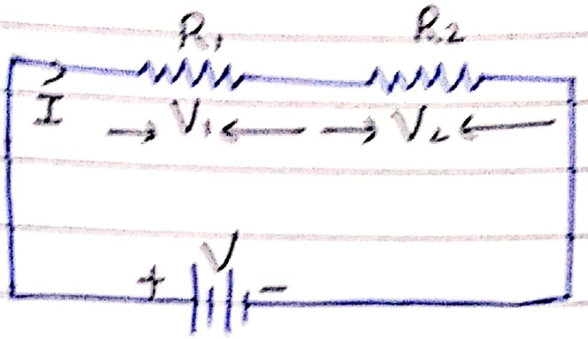
ELECTRONICS & ELECTRICAL ENGINEERING

Voltage Divider Rule



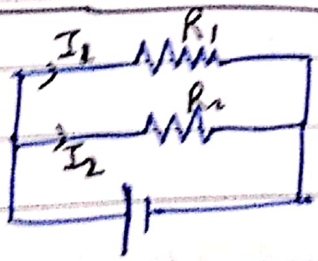
$$I = \frac{V}{R}$$

$$V_1 = IR_1$$

$$\boxed{V_1 = \frac{R_1}{R_1+R_2} V}$$

$$\boxed{V_2 = \frac{R_2}{R_1+R_2} V}$$

Current Divider Rule



$$I = \frac{V}{R} \qquad R = \frac{R_1 R_2}{R_1+R_2}$$

$$I_1 R_1 = I_2 R_2 = IR$$

$$I_1 R_1 = IR$$

$$I_1 = \frac{I \cancel{R_1} R_2}{\cancel{R_1}(R_1+R_2)}$$

$$\boxed{I_1 = \frac{IR_2}{R_1+R_2}} \qquad \boxed{I_2 = \frac{IR_1}{R_1+R_2}}$$

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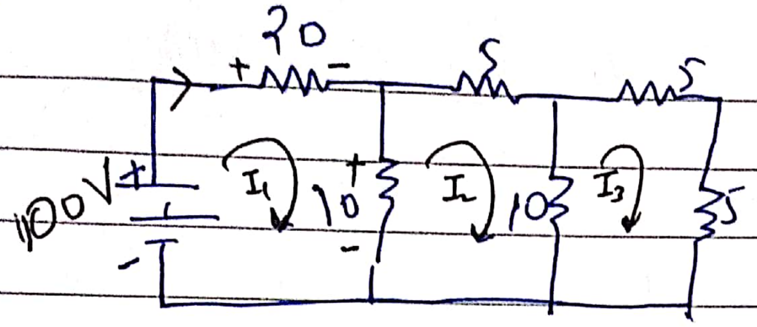


Every mesh is a loop but every loop is not a mesh

Voltage − to +   +ve

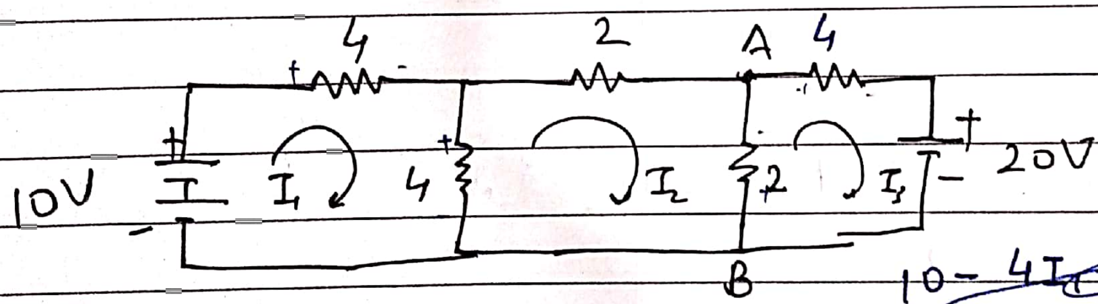
+ to −   −ve

Current entering +ve

exit −ve

★ Loop currents will be taken as maximum for a loop

$$100 - 20I_1 - 10(I_1 - I_2) = 0$$



$$10 - 4I_1 - 4(I_1 - I_2) = 0$$

$$10 = 4I_1 + 4I_1 - 4I_2$$

$$\cancel{I_2 = 2.5} \quad 8I_1 - 4I_2 = 10 \quad (1)$$

$$-20 - 2(I_3 - I_2) - 4I_3 = 0$$

$$\cancel{20 = -2I_3 + 2I_2 - 6I_3}$$

$$\cancel{20 + 8I_3 = 2(2.5) = 5}$$

$$I_3 = \frac{15}{8} = 1.8$$

DOAS

$$-2I_2 - 2(I_2 - I_3) - 4(I_2 - I_1) = 0 \quad - (2)$$

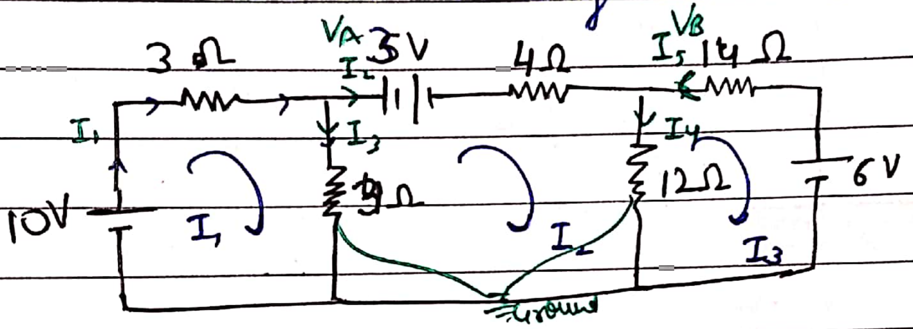
$$-8I_2 + 2I_3 - 4I_1 = 0$$

$$-20 - 2(I_3 - I_2) - 4I_3 = 0 \quad - (3)$$

$$-20 = -2I_3 - 2I_2$$

$I_1 = 1.0937$, $\quad I_2 = -0.3125$, $\quad I_3 = -3.4375$

Current through AB $= I_2 - I_3$ or $I_3 - I_2$



$$10 - 3I_1 - 3(I_1 - I_2) = 0$$

$$10 = 6I_1 - 3I_2 + 0I_3$$

$$-5 - 4I_2 - 12(I_2 - I_3) - 3(I_2 - I_1) = 0$$

$$5 = -19I_2 + 12I_3 + 3I_1$$

$$-6 - 12(I_3 - I_2) - 14I_3 = 0$$

$$6 = -26I_3 + 12I_2 + \cancel{0I_1}$$

$$\left|\begin{matrix} A_1x + B_1y + C_1z \\ A_2x + B_2y + C_2z \\ A_3x + B_3y + C_3z \end{matrix}\right| = \left|\begin{matrix} d_1 \\ d_2 \\ d_3 \end{matrix}\right|$$

$$\left|\begin{matrix} 6 & -3 & 0 \\ 3 & -19 & 12 \\ 0 & 12 & -26 \end{matrix}\right| = \left|\begin{matrix} d_1 \\ d_2 \\ d_3 \end{matrix}\right| \left|\begin{matrix} 10 \\ 5 \\ 3 \end{matrix}\right|$$

$$\Delta = 6(19 \times 26 - 144) + 3(-98 - 0)$$

$$= 6(350) - 294 = 1806$$

$$5 = -19I_2 + 12\left(\frac{12I_2 - 6}{26}\right) + 3\left(\frac{10 + 3I_2}{6}\right)$$

$$5 = -19I$$

19 × 26 = 114, 38, 494; 494 − 144 = 350

350 × 6 = 2100; 2100 − 294 = 1806

98 × 3 = 294

$$I_1 = I_2 + I_3 \quad \text{—(1)}$$

$$I_2 + I_5 = I_4 \quad \text{—(2)}$$

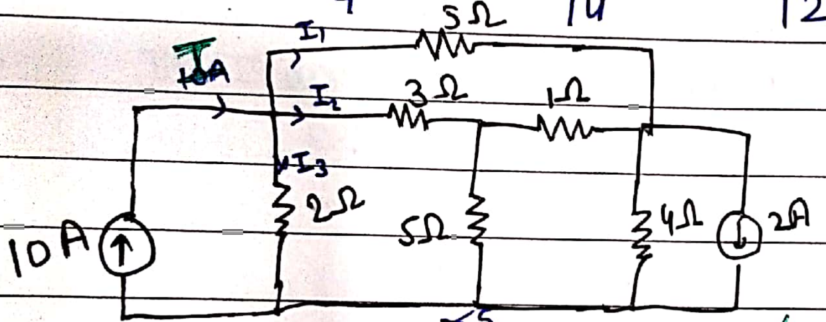
(1) $$\frac{10 - V_A}{3} = \frac{V_A - V_B - 3}{4} + \frac{V_A - 0}{8}$$

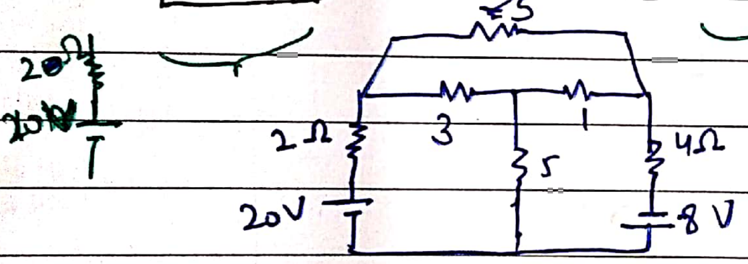
(2) $$\frac{V_A - V_B - 3}{4} + \frac{6 - V_B}{14} = \frac{V_B - 0}{12}$$

$$\frac{3}{4} + \frac{10}{3} = \frac{V_A}{3} + \frac{V_A}{4} + \frac{V_A}{8} - \frac{V_B}{4}$$

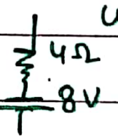
$$\frac{V_A}{4} - \frac{V_B}{4} - \frac{V_B}{14} - \frac{V_B}{12} = \frac{3}{4} - \frac{6}{14}$$

$$\frac{17}{24} V_A = \frac{V_B}{4}$$





for conv. of current source to V source
I source in parallel with load



$I = 10 = I_1 + I_2 + I_3$

Use Nodal analysis when current source is given & Loop analysis when voltage source is given

Thevenin theorum: Any 2 terminal bilateral linear DC circuit can be replaced by an equivalent circuit consisting of voltage source with series resistant

Steps -

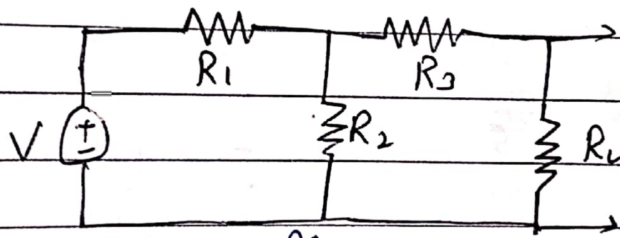
(1) Remove the load resistance & find the open

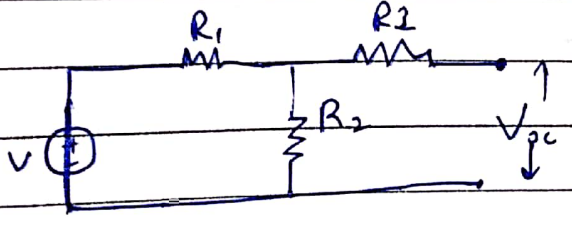
circuit voltage across the open circuited terminals

(2) Deactivate the constant sources (for voltage source remove it by internal resistance and for current source, replace it with open source and find the total internal resistance of the source side looking through open circuited load terminal

(3) Obtain thevenin equivalent circuit by placing eq. res. with open source in series.

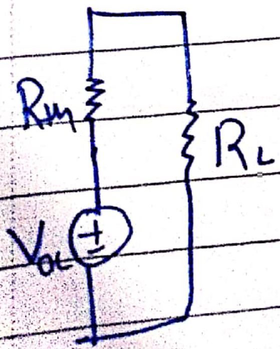
(4) Reconnect the load resistance across the load terminals





$$V_{oc} = \frac{VR_2}{R_1+R_2}$$

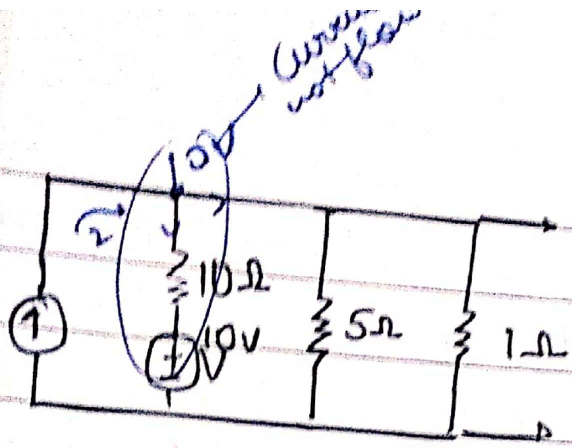
$$R_{th} = R_3 + (R_1 \| R_2)$$
$$= R_3 + \frac{R_1R_2}{R_1+R_2}$$



$$I = \frac{V_{oc}}{R+R_{th}}$$

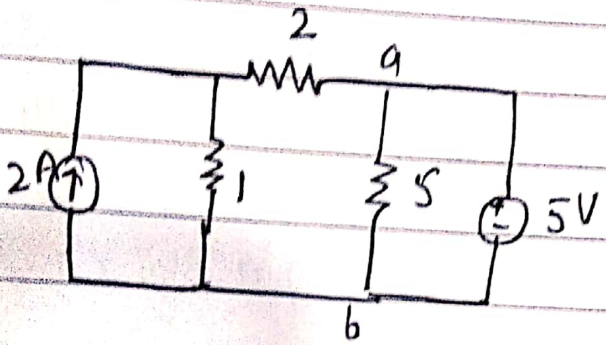
DOMS

Q.(1)



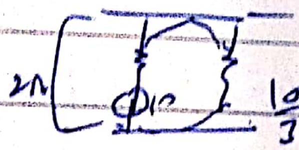
Power loss across 1 Ω

(2)

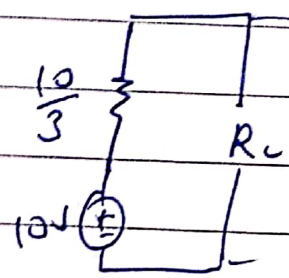


current through ab

(1)



$\frac{10}{3}$ $\quad V_0 = \frac{5\times10}{15}$ $\quad \frac{10}{3}\ R_{th}$



$$2 = \frac{V_{oc}-10}{10} + \frac{V_{oc}-0}{5}$$

~~$V_{oc} = 30$~~

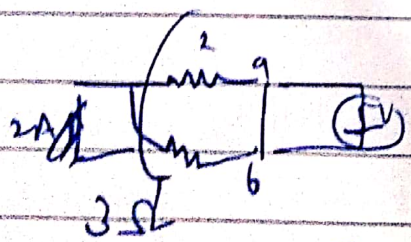
$$20 = V_{oc} - 10 + 2V_{oc}$$

$$3V_{oc} = 30$$

$$V_{oc} = 10V$$

$$I = \frac{10}{\frac{10}{3}+1} = \frac{30}{13}$$

(2)



$V_{oc} = 5$

$R_{th} = 0$

$$I = \frac{5}{0+5} = 1\,A$$

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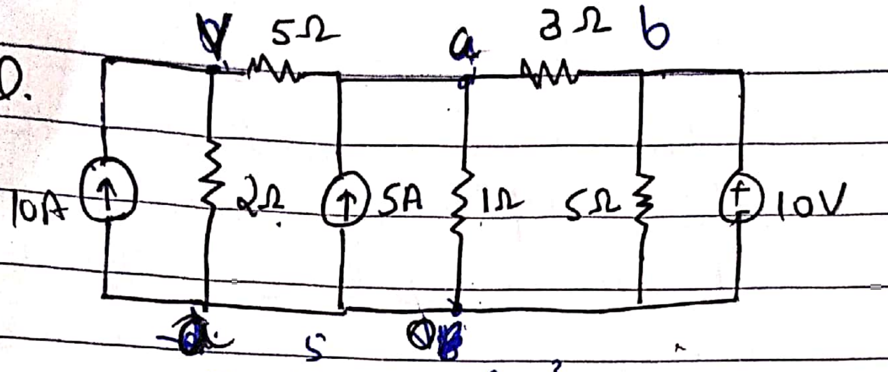
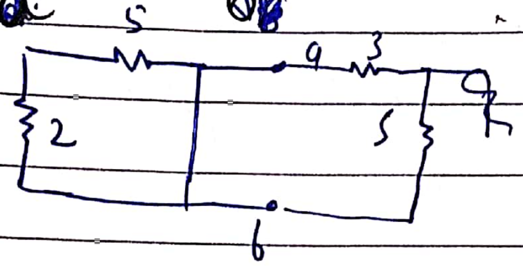
Q.

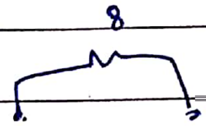


$a - b = 10$

$\frac{55}{8} + b$



8Ω



$V_b = 10$

$\cancel{V_b = 10}$

3.125

$\frac{V}{2} + \frac{V - a - 10}{5}$ $\quad 7V - 2a = 100$

$\frac{V-a}{5} + 5 = \frac{a}{1}$

$V_{th} = 10 - \frac{55}{8} = 3.125$

$V - a + 25 = 5a$

$V + 25 = 6a$

$V = \frac{3}{\cancel{6}} \times \frac{55}{\cancel{8}_4} - 25$

$7V + 25 \times 7 = 42a$

$= \frac{165 - 100}{4} = \frac{65}{4}$

$a = \frac{55}{8}$

$7V - 2a = 100$

$= 1$

$42a - 175 = 100 + 2a$

$40a = 275$

$V = 6a - 25$

$a = \frac{\cancel{275}\,55}{\cancel{40}\,8} = \frac{25}{4}\ \frac{55}{8}$

$= \frac{3}{\cancel{6}}\left(\frac{55}{\cancel{8}_4}\right) - 25$

$= 6.\ldots$

$= \frac{165 - 100}{4} = \frac{65}{4}$

16.25

DOMS

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Norton Theorem :→ A linear active network consisting of independent ~~an~~ and/or dependent voltage and current sources and linear bilateral network elements can be replaced by an equivalent circuit consisting of a current source in parallel way equivalent resistance

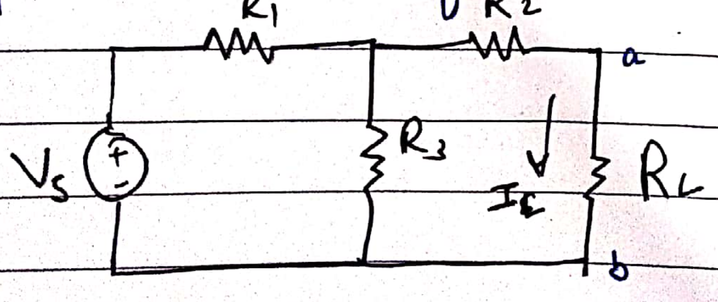
Steps →

(1) Short the load terminal and find the short circuit current flowing through the shorted load terminal using conventional network analysis

(2) Remove the load resistance and find the internal equivalent resistance of the source network after deactivating the current and voltage sources

(3) Draw norton equivalent circuits by keeping short circuit current in parallel way the equivalent resistance ~~and~~

(4) Reconnect the load resistance across the load terminal and find the current through it.



DOMS

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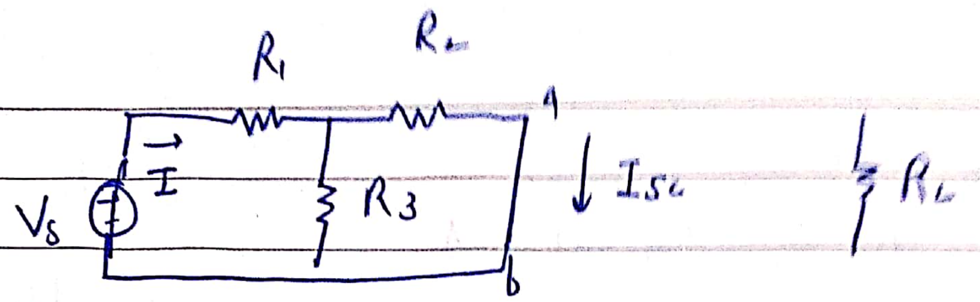
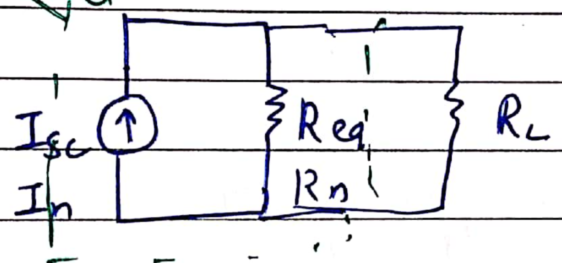


$$I = \frac{V}{R_1 + \frac{R_2 R_3}{R_2 + R_3}} \qquad I_{sc} = \frac{I R_3}{R_2 + R_3}$$

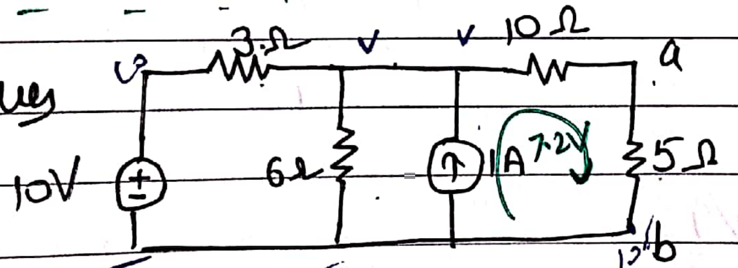
$$R_{eq} = R_2 + R_1 || R_3 = R_2 + \frac{R_1 R_3}{R_1 + R_3}$$

Norton circuit



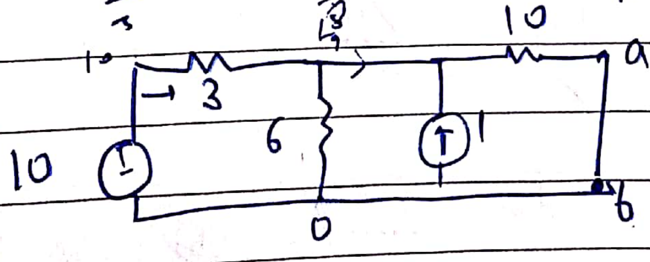
$$I_L = \frac{I_{sc} R_{eq}}{R_{eq} + R_L} \qquad \frac{V-0}{10}$$

Ques



$$I_{sc} = \frac{V}{10} \qquad V = 10x$$

$$\frac{10-V}{3} + \frac{0-V}{6} + 1 = I_{sc}$$



$$I_{sc} = \frac{10}{3} - \frac{V}{3} - \frac{V}{6} + 1$$

$$I_{sc} = \frac{13}{3} - \frac{V}{2}$$

$$I_{sc} + \cancel{\frac{10 I_{sc}}{2}} = \frac{13}{3}$$

$$I_{sc} = \frac{13}{6 \times 3} = \frac{13}{18}$$

0.51

$$I = \frac{10}{9} \qquad I_{sc} = \frac{10}{9} + 1 = \frac{19}{9}$$

$$R_{eq} = 10 + \frac{\cancel{18}}{9} 2 = \boxed{12\,\Omega = R_n}$$

~~Let V be Highest~~ potential

$$\frac{V-10}{3} + \frac{V-0}{6} + \frac{V-0}{10} - 1 = 0 \qquad \frac{10V - 100 + 5V + 3V}{30} = 1$$

$$16V = 30 + 100$$

$$V = \frac{130}{\cancel{18}} \quad \frac{65}{9} = 7.2\,V$$

DOMS

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Tara KN

$V - I_{sc}10 = 0$

$I_{sc} = \frac{V}{10} = \frac{7.2}{10} = 0.72\,A$

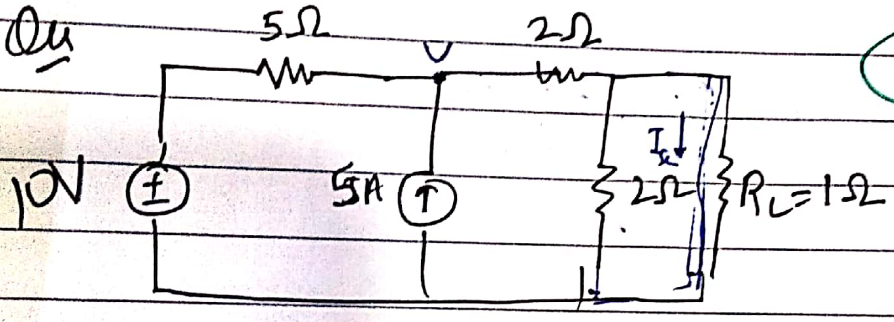
$I_L = \frac{I_{sc} R_n}{R_n + R_L}$

$= \frac{0.72 \times 12}{12+5}$

$= \frac{0.72 \times 12}{17}$

$= 0.508\,A$

Qu



$\frac{V-10}{5} - 5 + \frac{V-0}{2} = 0$

$4V - 40 - 120 + 10V = 0$

$14V = 140$

$V = \frac{140}{14} = 10\,V$

$V - I_{sc}(1) = 0$

$I_{sc} = \cancel{140}/9$

$V - I_{sc}(2) = 0$

$I_{sc} = \frac{10}{2} = 5A$

$R_n = 6\,\Omega$

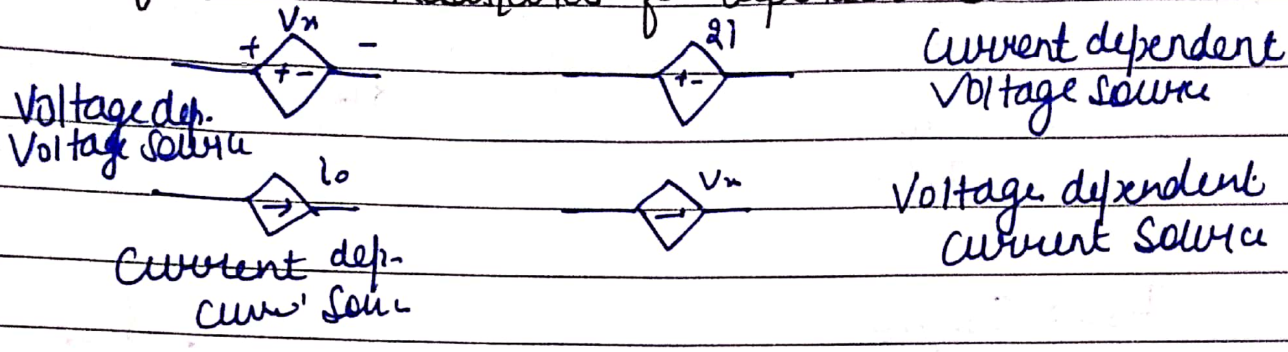
$\cancel{I_L = \frac{140/9 \times 6}{6+1} = \frac{140}{9} \times \frac{6}{7}}$

$= \frac{40}{3}$

$I_L = \frac{5 \times 7}{7+1} = \frac{35}{8}$

$= 4$

Equivalent Resistance for dependent Sources



Method I. Find V_{oc} across open circuited load terminal by conventional network analysis

2. Short the load terminal and find the short circuit current through the shorted terminal. $R_{th} = \frac{V_{oc}}{I_{sc}}$

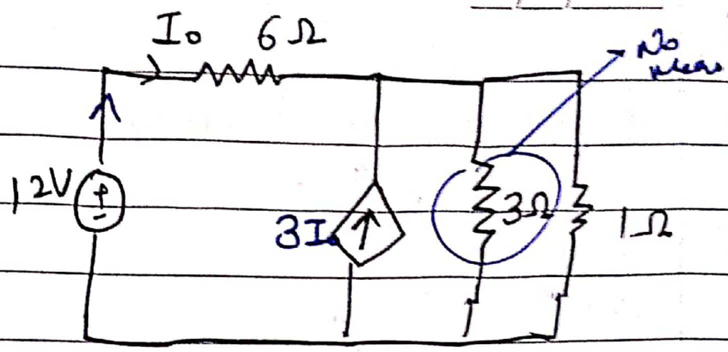
Method II

Remove the load resistance & apply the DC voltage V_{DC} at open circuited load terminals

Keep the other independent sources deactivated during this time. So, due to V_{DC}, the driving current I_{DC} will flow in the circuit from the load terminal. So, the equivalent terminal resistance is $\frac{V_{DC}}{I_{DC}} = R_{TH}$

$R_{th} = R_N = \frac{V_{oc}}{I_{sc}}$

$\Rightarrow \frac{V_{dc}}{I_{dc}}$



~~$I_{sc} = \frac{3I_o \times 3}{3+6}$~~

$3I_o = \frac{12}{6+3} = \frac{12}{9}$ ~~$I_o = \frac{4}{9}$~~

$=$

$I_o + 3I_o = I_{sc}$

$4I_o = I_{sc}$

$\boxed{I_{sc} = 8A}$

$\frac{12-0}{6} = 2A = I_o$

V_{oc}

$\frac{V_{oc}-12}{6} + 3I_o = \frac{V_{oc}-0}{3}$

$I_o + 3I_o = \frac{V_{oc}}{3}$

$\frac{V_{oc}-12}{6} - \frac{V_{oc}}{3} = -6$

~~$V_{oc} = 12 I_o = 24V$~~

~~$V_{oc} - 12 - 2V_{oc} = -36$~~

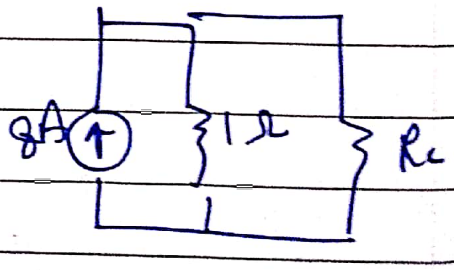
~~$36 - 12 = V_{oc} = 24$~~

$4I_o = \frac{V_{oc}}{3} = \left(\frac{12 - V_{oc}}{6}\right) \times 4$

$V_{oc} = 24 - 2V_{oc}$

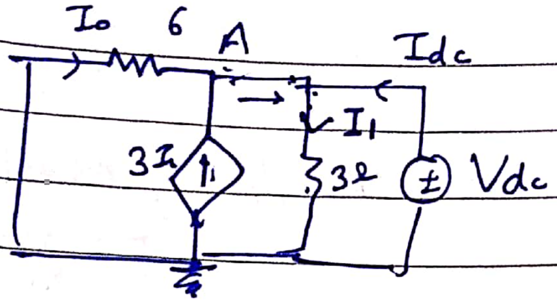
$V_{oc} = 8V$

$R_N = \frac{V_{oc}}{I_{sc}} = \frac{8}{8} = 1\Omega$



DOMS

Next Method



$$I_{dc} = I_1 - 3I_0 - I_0$$

$$I_{dc} = I_1 - 4I_0$$

$$I_{dc} = \frac{V_{dc}}{3} - 4I_0$$

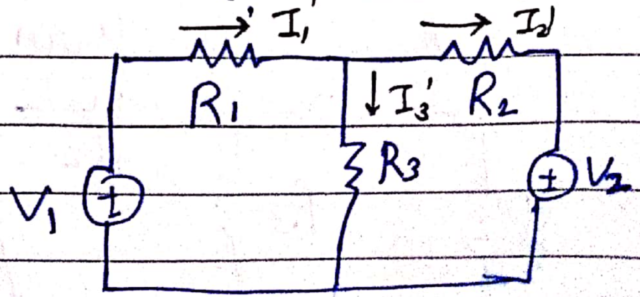
$$I_{dc} \; \cancel{\frac{V_{dc}}{6}} \; \cancel{I_{dc}} = \frac{V_{dc}}{3} - 4\left(\frac{V_{dc}}{6}\right)$$

$$I_{dc} = +\frac{V_{dc}}{}$$

$$\boxed{\frac{V_{dc}}{I_{dc}} = 1}$$

Superposition theorem

If a number of voltage and current sources are acting simultaneously in a linear network. The resultant current in any branch is algebraic sum of the currents that would be produce in it when each source acts alone replacing all other independent sources by their internal resistances



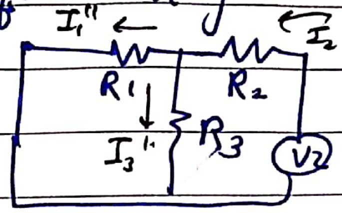
V_2 short circuit

$$I_1' = \frac{V_1}{R_1 + \frac{R_2 R_3}{R_2 + R_3}}$$

$$I_2' = \frac{I_1' R_3}{R_2 + R_3}$$

$$I_3' = I_1' - I_2'$$

Now take effect of 2nd Voltage source



$$I_2'' = \frac{V_2}{R_2 + \frac{R_1 R_3}{R_1 + R_3}}$$

$$I_1'' = \frac{I_2'' R_3}{R_1 + R_3}$$

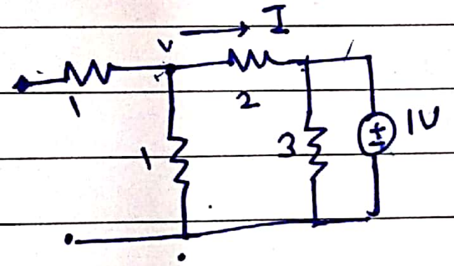
$$I_3'' = I_2'' - I_1''$$

$$I_1 = I_1' - I_1''$$

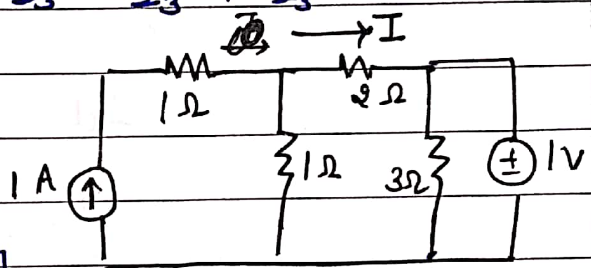
$$I_2 = I_2' - I_2''$$

$$I_3 = I_3' + I_3''$$

Que



short

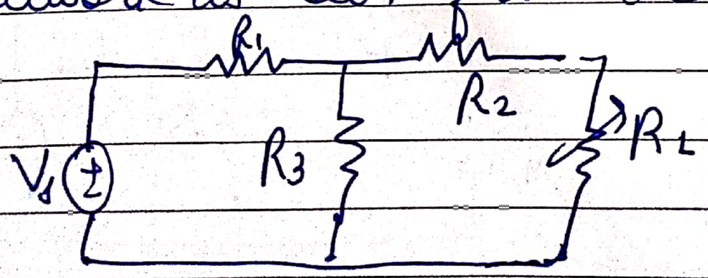


$I' = 1/3$ $\quad I'' = 1/3$

$$I = I' - I'' = \frac{1}{3} - \frac{1}{3} = 0$$

Max. Power Transfer theorem

A resistive load being connected to DC circuit receives the max. power when the load resistance = Internal equivalent resistance of the source network as seen from the load terminal



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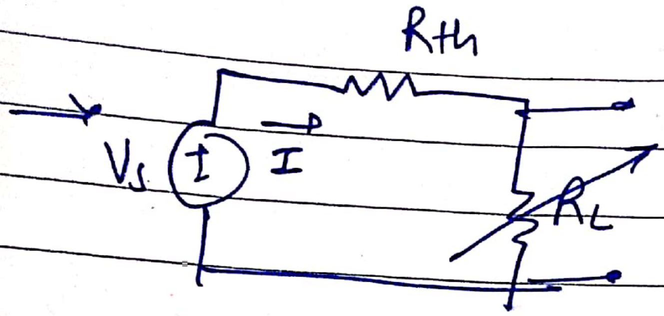


$$I = \frac{V_s}{R_{th} + R_L}$$

$$V_0 \; \frac{V_s}{R_{th}+R_L} \times R_{th}$$

$$P = VI$$

$$P = \frac{V_s^2}{(R_{th}+R_L)^2} \times R_L$$

for Maxima $\Rightarrow \dfrac{dP}{dR_L} = 0$

$$\frac{dP}{dR_L} = \cancel{V_s^2} \frac{\cancel{2}}{R_{th}+R_L} \quad V_s^2 \left[\frac{(R_{th}+R_L)^2 \cdot 1 - R_L 2 (R_{th}+R_L)}{((R_{th}+R_L)^2)^2} \right]$$

$$= V_s^2 \frac{\cancel{(R_{th}+R_L)}(R_{th}+R_L-2R_L)}{((R_{th}+R_L)^2)^2}$$

$$R_{th} + R_L - 2R_L = 0$$

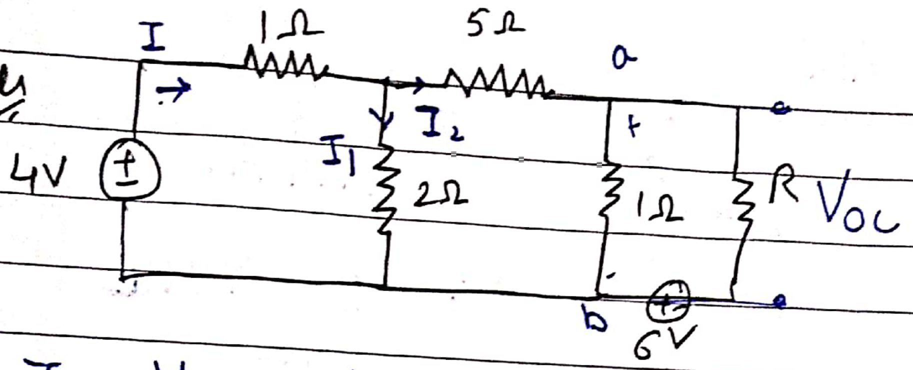
$$R_{th} - R_L = 0$$

$$\boxed{R_{th} = R_L}$$

$$\text{Power} = \frac{V_s^2 R_L}{4R_L^2}$$

$$\boxed{P = \frac{V_s^2}{4R_L}}$$

Que/



$I = \frac{V}{R_{eq}} = \frac{4}{} = \frac{8}{5} = 1.6$

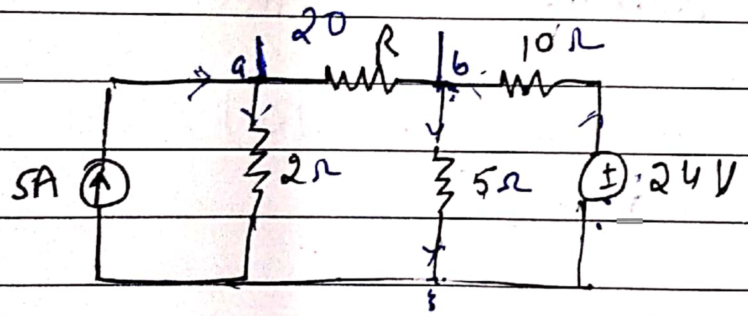
$I_2 = \frac{I \times 2}{8} = \frac{8}{5}\times\frac{2}{8} = \frac{2}{5}$

$V_{ab} = \frac{2}{5} V$ $\quad$ $V_{ab} - V_{oc} + 6 = 0$

$V_{oc} = 6 + 2/5 = \frac{32}{5} = 6.4V$

$R_{th} = \frac{17}{20}$

Que/



$\frac{V_a}{2} = 5$ $\quad$ $V_a = 10$ $\quad$ $\frac{V_b - 24}{10} + \frac{V_b}{5} = 0$

$V_b - 24 + 2V_b = 0$

$3V_b = 24$

$V_b = 8$

$V_{ab} = 10 - 8 = 2V$

~~$R_{th} = \frac{10 \times 7}{17} = \frac{70}{17}$~~

$R_{th} = \frac{16}{3}$

$\frac{2}{3}+1 \quad \frac{\frac{5}{3}\times 5}{\frac{5}{3}+5} \quad \frac{15}{8}\times\frac{1}{20}$

$\frac{5\times3}{8} = \frac{15}{8}+1$

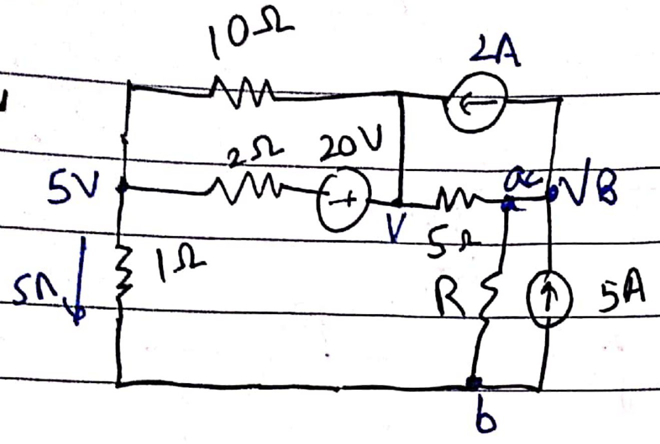
$\frac{23}{8}$

$\frac{2}{3}+5 \quad \frac{17}{\frac{2}{3}}$

DOMS

/ /

Ques



I = 5A

$$\frac{V-5}{10} + \frac{V-5-20}{2} + \frac{V_B - V_{oc}}{5} = 0$$

$$V - 5 + 5V - 125 + 2V - 2V_{oc} = 0$$

$$8V - 2V_{oc} = 130$$

$$4V - V_{oc} = 65$$

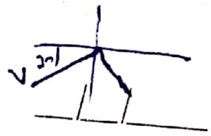
$$\boxed{45\ V_{oc}}$$

$$\frac{V_B - V_{oc} -}{5}$$

$$R = \frac{23}{3}$$

$\boxed{166\ \text{Watt} = \text{Power}}$

A.C.



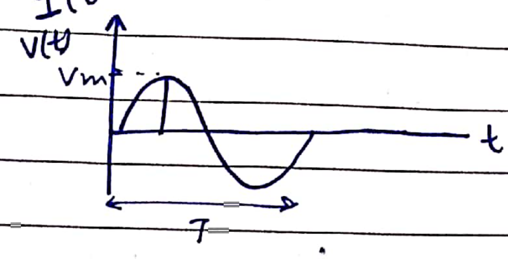
UNIT-2

Steady State Analysis of AC Circuits

$$\boxed{V(t) = V_m \sin(\omega t + \phi)}$$

Ang. freq.

↓ Amplitude — Nature of signal — Phase angle



$\omega = 2\pi f = \frac{2\pi}{T}$

Polar & Rectangular comp.

$A\angle\theta = (a + jb)$

$A = \sqrt{a^2+b^2}$

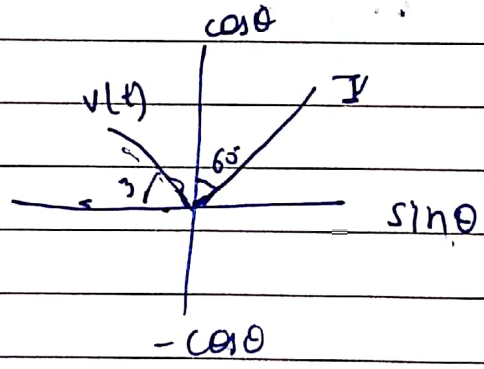
$\theta = \tan^{-1}\left(\frac{b}{a}\right)$

$a = A\cos\theta$

$b = A\sin\theta$

$V(t) = -5\sin(100t - 30)$

$i(t) = 8\cos(100t - 60$



Resistance

} Reactance

} Impedance

$I(t) \rightarrow DC$

$i(t) \rightarrow AC$

V_{BE} - DC $v_{BE} \rightarrow DC + AC$

$v_{be} \rightarrow AC$

$T \;\; \omega L$

$X_C = \frac{1}{j\omega C} = \frac{-j}{\omega C}$

$V = IR$

$V_L = L\frac{di(t)}{dt}$

$V = \frac{1}{C}\int i(t)\,dt$

$i(t) = C\frac{dv(t)}{dt}$

CIVIL

C me I leading to V and in L, V is leading

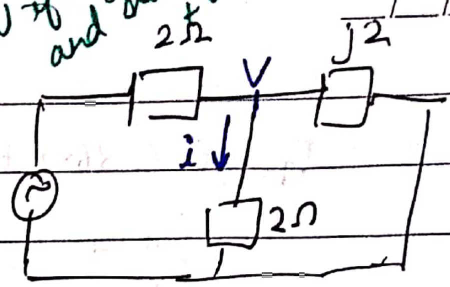
DOMS

Angles in fraction are added in N of negative and subtracted if +ve

$\tan^{-1}\left(\frac{-1}{2}\right)$

$X_L =$

$L.$



$V_m = 5\sin(100t + 30^\circ)$

$5 \angle 30^\circ$

$$\frac{V - 5\angle 30}{2} + \frac{V}{2} + \frac{V}{2j} = 0$$

$$V + \frac{V}{2j} = \frac{5\angle 30}{2} \qquad V\left(1 + \frac{1}{2j}\right) = \frac{5\angle 30}{2}$$

$$\cancel{V = \frac{5\angle 30}{2\left(1+\frac{1}{2j}\right)} = \frac{5\angle 30\,(2j)}{2(2j+1)}}$$

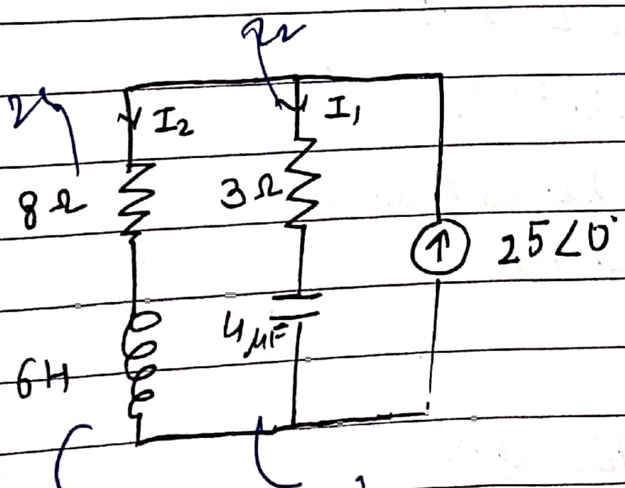
$$V\left(1 - \frac{j}{2}\right) = \frac{5\angle 30}{2}$$

$$V\left(\frac{2-j}{}\right) = 5\angle 30$$

$$V = \frac{5\angle 30}{(2-j)} = \frac{5\angle 30}{\sqrt{5}\tan^{-1}\left(\frac{-1}{2}\right)} \qquad \frac{\sqrt{5}\angle 30}{\angle -26.5} \qquad \sqrt{5}\angle 30 + \angle 26.5$$

$$V = \sqrt{5}\angle 56.5$$

$$i = \frac{V}{2} = \frac{\sqrt{5}}{2}\angle 56.5 = 1.118\angle 56.5$$



$8 + 6j$ $\qquad$ $3 - 4j$

$10\tan^{-1}\left(\frac{3}{4}\right)$ $\qquad$ $\cancel{5\angle 53.13}$

$10\angle 36.87$ $\qquad$ $5\angle -53.13$

$$Z_1 \| Z_2$$

$$\frac{Z_1 Z_2}{Z_1 + Z_2}$$

$$\frac{10\angle 36.87 \times 5\angle -53.13}{10\angle 36.87 + 5\angle -53.13}$$

$$\frac{50\angle -16.26}{\sqrt{125}\angle 10.30}$$

$$Z = 4.47\angle -26.56$$

$11 + 2j$

DOMS

$I_1 = 22.36\angle 26.5$
$I_2 = 11.18\angle -63.43$

$I_2 \, 10\angle 36.87 = I_1 \, 5\angle -53.13$

$\frac{I_2}{I_1} = \frac{5\angle -53.13}{10\angle 36.87}$

$\frac{I_2}{I_1} = 0.5\angle -90.00$

$I_1 + I_2 = 25\angle 0$

$(0.5\angle -90 + 1) I_2 = 25\angle 0$

$25\angle 0 - I_2 = 0.5\angle -90 \, I_2$

$\frac{25\angle 0}{(0.5\angle -90 + 1)} = I_2$

$I_1 = \frac{25\angle 0}{1 - 0.5j}$

$I_1 \; \frac{25\angle 0}{\sqrt{1.25}\angle -26.5}$

$I_1 = 22.36\angle 26.5$

$I_2 = 0.5\angle -90 \times 22.36\angle 26.5$
$= 11.18\angle -63.43$

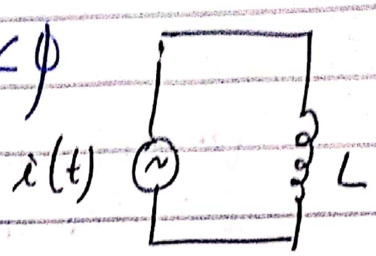
$V = IZ$
$= 25\angle 0 \times 4.47\angle -26.56$
$= 111.75\angle \cancel{63.44} -26.56$

63.43
26.56
37.07

DOMS

Inductor

$$i(t) = I_m \cos(\omega t + \phi) \qquad I_m \angle \phi$$

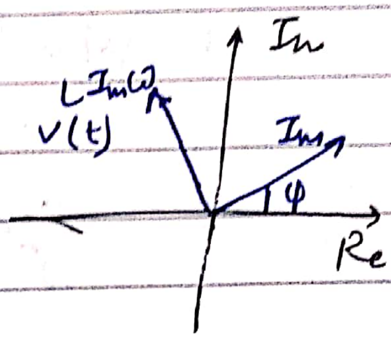


$$V_L = L \frac{di(t)}{dt}$$

$$= L \frac{d}{dt} I_m \cos(\omega t + \phi)$$

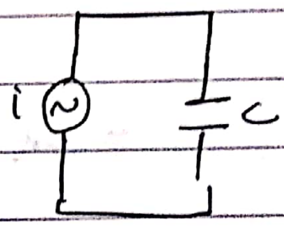
$$= -L I_m \omega \sin(\omega t + \phi)$$

$$V_L = L I_m \omega \cos(\omega t + 90 + \phi)$$



Capacitor

$$i(t) = I_m \cos(\omega t + \phi)$$



$$V = \frac{Q}{C} = \frac{\int i\,dt}{C}$$

$$V = \frac{\int I_m \cos(\omega t + \phi)\,dt}{C}$$

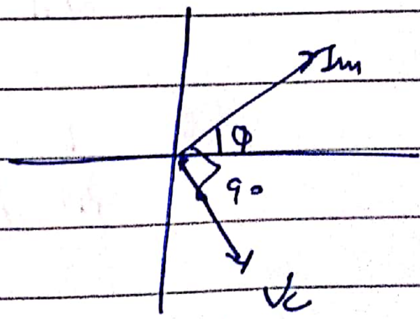
$Q = CV$

$V = \frac{Q}{C} = \frac{\int i\,dt}{C}$

$$= \frac{I_m \sin(\omega t + \phi)}{\omega C}$$

$$= \frac{I_m \cos(90 - (\omega t + \phi))}{\omega C}$$

$$V_c = \frac{I_m}{\omega C} \cos(90 - (\omega t + \phi))$$



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Power :-

$$v = V_m \sin \omega t$$

$$i = I_m \sin(\omega t + \phi)$$

?

$$P = vi = V_m I_m \sin(\omega t)\sin(\omega t - \phi)$$

$$= \frac{V_m I_m}{2}\left[\cos(\omega t - \omega t + \phi) - \cos(\omega t + \omega t - \phi)\right]$$

$$= \frac{1}{2} V_m I_m \cos\phi - \frac{I_m V_m}{2}\cos(2\omega t - \phi)$$

$\downarrow$ Constant power $\qquad$ $\downarrow$ Pulsating Power

$$= \frac{V_m}{\sqrt{2}}\,\frac{I_m}{\sqrt{2}}\cos\phi \Rightarrow \boxed{VI\cos\phi = P_{avg}}$$

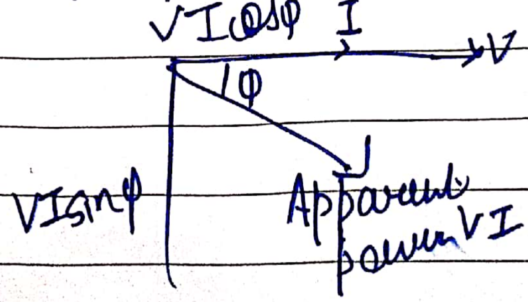
$$P_{avg} = \frac{1}{2\pi}\int_0^{2\pi} V_m I_m \sin(\omega t)\sin\left(\omega t + \frac{\pi}{2}\right) d\omega t$$

$$\text{Diff} = \frac{1}{2\pi}\int_0^{2\pi} V_m I_m \sin(\omega t)\sin(\omega t)\, d\omega t$$

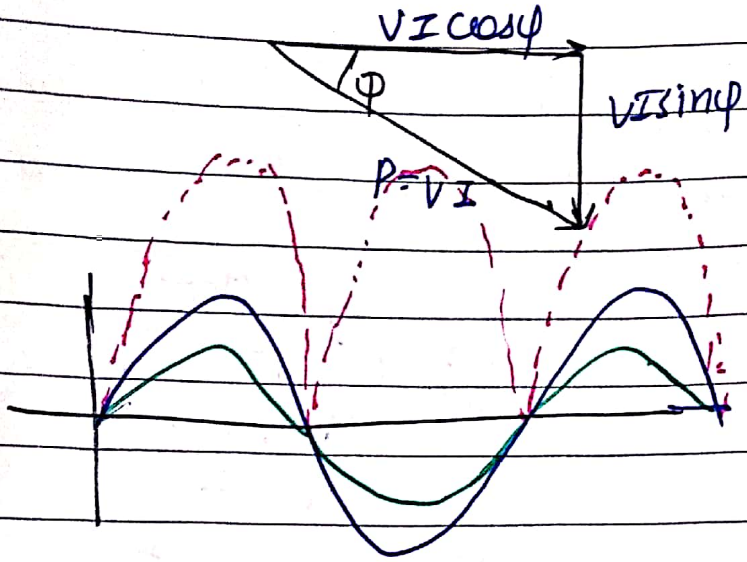
$$\text{Diff} \quad \frac{1}{2\pi}\int_0^{2\pi} V_m I_m \sin(\omega t)\sin\left(\omega t - \frac{\pi}{2}\right) d\omega t$$

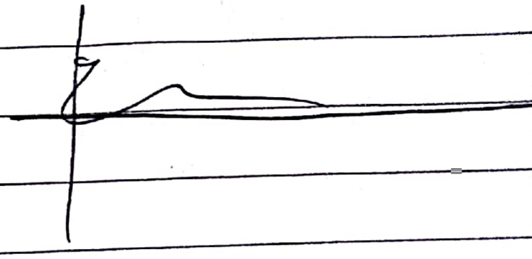
$VI\cos\phi$ = True Power / Active / simple

$VI\sin\phi$ = Reactive Power



DOMS





Power Consumer

$P = VI\cos\phi$

Power factor

$$\cos\phi = \frac{P}{VI} = \frac{V_R I}{VI} = \frac{IR}{IZ} = \frac{R}{Z}$$

$I = P / V\cos\phi$

$$KVA = \frac{KW}{\cos\phi}$$

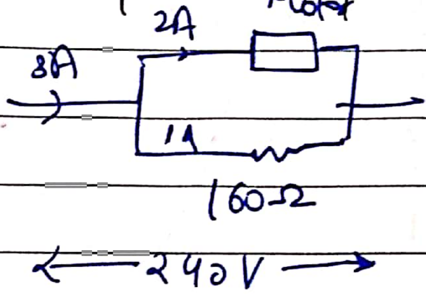
Active Power – Power which is rarely consumed or utilised in AC circuit or power consumed in resistive circuit called Active Power

$P = VI\cos\phi$

Reactive Power – Power which flows back and forth or reacts itself is called Reactive power or whenever the current is not in the phase with voltage will produce reactive power

__/__/__

Que. A single phase 240 Volt induction motor runs parallel with 160 Ω resistor. If motor takes 2A and the total current is 3A. So find the power & powerfactor of Motor



$\frac{240}{160} = 1.5$

$I_m = 2A$, $I_R = 1.5A$

$I_m = I_\omega - J I_\mu$

$2 = I_\omega - J I_\mu$

$4 = I_\omega^2 + I_\mu^2$ — ①

$I_m + I_R = 3A$

$I_\omega - J I_\mu + I_R = 3$

$(I_\omega + I_R) - J I_\mu = 3$

$(I_\omega + 1.5) - j I_\mu = 3$

$(I_\omega + 1.5)^2 + (I_\mu)^2 = 9$ — ②

$4 - \cancel{I_\omega^2} = 9 - \cancel{I_\omega^2} - 2.25 - 3I_\omega$

$3I_\omega = 9 - 4 - 2.25 = 9 - 6.25$

$I_\omega = \frac{2.75}{3} = 0.916$

$I_\mu = \sqrt{4 - (0.916)^2} = \sqrt{3.161} = 1.777$

DOMS

__/__/__

$I_m = (0.917 - J\,1.78)$

Power factor b/w 0 and 1

Resonance in RLC N/W

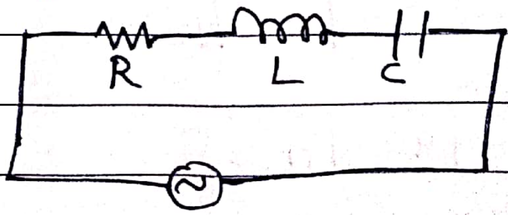
Whenever natural frequency of oscillation of a system coincide with frequency of driving force, the two system resonate w.r.t each other. and system has the maximum response to a fixed magnitude. So, the phenomena by virtue of which the resulting current of an AC circuit is in the phase of the sinosoidal excitation even in the due presence of reactive components called Resonance

The frequency at which resonance occurs is called Resonant frequency.

It is of 2 types—

→ Series Resonance (Voltage)

→ ~~Current~~ Parallel Resonance (Current



$$Z = R + j\,\omega L - \frac{1}{\omega C}$$

$$Z = R + J\left(\omega L - \frac{1}{\omega C}\right)$$

$$\omega L - \frac{1}{\omega C} = 0$$

$$\omega^2 = \frac{1}{LC} \Rightarrow \omega_r = \frac{1}{\sqrt{LC}}$$

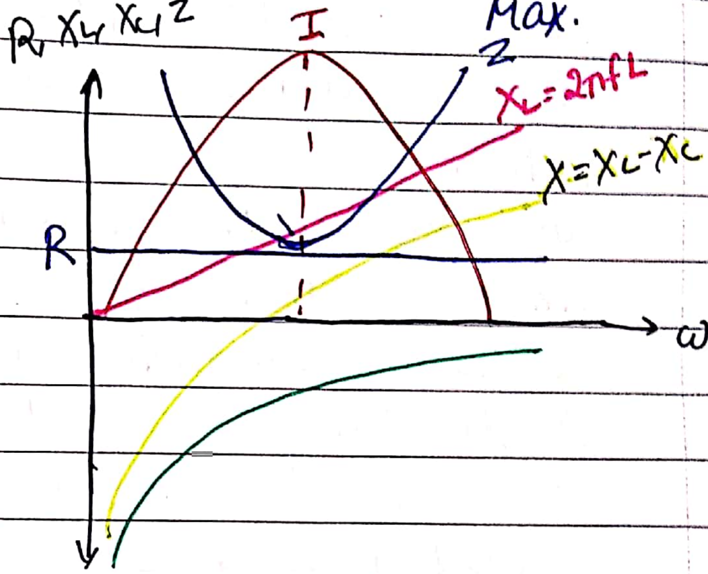
$$\boxed{f_r = \frac{1}{2\pi\sqrt{LC}}}$$

With this freq. current will be Max.

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

$$X_L = \omega L$$
$$= 2\pi f L$$

$$X_C = \frac{1}{2\pi f C}$$

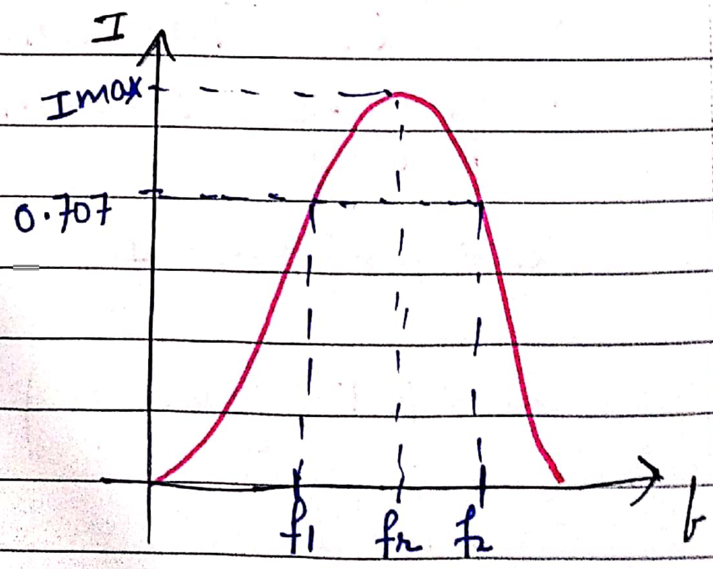


Band Width

The Range of frequencies over which the circuit current is equal to or more than 70.7% of the Max. current is known as Band Width

Band Width
$= f_2 - f_1$

$f_r = \sqrt{f_1 f_2}$



DOMS

$\frac{fr^2}{f_1} - f_1$

$$fr^2 = f_1(\cancel{BW}fr + BW)$$
$$fr^2 = f_1^2 + f_1 BW$$
$$f_1^2 + f_1 BW - fr^2 = 0$$
$$f_1 = \frac{-BW \pm \sqrt{(BW)^2 + 4fr^2}}{2}$$

BW Neglect

$$f_1 = \frac{-BW \pm 2fr}{2}$$
$$f_1 = -\frac{BW}{2} + fr = \boxed{f_1 = fr - \frac{BW}{2}}$$
$$f_2 = BW + f_1 = BW + fr - \frac{BW}{2}$$
$$\boxed{f_2 = fr + \frac{BW}{2}}$$

Quality factor It is the Ratio of voltage across L or C and applied voltage

$$Q = \frac{IX_L}{IR} \text{ or } \frac{IX_C}{IR}$$
$$Q = \frac{\omega L}{R}$$
$$fr = \frac{1}{2\pi\sqrt{LC}}$$
$$\omega = \frac{2\pi}{2\pi\sqrt{LC}} = \frac{1}{\sqrt{LC}}$$

DOMS

$$Q = \frac{\omega L}{R} = \frac{L}{R\sqrt{LC}}$$

$$\boxed{Q = \frac{1}{R}\sqrt{\frac{L}{C}}}$$

Relationship b/w Quality factor and Band Width

$X = \pm(X_L - X_C) = R$

Let f_1 is the frequency when net Resistance $= -ve$

f_2 " " " " " " $= +ve$

$$\left(\omega_2 L - \frac{1}{\omega_2 C}\right) = R \quad \text{—— (1)}$$

$$\left(\omega_1 L - \frac{1}{\omega_1 C}\right) = -R \quad \text{—— (2)}$$

(1) + (2)

$$(\omega_1 + \omega_2)L - \left(\frac{1}{\omega_1} + \frac{1}{\omega_2}\right)\frac{1}{C} = 0$$

$$(\omega_1 + \omega_2)L - \frac{1}{C}\left(\frac{\omega_1 + \omega_2}{\omega_1 \omega_2}\right) = 0$$

$$L = \frac{1}{\omega_1 \omega_2 C}$$

$$\boxed{\omega_1 \omega_2 = \frac{1}{LC}}$$

(1) − (2) $\quad (\omega_2 - \omega_1)L - \frac{1}{C}\left(\frac{1}{\omega_2} - \frac{1}{\omega_1}\right) = 2R$

$$(\omega_2-\omega_1)L + \frac{1}{C}\frac{(\omega_2-\omega_1)}{\omega_1\omega_2} = 2R$$

$$\cancel{\omega L} = \cancel{\frac{1}{C\omega_1\omega_2}}$$

$$\boxed{\cancel{\omega_1\omega_2 = \frac{1}{LC}}}$$

$$(\omega_2-\omega_1)\left(L + \frac{1}{C\omega_1\omega_2}\right) = 2R$$

$$L + \frac{1}{C\omega_1\omega_2} = \frac{2R}{\omega_2-\omega_1}$$

$$\left[\omega_1\omega_2 = \frac{1}{LC}\right]$$

$$L + \frac{L\cancel{C}}{\cancel{C}} = \frac{2R}{\omega_2-\omega_1}$$

$$\cancel{2}L = \frac{\cancel{2}R}{\omega_2-\omega_1}$$

$$R = L(\omega_2-\omega_1) \quad \text{or} \quad \boxed{\omega_2-\omega_1 = \frac{R}{L}}$$

$$\left[Q = \frac{\omega L}{R}\right] \Rightarrow \frac{R}{L} = \frac{\omega}{Q}$$

Now $\frac{\omega_r}{Q} = \omega_2-\omega_1$

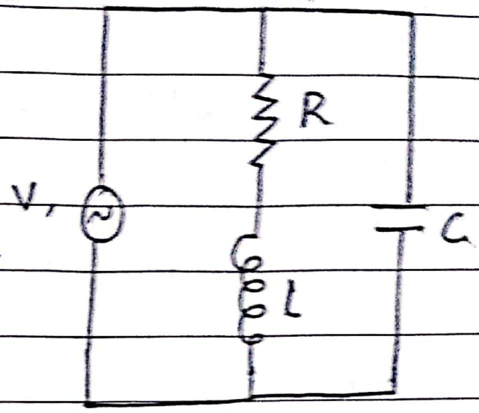
Band Width $\boxed{B.W = \frac{\omega_r}{Q}}$ Resonating frequency / Quality factor

Admittance $= \frac{1}{Z}$

Conductance $= \frac{1}{R}$

Susceptance $= \frac{1}{X}$

PARALLEL RESONANCE



$$Z_1 = R + J X_L$$

$$Y_1 = \frac{1}{Z_1} = \frac{1}{R + J X_L} \times \frac{R - J X_L}{R - J X_L}$$

$$Y_1 = \frac{R - J X_L}{R^2 + X_L^2}$$

$$Z_2 = -J X_C$$

$$Y_2 = \frac{1}{Z_2} = \frac{-1}{J X_C} = \frac{J}{X_C}$$

$$Y = Y_1 + Y_2$$

$$= \frac{R - J X_L}{R^2 + X_L^2} + \frac{J}{X_C} = \frac{R}{R^2 + X_L^2} + J\left(\frac{1}{X_C} - \frac{X_L}{R^2 + X_L^2}\right)$$

Imaginary term = 0

$$\frac{1}{X_C} = \frac{X_L}{R^2 + X_L^2}$$

$$R^2 + X_L^2 = X_L X_C$$

$$R^2 + \omega^2 L^2 = \cancel{\omega} L \frac{1}{\cancel{\omega} C}$$

$$\omega^2 L^2 = \frac{L}{C} - R^2$$

$$\omega^2 = \frac{1}{L^2}\left(\frac{L}{C} - R^2\right) = \frac{1}{LC} - \frac{R^2}{L^2}$$

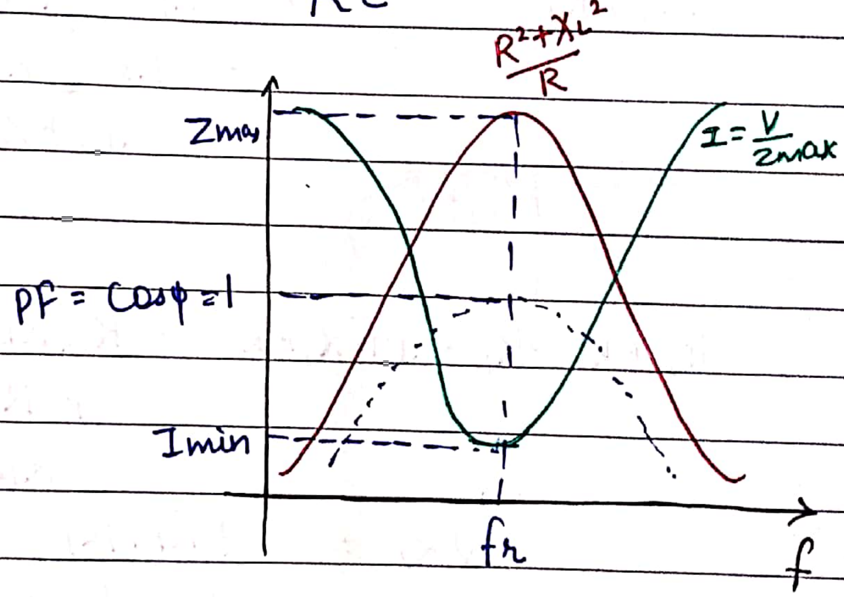
$$\boxed{\omega = \sqrt{\frac{L - R^2 C}{L^2 C}}}$$

$$\boxed{f_r = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}}$$

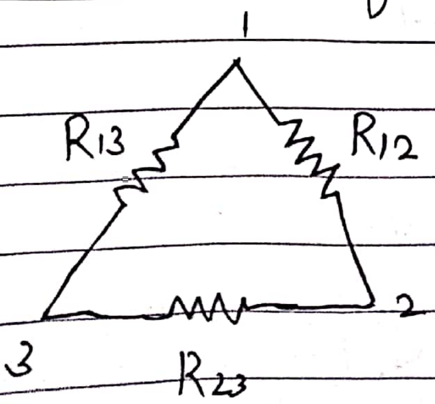
Resistance of Parallel Circuit at Resonance

$$= \frac{R^2 + X_L^2}{R} = \frac{R^2 + \left(\frac{L - R^2C}{\cancel{L^2}C}\right)\cancel{L^2}}{R}$$

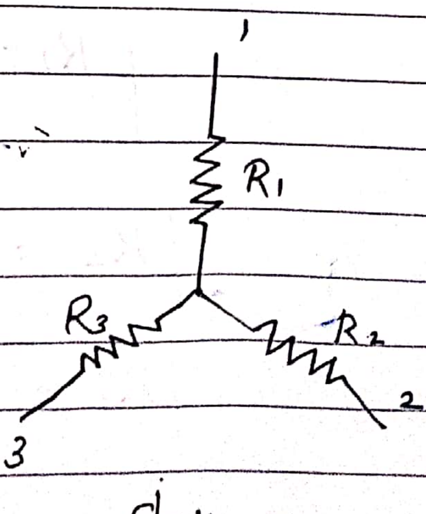
$$= \frac{\cancel{R^2} + \left(\frac{L}{C} - \cancel{R^2}\right)}{R} = \frac{L}{RC}$$



Star Delta Transformation



Delta



Star

Star

Delta

$$R_1 + R_2 \Rightarrow R_{12} \,||\, (R_{13} + R_{23})$$

$$= \frac{R_{12}(R_{13}+R_{23})}{R_{12}+R_{13}+R_{23}} \quad \text{— } 1$$

$$R_2 + R_3 \Rightarrow R_{23} \,||\, (R_{13} + R_{12})$$

$$= \frac{R_{23}(R_{13}+R_{12})}{R_{23}+R_{13}+R_{12}} \quad \text{— } 2$$

$$R_3 + R_1 \Rightarrow R_{13} \,||\, (R_{12} + R_{23})$$

$$= \frac{R_{13}(R_{12}+R_{23})}{R_{13}+R_{12}+R_{23}} \quad \text{— } 3$$

$$[1 - 2] + 3$$

$$R_1 + \cancel{R_2} - \cancel{R_2} - \cancel{R_3} + R_3 + R_1 = \frac{R_{12}R_{13} + R_{12}\cancel{R_{23}} - \cancel{R_{23}}R_{13} - \cancel{R_{23}}R_{12} + R_{13}R_{12} + R_{13}\cancel{R_{23}}}{R_{12}+R_{13}+R_{23}}$$

$$2R_1 = \frac{2R_{12}R_{13}}{R_{12}+R_{13}+R_{23}}$$

$$\boxed{R_1 = \frac{R_{12}R_{13}}{R_{12}+R_{23}+R_{13}}} \quad \text{— } 4$$

$$\boxed{R_2 = \frac{R_{23}R_{12}}{R_{12}+R_{23}+R_{13}}} \quad \text{— } 5$$

$$\boxed{R_3 = \frac{R_{13}+R_{23}}{R_{12}+R_{23}+R_{31}}} \quad \text{— } 6$$

DOMS

$$\frac{10\times10}{10+10} = \frac{100}{20} = 5+5=10$$

$$4\times5 + 5\times6 + 6\times4$$

$$R_1R_2 + R_2R_3 + R_3R_1 = \frac{R_{12}^2R_{13}R_{23} + R_{12}R_{23}^2R_{13} + R_{12}R_{23}R_{13}^2}{(R_{12}+R_{23}+R_{13})^2}$$

$$R_1R_2+R_2R_3+R_3R_1 = \frac{(R_{12}R_{23}R_{13})(R_{12}+R_{13}+R_{23})}{(R_{12}+R_{13}+R_{23})(R_{12}+R_{13}+R_{23})}$$

$$R_1R_2+R_2R_3+R_3R_1 = \frac{R_{12}R_{23}R_{13}}{R_{12}+R_{23}+R_{13}}$$

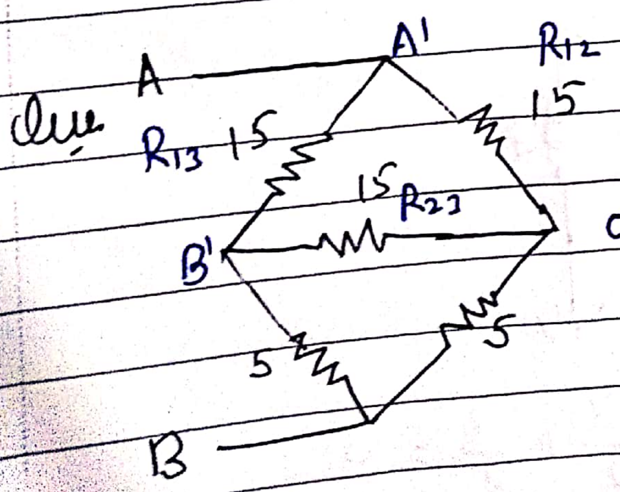
$$\frac{R_1R_2+R_2R_3+R_3R_1}{R_3} = R_{12}$$

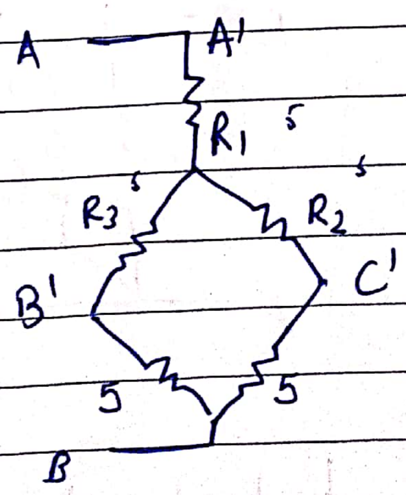
$$\boxed{R_{12} = R_1+R_2+\frac{R_1R_2}{R_3}}$$

$$\boxed{R_{23} = R_2+R_3+\frac{R_2R_3}{R_1}}$$

$$\boxed{R_{31} = R_3+R_1+\frac{R_3R_1}{R_2}}$$

Que



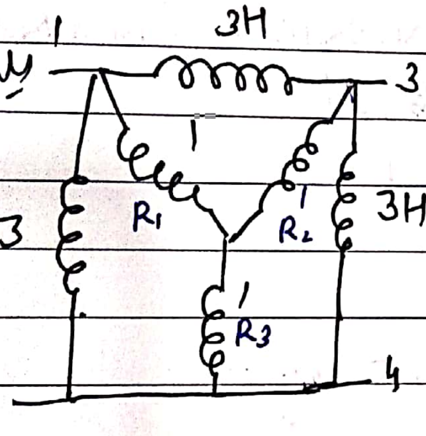


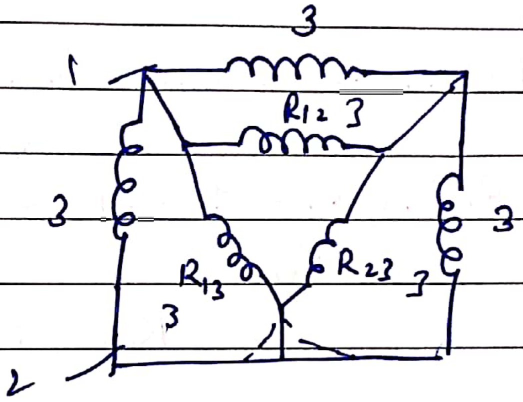
$$R_1 = \frac{15 \times 15}{15+15+15} = \frac{15}{3} = 5$$

$$R_2 = R_3 = \frac{15}{3} = 5$$

$$R_{eq} = 5 + \left(\frac{10 \times 10}{10+10}\right) = 5+5 = 10\,\Omega$$

Que

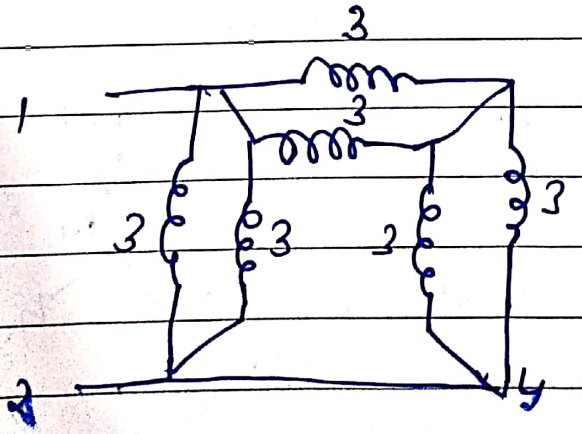




$$X_{12} = 1+1+\frac{1 \times 1}{1} = 3$$

$$X_{13} = 3, \quad X_{23} = 3$$

Inductor k case me jX_L lena h $\boxed{90° \text{ is must}}$



$X_L = 3j$

$$\frac{3}{2} + \frac{3}{2} = 3$$

$$\frac{1}{3} + \frac{1}{3} + \frac{1}{3} = \frac{3}{3} = 1j$$

DOMS