + 109.83} \\ &= 13.18 \ \Omega \end{aligned}$$

$$ii) I = \frac{V}{R} = \frac{200}{13.18} = 15.17 \text{ A}$$

$$iii) \frac{200}{80 \times 10^{-3}} =$$

$$iv) V_C = \frac{Q}{C} = \frac{CV}{C} = \frac{40 \times 10^{-6} \times 200}{40 \times 10^{-6}} = 200 \text{ V}$$

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$$\text{iv) } \tan P = \frac{X_L - X_C}{R}$$

$$P = \tan^{-1} \left(\frac{X_L - X_C}{R} \right)$$

$$= \tan^{-1} \left(\frac{10.48}{8} \right)$$

$$P = 52.64^\circ$$

⑥

$$\text{i) } f_r = \frac{1}{2\pi\sqrt{LC}}$$

$$= \frac{1}{2\pi\sqrt{(100 \times 10^{-3})(0.12 \times 10^{-6})}}$$

$$= 1452.88 \text{ Hz}$$

$$\text{ii) } X_L = 2\pi fL$$

$$= 2\pi (1452.88)(100 \times 10^{-3})$$

$$= 912.87 \Omega$$

$$\text{iii) } X_C = \frac{1}{2\pi fC}$$

$$= \frac{1}{2\pi (1452.88)(0.12 \times 10^{-6})}$$

$$= 912.87 \Omega$$

$$\text{iv) } I = \frac{V}{R} = \frac{200}{25} = 8 \text{ A}$$

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Question 4

$$\textcircled{b} \quad R_1 = 27\text{K}, R_2 = 7.8\text{K}, R_C = 2.2\text{K}, R_E = 1\text{K} \\ V_{CC} = 15\text{V} \quad V_{BE} = 0.7\text{V} \quad I_{R_1} = 0.44$$

Assume V_C is 6V

$$I_C = \frac{V_C}{R_C} = \frac{6}{2.2 \times 10^3} = 2.7\text{mA}$$

$$I_B = \frac{I_C}{200} = \frac{2.7\text{mA}}{200} = 1.35 \times 10^{-5}$$

$$I_{R_2} = I_B \times 10 \\ = 1.35 \times 10^{-4}$$

$$\text{ii) } I_C \approx I_E \\ = 1.35 \times 10^{-5}$$

$$\text{iii) } \frac{R_C}{R_E} = \frac{2.2\text{K}}{1\text{K}} = 2.2 \text{ gain}$$