Theorems

When ever N/W having more no:of nodes then Nodal Analysis makes more no:of nodal eqn's. If the N/W is having more meshes then mesh Analyses is required more mesh eqn's.

=> more complexity will present.

For Analysis of large n/w's the nodal Analysis, mesh Analysis is difficult since complexity.

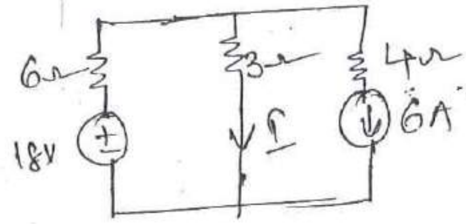
By using some special Techniques we can reduce the Complexity of calculations. Thevenin's & Norton's Theorems make the large n/w into a single N/w having voltage source in series with resistance like wise Norton's also.

When the N/W is having (or) serving more No:of Nodes & meshes the response in any one of the branches can be easily obtained by using theorems.

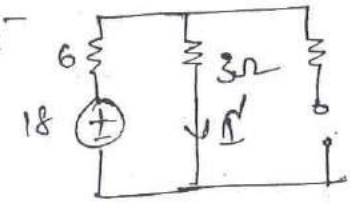
Superposition theorem :-

In any linear bidirectional ckt having more than one independent source the response in any one of the branches is equal to the algebraic sum of responses caused by individual sources, while the rest of the sources are replaced by its internal resistances.

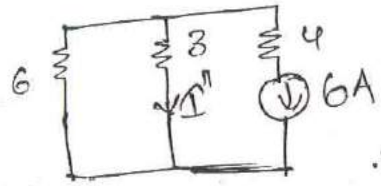
(Pb) Find the value of 'I' by using superposition Theorem.



Sol:-



$I' = \frac{18}{9} = 2A$



$I'' = (-6)\cdot\left(\frac{6}{9}\right)$

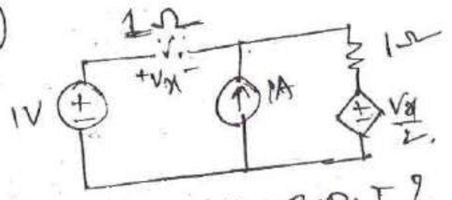
$= -4\ A$

$\therefore I = I' + I''$

$= 2 - 4$

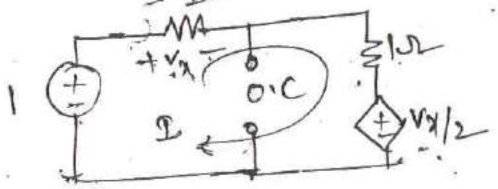
$= -2A$

(Pb)



Find V_x by S.P.T ?

Sol:-

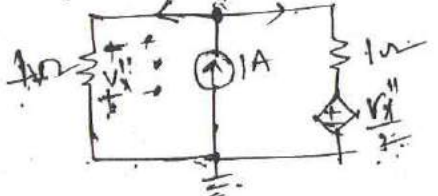


$-1 + I + I + \frac{I}{2} = 0$

$\Rightarrow \frac{5I}{2} = 1$

$I = \frac{2}{5}\ A \qquad \Rightarrow V_x' = \frac{2}{5}\ V$

NOTE:- while applying superposition theorem is replaced by Neither open circuit nor short ckt. And it remains same as the original ckt.



$\frac{V-0}{1} + \frac{V-(V_x''/2)}{1} = 1 \rightarrow (1)$

$V_x'' = -1\cdot\left(\frac{V}{1}\right) = V \rightarrow (2)$

$\Rightarrow -V_x'' + \left(V_x'' - \frac{V_x''}{2}\right) = 1 \Rightarrow -2V_x'' * V_x'' = 2$

$V_x = -\frac{2}{5}$ Volts

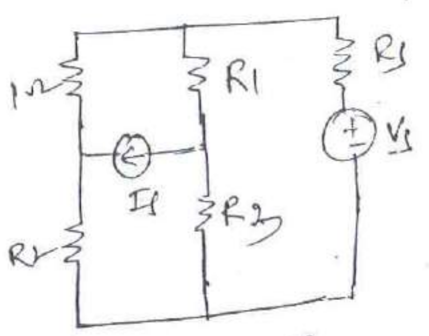
$\Rightarrow V_x'' = -\frac{2}{5}$ Volts $\Rightarrow$ which is −ve since in the first ckt $+V_x - 2I$ in second n/w $-V_x + 2I$

$\therefore V_x = V_x' + V_x''$

$= \frac{2}{5} * \frac{2}{5} = \frac{6*10}{-15} = \frac{16}{15}V$

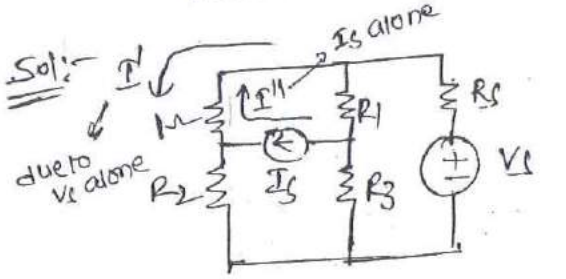
$V_x = 0\ V \qquad = -\frac{4}{15}V$

(Pb)



In the ckt shown Power dissippation in the 1Ω resr is 576W, when voltage source is acting alone. & Power dissippation in the 1Ω resistor is 1W when Current source is acting alone. Find Total Power dissippation in the 1Ω resistor?

Sol:-



$$\boxed{\begin{aligned} I &= \pm I' \pm I'' \\ V &= \pm V' \pm V'' \\ P &= \pm P' \pm P'' \end{aligned}}$$

S.P.T valid

S.P.T is not valid for calculation of power since Power is nonlinear qty $(P = I^2R)$

Note:
$P = I^2R$

Note:- S.P.T can not be used for the calculation of power. Since Power is Nonlinear qty.

$$P_1 = I'^2R \Rightarrow I' = \sqrt{\frac{P_1}{R}}$$

$$P_2 = I''^2R \Rightarrow I'' = \sqrt{\frac{P_2}{R}}$$

$$I = \pm I' \pm I''$$
$$= \pm\sqrt{\frac{P_1}{R}} \pm \sqrt{\frac{P_2}{R}}$$

$$\therefore P = I^2R$$
$$= \left(\pm\sqrt{\frac{P_1}{R}} \pm \sqrt{\frac{P_2}{R}}\right)^2 \cdot R$$

$$\boxed{P = \left(\pm\sqrt{P_1} \pm \sqrt{P_2}\right)^2}$$ → General Expression for Power

$$\therefore P = \left(\sqrt{576} - \sqrt{1}\right)^2 = 529 \ldots$$

(Pb) In the ckt shown If the Source voltage is incremented by 10%. find variation of the power in the R_4 resistor?

(a) 10% (b) 15% (c) 21% (d) 40%

Sol:-

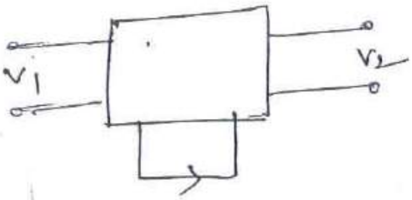
Since All the elements are linear. If Excitation is changed by 'k' factor then responce of each element same changes with present in all the elements by factor of 'k'.

$$P_4 = \frac{V_4^2}{R_4} \quad ; \quad P_4' = \frac{(1.1V_4)^2}{R_4} = 1.21\frac{V_4^2}{R_4}$$

$$\Rightarrow P_4' = 1.21P_4 \ldots$$

NOTE:- when the N/W is having linear bidirectional elements based on the Homogenity Principle if excitation is multiply with constant 'k' response of each element also multiply with constant 'k'.

(Pb) find the value of 'I' when $V_1 = -15V$ & $V_2 = 10V$.



V_1	V_2	I
0	2V	3A
3V	0	-2A

[Note:- when excitation ↑ k times ⇒ response ↑ k times]

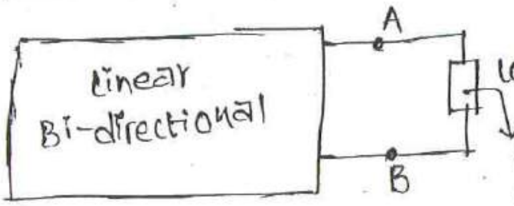
Sol:- $V_1 = 3V$; $I = -2A$
when $V_1 = -15V \Rightarrow I' = 10A$

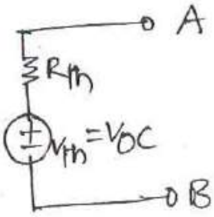
$V_2 = 2V$; $I = 3A$
when $V_2 = 10V$; $I'' = 15A$

Based on S.P.T

$$I = I' + I'' = 10 + 15 = 25\,A$$

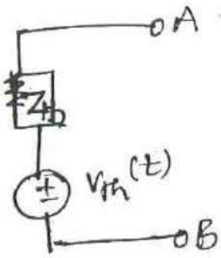
Thevenin's theorem :-





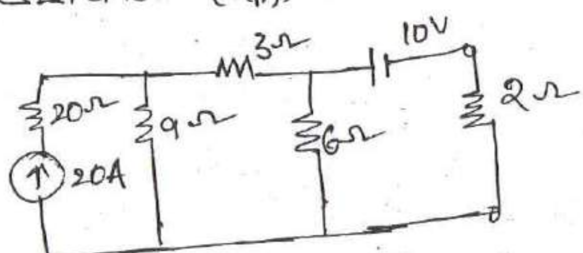
DC

An Any linear bidirectional circuit having more number of passive elements, it can be replaced by single equivalent circuit consisting of equivalent voltage source (V_{th}) in series with equivalent resistance (R_{th}).



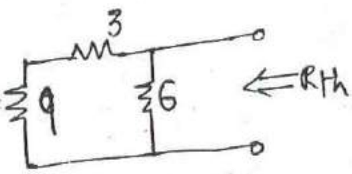
AC

(Pb)



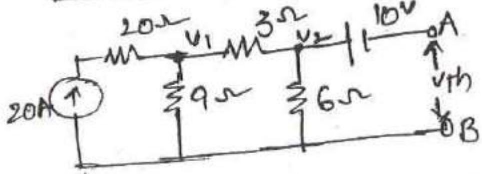
find $I_{2\Omega}$ by using Thevenin's theorem?

R_{th}:-



$$R_{th} = 12 \| 6 = \frac{12 \times 6}{18} = 4\Omega$$

Sol:-



$$\frac{V_1}{9} + \frac{V_1 - V_2}{3} = 20 \rightarrow ①$$

$$\frac{V_2 - V_1}{3} + \frac{V_2}{6} = 0 \rightarrow (2)$$

$$6V_2 - 6V_1 + 3V_2 = 0$$

$$\Rightarrow 9V_2 - 6V_1 = 0 \rightarrow (2)$$

$$8V_1 + 9V_1 - 9V_2 = 180$$

$$4V_1 - 3V_2 = 180 \rightarrow (3)$$

from (2) & (3)

$$9V_2 - 6V_1 = 0$$

$$-9V_2 + 12V_1 = 180$$

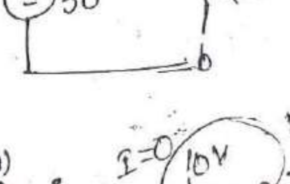
$$\Rightarrow V_1 = 90V$$

$$V_2 = 60V$$

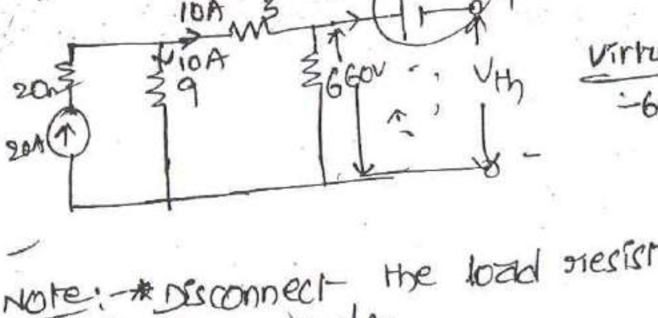
Now virtual KVL for last loop.

$$-6\left[\frac{V_2}{6}\right] + 10 + V_{th} = 0 \Rightarrow V_{th} = 50V$$

$\therefore$



$$I_{2\Omega} = \frac{50}{6} = 8.33A$$



Virtual KVL

$$-60 + 10 + V_{th} = 0$$

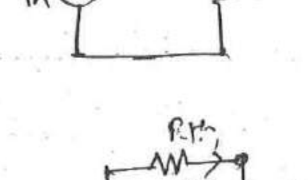
$$\Rightarrow V_{th} = 50V$$

Note:- * Disconnect the load resistor & find open ckt voltage across the load Terminals.

* Deactivate all the independent sources & find Equi resistance find R_{eq}:

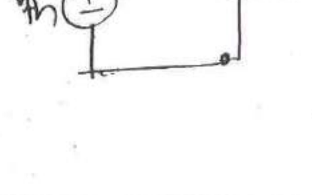
(Pb) A Battery charger drives a current of 5A, when it is connected to load resistor of 1Ω. & when the same battery charger is used to charging of ideal 2V battery at 7A rate. Find V_{th} & R_{th}?

Sol:-



battery charge is represented as Thevenin's ckt.

$$\frac{V_{th}}{R_{th}+1} = 5 \rightarrow (1) \Rightarrow V_{th} - 5R_{th} = 5 \rightarrow (3)$$



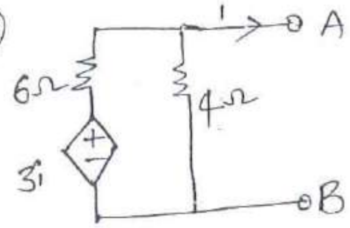
$$-V_{th} + 7R_{th} + 2 = 0$$

$$\Rightarrow -7R_{th} + V_{th} = +2 \rightarrow (2)$$

from (2) & (3) $V_{th} = 12.5V$

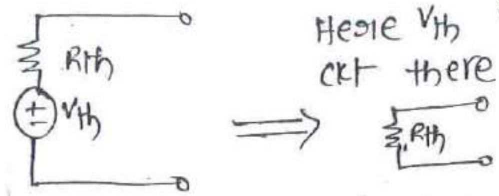
$R_{th} = 1.5\Omega$

(P6)



Find V_{th} & R_{th} w.r.to A & B?

sol:-

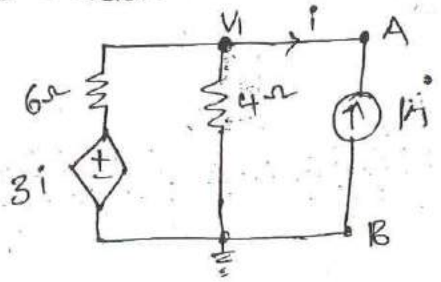


Here V_{th} is independent source. but in the given ckt there is no independent source. so $V_{th} = 0$...

while finding R_{th} in the above ckt dependent source is replaced by Neither open circuit Nor short ckt. And it remains same as the original ckt.

Assum voltage source (or) current source b/w A & B with any magnitude

Now ~~selet~~ select a current source with 1A.



$$R_{th} = R_{AB} = \frac{V_{AB}}{I_{AB}} = \frac{V_{AB}}{1A}$$

Nodal Analysis $\rightarrow$ $\frac{V_1 - 3i}{6} + \frac{V_1}{4} = 1 \rightarrow (1)$

but $i = -1A$

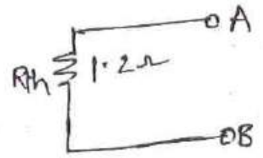
$(1) \Rightarrow \frac{V_1 + 3}{6} + \frac{V_1}{4} = \cancel{0}1 \Rightarrow V_1 = \cancel{0.2}$

voltage across $4\Omega = \left(\frac{V_1}{4}\right)4$

$= V_1 = 1.2V$...

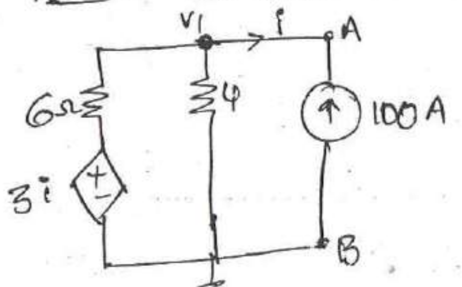
$\therefore R_{th} = \frac{1.2}{1} = 1.2\Omega$

$\therefore$



$\Leftarrow$ thevenin's equ ckt.

Note:- let current source $= 100A$



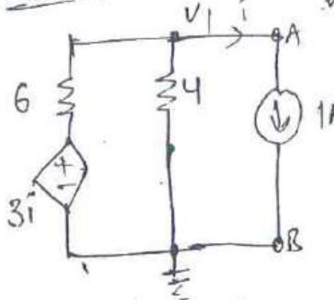
$$\frac{V_1 + 3}{6} + \frac{V_1}{4} = 100 \Rightarrow V_1 = 120$$

$$\therefore R_{th} = \frac{120}{100} = 1.2\Omega \ldots$$

When ever $I\uparrow \Rightarrow V\uparrow$ proportionally. Since the N/W is Linear N/W.

Always $\frac{V_{AB}}{I_{AB}}$ ratio is constant.

Note :-



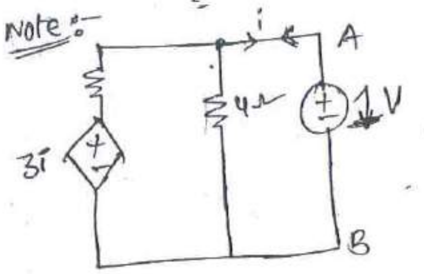
$$\frac{V_1-3(i)}{6}+\frac{V_1}{4}+1=0 \Rightarrow V_1=-1.2V$$

$$R_{th}=\frac{V_{AB}}{I_{AB}} = \frac{-1.2}{-1} = 1.2\Omega$$

Note :- whenever elements are connected in parallel Current source is taken since calculation is simple.

whenever " " series voltage source " ".

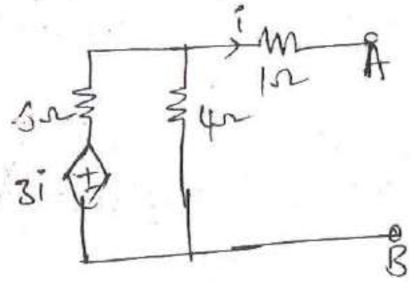
Note :-



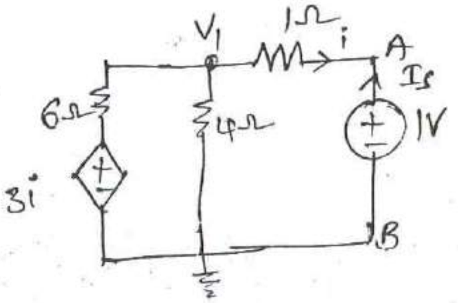
$$\frac{V_{AB}}{I_{AB}} = \frac{1}{I_{AB}} = 1.2\Omega$$

Note :- we can take any source b/w A & B, but finally R_{th} = constant = 1.2Ω

(Pb) Find R_{th} w.r.to A & B?



Sol:-



$$\frac{V_1-3i}{6}+\frac{V_1}{4}+\frac{V_1-1}{1}=0 \rightarrow (1)$$

$$i=\frac{V_1-1}{1} \rightarrow (2)$$

From (1) & (2) $\Rightarrow V_1 = 6/11$

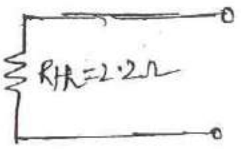
$$i=\frac{6}{11}-1=\frac{-5}{11}$$

$\therefore I_S = -i = 5/11$ A

$$R_{AB} = \frac{V_{AB}}{I_S} = ?$$

$V_{AB} = 1V$

$$\therefore R_{AB} = \frac{1}{5/11} = \frac{11}{5} = 2.2\Omega$$



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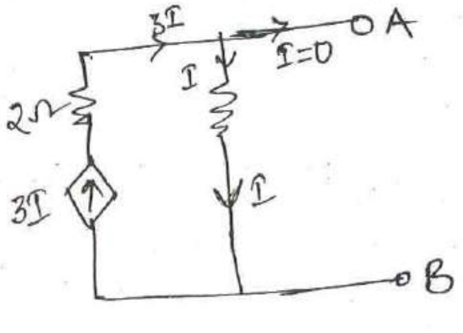
(Pb) Find Openckt voltage w.r.to A & B

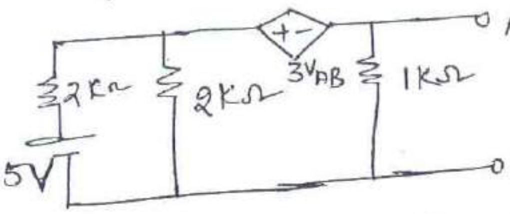


(a) 0
(b) 3
(c) 4V
(d) None

KCL Not Satisfied.

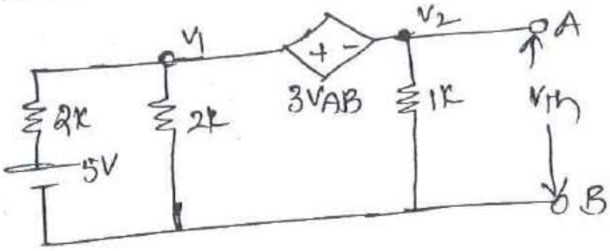
NOTE:- In the above N/W it is Not possible to find open circuit voltage since it is not satisfying KCL.

(P3)



find V_{th} & R_{th} w.r.to A & B?

Sol:-



$$\frac{V_1-5}{2K}+\frac{V_1}{2K}+\frac{V_2}{1K}=0 \quad \to (1)$$

$$V_1-V_2=3V_{AB}$$

but $V_2=V_{AB} \Rightarrow V_1=4V_{AB}$ ....

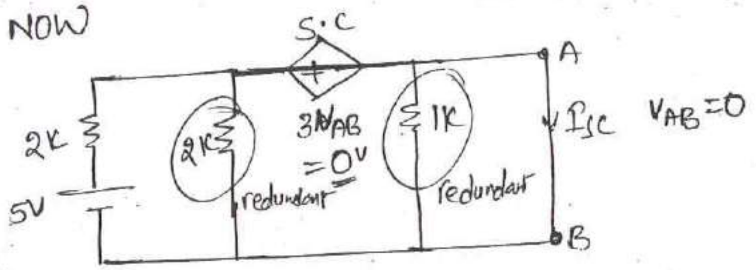
from (1) $\Rightarrow \frac{4V_{AB}-5}{2K}+\frac{4V_{AB}}{2K}+\frac{V_{AB}}{1K}=0$

$$4V_{AB}+4V_{AB}+2V_{AB}=5$$

$$10V_{AB}=5$$

$$V_{AB}=\frac{1}{2} \text{ volts}$$

NOW



$$I_{SC}=\frac{5}{2K}$$

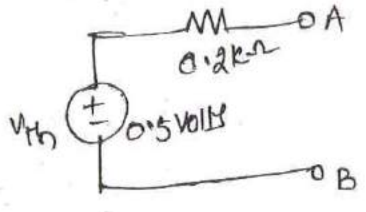
$$=2.5mA$$

$$\therefore R_{th}=\frac{V_{OC}}{I_{SC}}=\frac{\frac{1}{2}}{2.5}$$

$$=\frac{1}{5 mA}$$

$$=0.2 K\Omega$$

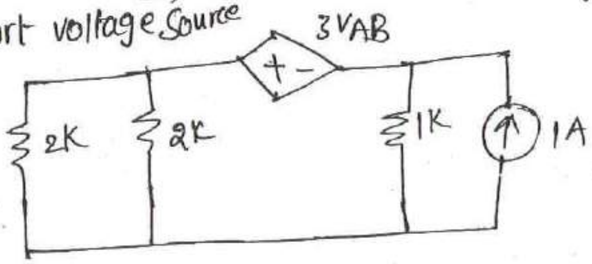
$\therefore$ Thevenin's equi ckt is



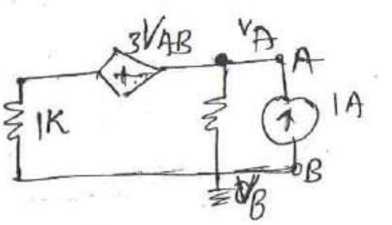
while finding R_{th} make all independent voltage sources are replaced with its internal resi.

(or)

Short voltage Source
⇓



⇒



$$\frac{V_A+3V_{AB}}{1\times10^3}+\frac{V_A}{1\times10^3}=1$$

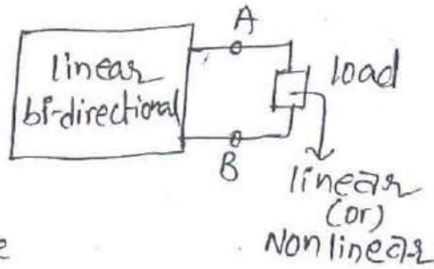
$$\Rightarrow V_{AB}=200 \text{ Volts}$$

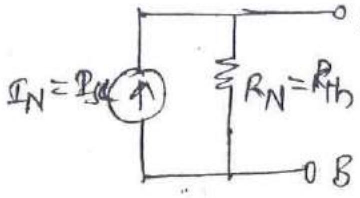
$$R_{th}=\frac{V_{AB}}{I_S}=\frac{200}{1A}$$

$$=200\Omega$$

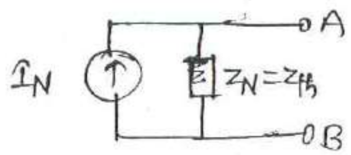
NORTON'S THEOREM :-

An any linear bidirectional circuit having more No. of Active & Passive elements, it can be replaced by single equi ckt consisting of equi current source [I_N] in parallel with equi resistance (R_N).



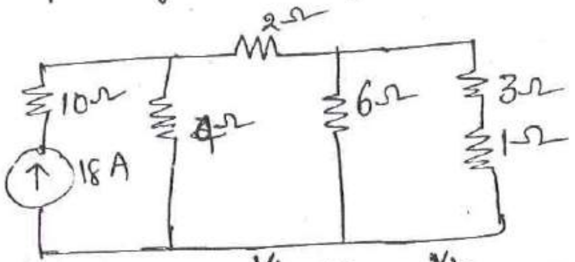


DC

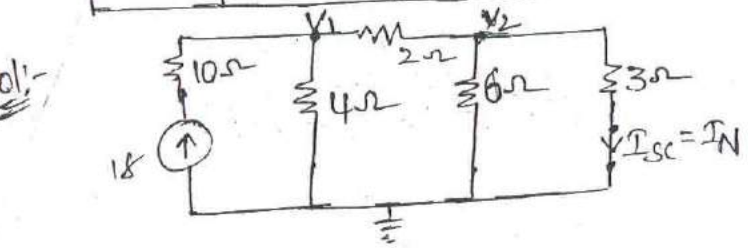


AC

(Pb) find Current in the 1Ω resistor by using Norton's Theorem ?



Sol:-



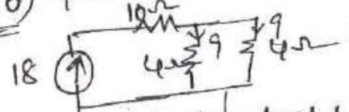
$$\frac{V_1}{4} + \frac{V_1 - V_2}{2} = 18 \rightarrow ①$$

$$\frac{V_2 - V_1}{2} + \frac{V_2}{6} + \frac{V_2}{3} = 0 \rightarrow ②$$

from ① & ② $V_1 = $
$V_2 = 18\,V$

$$\therefore I_{sc} = \frac{V_2}{3} = \frac{18}{3} = 6\,A$$

By reduction Technique
(or) $(3 \| 6) + 2 = 4\Omega$

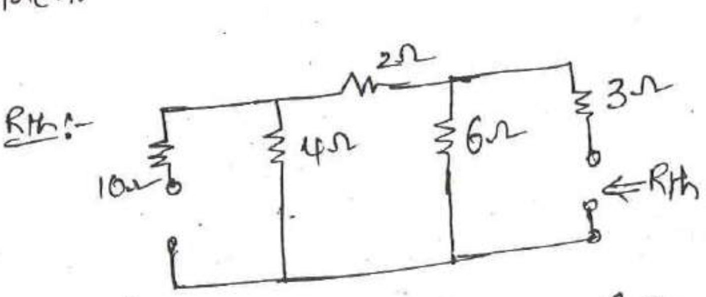


Note :- Replace the load resistor by short ckt & find short ckt current.

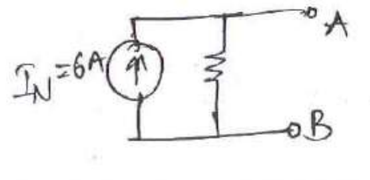
$$\therefore I_{3\Omega} = 9 \times \frac{6}{(6+3)} = 6\,A$$

$I_N = 6A$

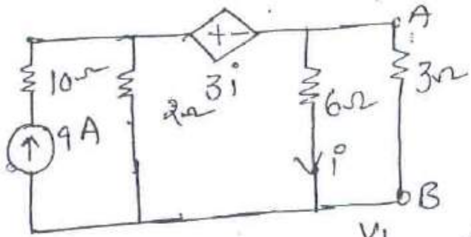
R_{th} :-



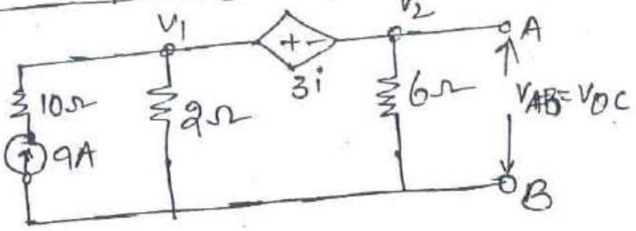
$$R_{th} = (6 \| 6) + 3 = 6\Omega$$



(Pb) find short ckt current w.r.to A & B?



sol:- ~~R_{th}~~ =



$$\frac{V_1}{2} + \frac{V_2}{6} = 9 \rightarrow (1)$$

$$V_1 - V_2 = 3i$$

$$V_1 - V_2 = 3\left(\frac{V_2}{6}\right)$$

$$V_1 = V_2\left(1 + \tfrac{1}{2}\right)$$

$$V_1 = \frac{3}{2}V_2 \rightarrow (2)$$

from (1) $\Rightarrow$ $\frac{\frac{3}{2}V_2}{2} + \frac{(V_2)}{6} = 9$

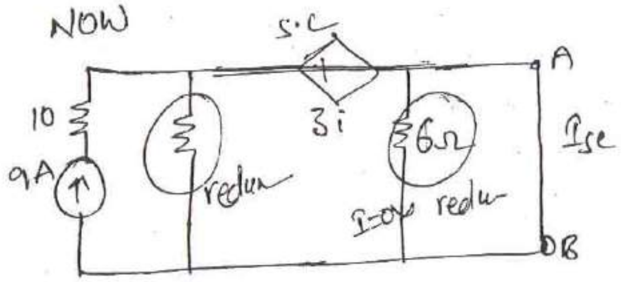
$$\frac{3}{4}V_2 + \frac{V_2}{6} = 9$$

$$\frac{9V_2 + 2V_2}{12} = 9$$

$$11V_2 = 108$$

$$V_2 = \frac{108}{11} = V_{OC}$$

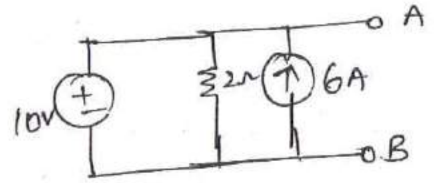
NOW



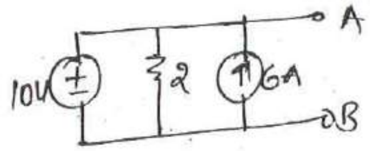
$I_{sc} = 9A$

$$\therefore R_{th} = \frac{V_{OC}}{I_{SC}} = \frac{108/11}{9} = \frac{12}{11}\,\Omega$$

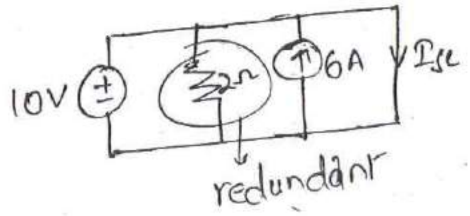
(Pb) find V_{oc} & I_{sc}?



Sol:-



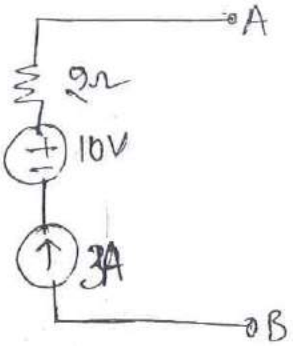
$V_{AB} = 10V = V_{OC}$



KVL Not satisfied.

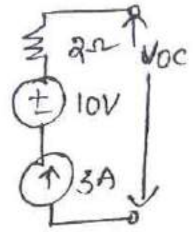
Note:- In the above N/W it is not possible to find short ckt current, since it is not satisfies KVL.

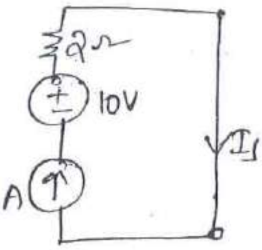
(Pb) find V_{oc} & I_{sc} w.r.to A & B.



sol:- $I_{sc} = 3A$

$V_{oc} = ?$



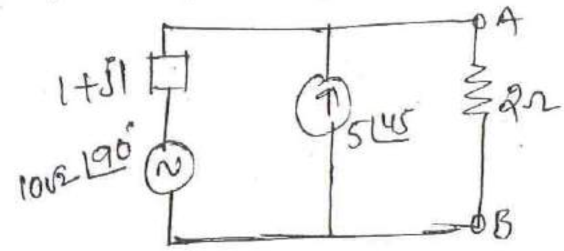


KVL can't applied, since current source exist
(or)

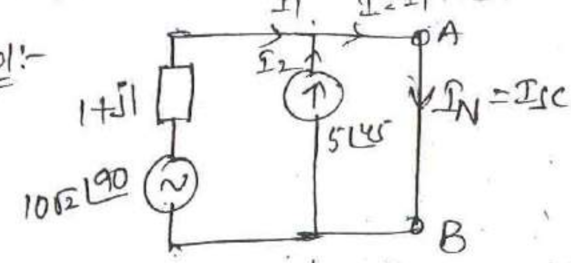
$I=3A$, $I=0$ (O.C) not satisfies KCL.

Note:- In the above ckt it is Not possible to find openckt voltage since it is not satisfying KCL.

(Pb) Find short ckt current w.r.to A & B.



sol:-



$$I_1 = \frac{10\sqrt{2}\angle 90}{\sqrt{2}\angle 45} = 10\angle 45^\circ$$

$$I_2 = 5\angle 45$$

$$\therefore I = I_1 + I_2$$

$$= 10\angle 45 + 5\angle 45$$

$$= 15\angle 45^\circ \text{ A}$$

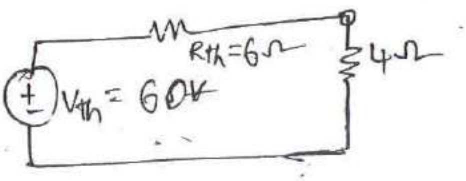
(Pb) find current in the 4Ω res" by using the following data.

V	60V	0
I	0	10A

sol:- $V_{oc} = 60$

$I_{sc} = 10A$

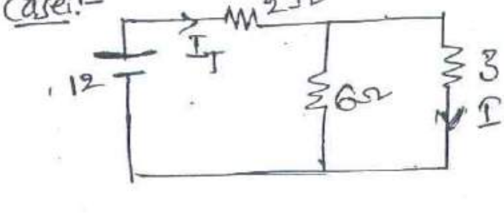
$\frac{V_{oc}}{I_{sc}} = 6\Omega = R_{th}$ → (based on Source Transformation theorem we can write this)



$$I_{4\Omega} = \frac{60}{10} = 6A = 6A$$

Reciprocity :-

case:-



$I = I_T \cdot \frac{6}{6+3}$

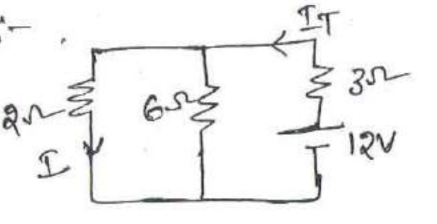
$I_T = \frac{12}{R_{eq}}$

$R_{eq} = (3 \| 6) + 2 = \underline{4}\,\Omega$

$\Rightarrow I_T = \frac{12}{4} = 3A \quad \therefore I = 3 \times \frac{6}{9} = \underline{2A} \ldots$

$\frac{I_2}{V_1} = \frac{\text{Response}}{\text{Excitation}} = \frac{2}{12} = \frac{1}{6} // \ldots$

case(ii):-



$R_{eq} = (2 \| 6) + 3 = \frac{\cancel{2} \times \cancel{6}^{3}}{\cancel{8}_{\cancel{4}_2}} + 3 = \frac{9}{2}$

$I_T = \frac{12}{9/2}$

$I_{2\Omega} = I_T \cdot \frac{6}{6+2} = \left(\frac{\cancel{12}^{4} \times 2}{\cancel{9}_3}\right) \times \frac{\cancel{6}^{2}}{\cancel{8}_{4}}$

$= \underline{2\,A} \ldots$

$\therefore \frac{I_1}{V_2} = \frac{\text{Response}}{\text{Excitation}}$

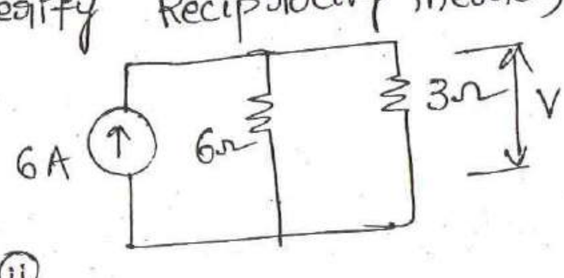
$= \frac{2}{12} = \underline{\frac{1}{6}} \ldots$

$\frac{I_2}{V_1} = \frac{I_1}{V_2}$

$\Rightarrow \boxed{\frac{V_2}{I_1} = \frac{V_1}{I_2}} // \ldots$

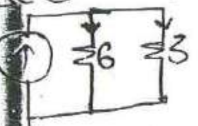
In the above N/W after interchanging response & excitation the ratio of response to excition is constant. Hence given N/W satisfy the resiprocity. [linear N/W].

(Pb) verify Reciprocity Theorem of the ckt shown:



Sol:- $V = ?$

case(i)



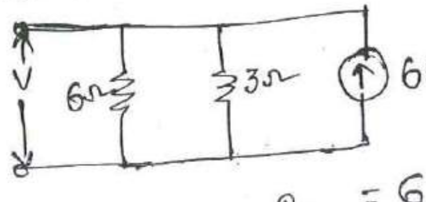
$I_{3\Omega} = 6 \times \frac{6}{9}$

$= \underline{4A} \ldots$

$V = 4 \times 3 = 12V$

$\frac{\text{Response}}{\text{excitation}} = \frac{12}{6} = \underline{2} \ldots$

case(ii)

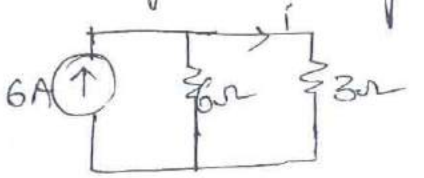


$I_{6\Omega} = 6 \times \frac{3}{6+3} = 2A$

$V = 6 \times 2 = \underline{12V}$

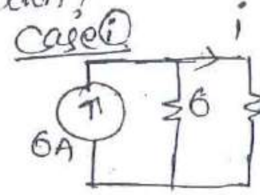
$\therefore \frac{\text{Response}}{\text{excitation}} = \frac{12}{6} = 2 //$

(Pb) verify Reciprocity Theorem of the ckt shown?

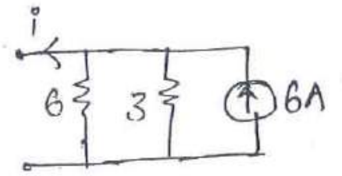


Sol:- $i_{3\Omega} = 6 \times \frac{6}{6+3}$
$= \underline{4\,A}$

Case(i)



Case(ii):



$\frac{Res}{Exc} = \frac{4}{6} = \frac{2}{3}$

$\frac{Res}{Exc^n} = \frac{0}{6} = 0$

$\underline{i = 0}$....

Not satisfies

Note:-

for first pblm

1) $\frac{Res^n}{Exc^n} = \frac{i}{V_S} \rightarrow$ mho

for second pblm

2) $\frac{Res}{Exc} = \frac{V}{I_S} \rightarrow \Omega$

for 3rd pblm

3) $\frac{Res}{Exc} = \frac{i}{I_S}$ } No units

similarly

4) $\frac{Res}{Exc} = \frac{V}{V_S}$

[Only for first TWO cases we can apply the Reciprocity theorem. for last two cases Reci theo. not applicable.]

Note:-

* To apply the Reciprocity Theorem unit of Response to Excitation should be either Mho (or) ohms.
* while applying Reciprocity theorem ckt should consists of only one independent source.
* When the N/W is having any dependent sources Reciprocity theorem can not be applied.

(Pb) When given N/W satisfy the Reciprocity find the value of I?

Sol:- According to Reciprocity theorem Ratio of Response to Excitation is constant. so

ckt 1:
$\frac{2}{10} = \frac{1}{5}$

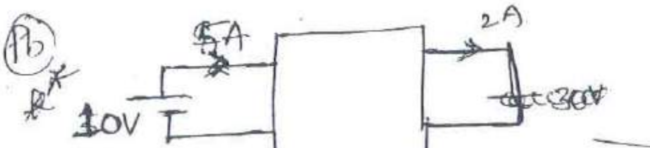
for ckt 2:-
$\frac{I}{V} = \frac{I}{30} = \frac{1}{5}$
$\Rightarrow \underline{I = 6\,A}$

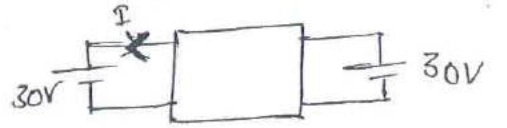
Now come to direction

$\underline{I = -6\,A}$ ... since Actually the

direction is 

(Pb) When Given N/W satisfy the Reciprocity findout I?

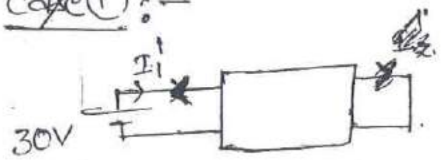




Sol:-

$$\frac{\text{Response}}{\text{excitation}} = \frac{2}{10}$$

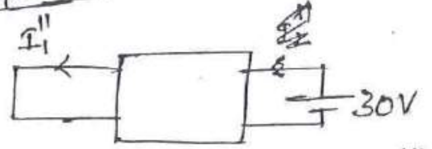
case (i):-



$$\frac{\text{Response}}{\text{excitation}} = -\frac{I_1'}{30} = \frac{5}{10}$$

$$\Rightarrow I_1' = -15$$

case (2):-



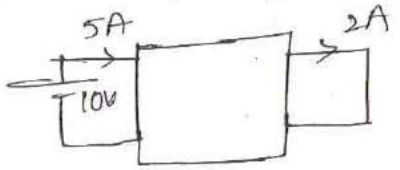
$$\frac{\text{Response}}{\text{excitation}} = \frac{I_1''}{30_3} = \frac{2}{10}$$

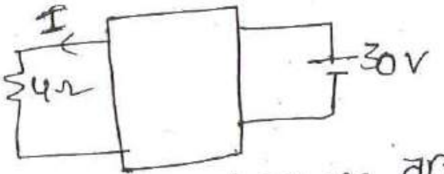
$$\Rightarrow I_1'' = 6A$$

$$\therefore I = I_1' + I_1'' = 6 - 15 = \underline{-9A}$$

This is done by Superposition theorem & Reciprocity Theorem.

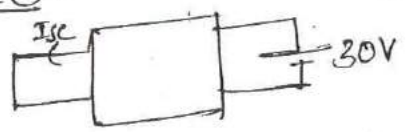
(Pb) When Given N/W satisfies the Reciprocity find I?





Sol:- To find out I, load res. is s.c. so here we are using Norton's & Reciprocity Theorems.

case (i):-

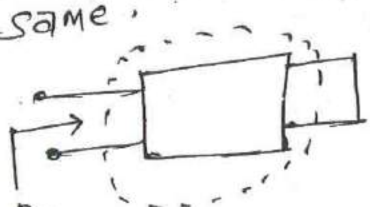


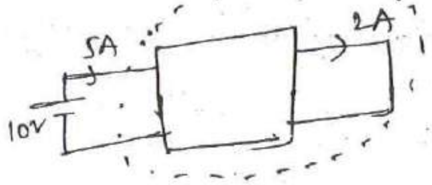
$$\frac{I_{sc}}{30} = \frac{2}{10}$$

$$\Rightarrow \boxed{I_{sc} = 6A}$$

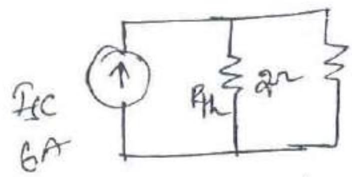
case (ii):-

When ever physical connections are same ⇒ ckt elements are same.



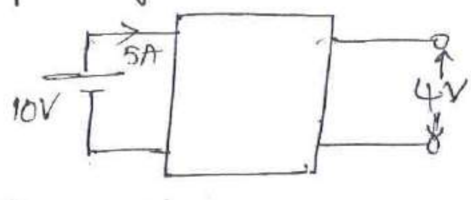


$$R_{th} = \frac{10}{5} = 2\Omega$$



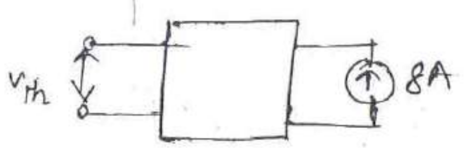
$\therefore I_{4\Omega} = \cancel{6} \times \frac{2}{\cancel{6}} = 2A$

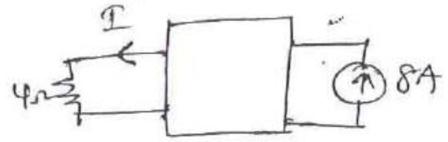
(Pb) When Given N/W satisfy the Recipsiocity find the value of I ?



Sol:-

Case(i):-



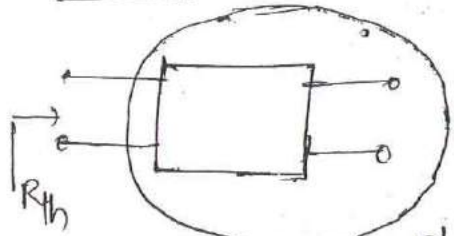


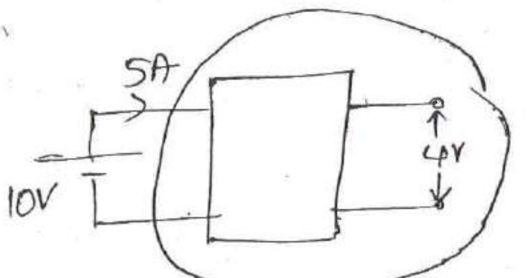
$\frac{\text{Response}}{\text{Excitation}} = \frac{V_{th}}{8} = \frac{4}{5}$

case from original N/W the excitation is 10V. Response is 4V. So Reciprocity Theorem not satisfies. The second N/W Excitation is 8A. so we are taking 5A as Excitation since in the Pblm they given Reciprocity Theorem is satisfied.

$\Rightarrow V_{th} = \frac{32}{5}$ volts

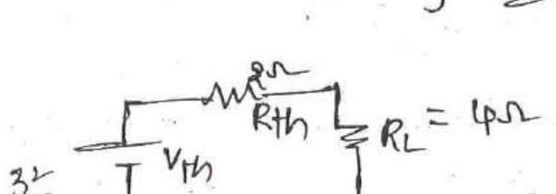
case(ii):-





physical Connections are same.

so $R_{th} = \frac{10}{5} = 2\Omega$...



Note: Here we are using Reciprocity & Thevenin's Theorem.

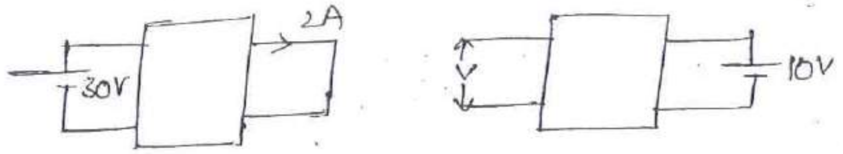
$I_{R_L} = \frac{(32/5)}{6}$

$= \frac{32}{30} = \frac{16}{15} A$ ...

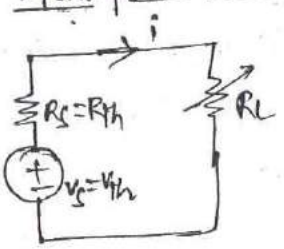
Maximum Power Transfer theorem :-

H.W When Given N/W satisfies the Reciprocity find the value of V?

(a) 2V (b) 1V (c) 3V (d) 4V



Max^m power Transfer theorem :-



$$i = \frac{V_s}{R_s + R_L}$$

$$P_L = i^2 R_L$$

$$P_L = \left(\frac{V_s}{R_s + R_L}\right)^2 \cdot R_L \rightarrow (1)$$

Differentiate eq (1) w.r.to R_L & Equate to zero.

$$\boxed{R_L = R_S} \; //...$$

$$\boxed{R_S = R_L} \; \times$$

$$P_{max} = \frac{V_s^2}{(R_L + R_L)^2} \cdot R_L$$

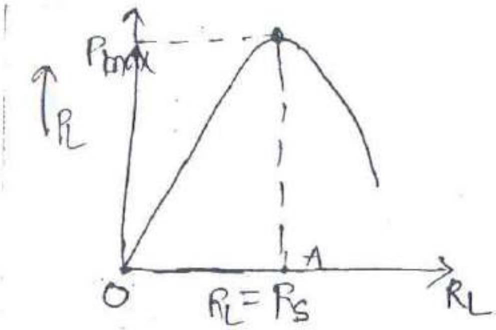
$$\boxed{P_{max} = \frac{V_s^2}{4R_L}} \; //..$$

$$\text{Efficiency } (\eta) = \frac{O/P}{I/P} \times 100$$

$$= \frac{I^2 R_L}{I^2 (R_S + R_L)} \times 100$$

$$= \frac{R_L}{2R_L} \times 100$$

$$\boxed{\eta = 50\%}$$



corresponds to OA portion → $R_S > R_L$

$\boxed{\eta < 50\%}$

exactly at $R_S = R_L$ → $\boxed{\eta = 50\%}$

corresponds to $R_L > R_S$ portions

$\boxed{\eta > 50\%}$

ex:

$\eta = \frac{R_L}{R_S + R_L}$

$R_S = 10,\ R_L = 12\Omega$

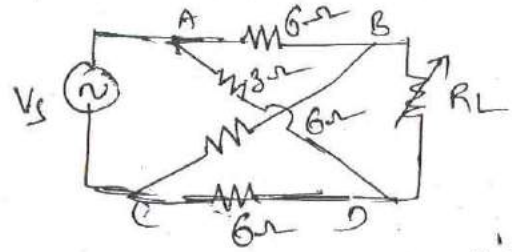
$\Rightarrow \%\eta = \frac{12}{12+10} \times 100$

$= \frac{12}{22} \times 100$

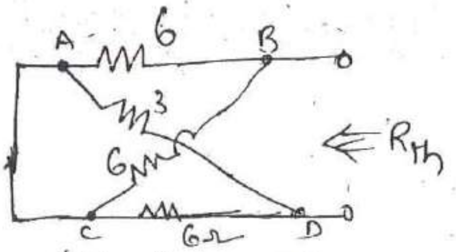
$\eta \Rightarrow 50\%$

Note:-
So Generally while designing any Machine we are choosing as R_s as low as Possible so that 'η' will be high.

(Pb) In the ckt shown at what value of R_L the power delivered from source to load is max.



sol:-

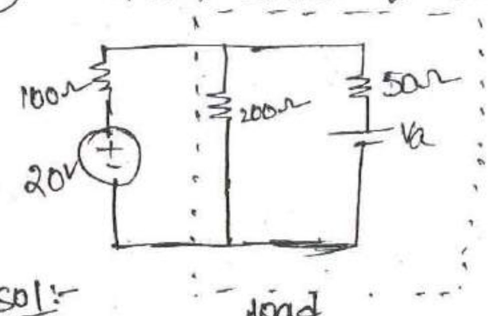


$= (6 \| 3) + (6 \| 6)$

$= 2 + 3$

$= 5\Omega$

(Pb) In the ckt shown at value of 'V_a' Power delivered from source to load is max?

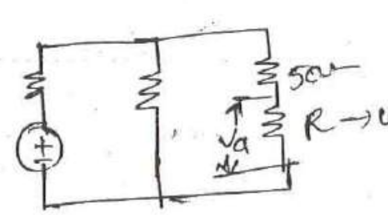


load

(a) 7.5V
(b) 10V
(c) 15V
(d) 20V

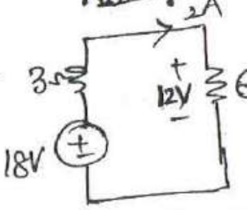
sol:-

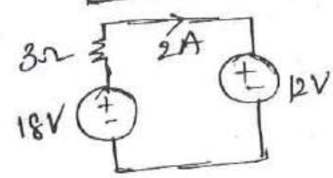
Now that ckt will becomes as



Now $(R_{eq})_{load} = \frac{200(50+R)}{200+50+R}$

Note:-





So res is replaced by a voltage source with that res.

$I = \frac{18-12}{3} = \frac{6}{3} = 2A$

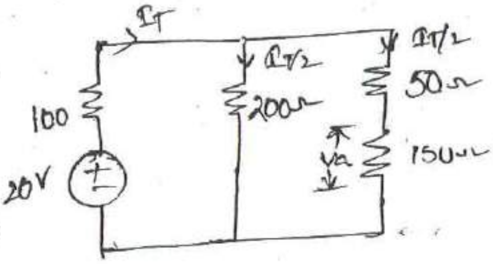
$(R_{eq})_{load} = R_S = 100\,\Omega \rightarrow$ for max^n power Transfer.

$\therefore I_T = \dfrac{20}{R_S + (R_{eq})_{Load}}$

$I_T = \dfrac{20}{100+100} = \dfrac{1}{10}$ A...

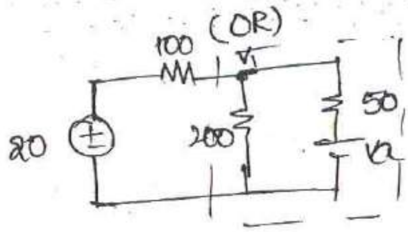
$\therefore (R_{eq})_{load} = \dfrac{200\,(50+R)}{250+R}$

$100 = \dfrac{(R+50)\,200}{250+R} \Rightarrow \boxed{R = 150\,\Omega}$



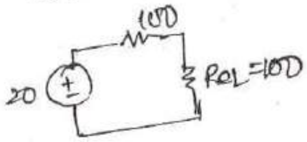
$V_a = \left(\dfrac{1}{2\times 10}\right) \times 150 = \dfrac{15}{2}$
$= 7.5\,V$....

(OR)



for P_{max} ; load R_{eq} must be $100\,\Omega$

So



$\dfrac{20}{200} = 0.1$

$I_{load\,(200\Omega)} = 0.05\,A$ $\qquad 200 \times 0.05 = \underline{10V}$

so $V_1 = 10V$

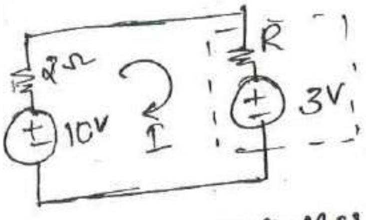
$I_{(50\Omega + V_a)} = 0.05\,A$

$\dfrac{V_1 - V_a}{50} = 0.05$

$\dfrac{10 - V_a}{50} = 0.05 \Rightarrow V_a = 7.5$

(P5) IE Gate 2008

In the ckt shown for what value of 'R' power deliver from source to load is Max!



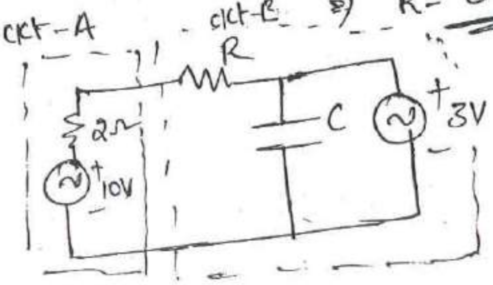
Sol:- ** for max^n power Transfer $R_{eq\,load} = 2\,\Omega$... $\rightarrow$ You have to more concentrate on this.

So $I = \dfrac{10}{2+2} = 2.5\,A$

$-10 + 2(2.5) + R\cdot(2.5) + 3 = 0$

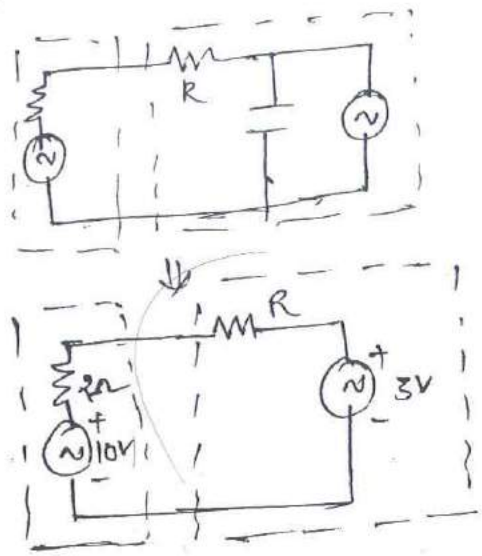
$\Rightarrow R = \underline{0.8\,\Omega}$....

Gate 2012 EE EC (P6)

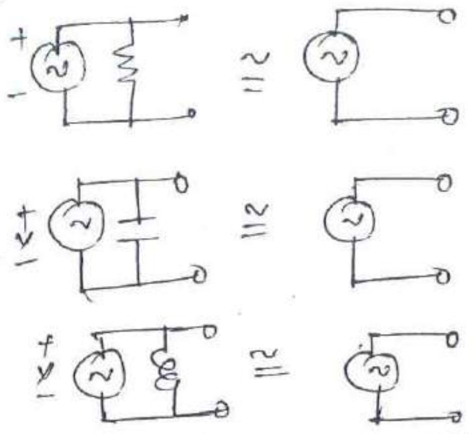


In the figure shown at what value of 'R' Power delivered from ckt 'A' to ckt 'B' is Max^m?

Sol:-



note:-



whenever any element is connected across ideal voltage source, the element doesn't produce any effect while finding load current. so we can eliminate.

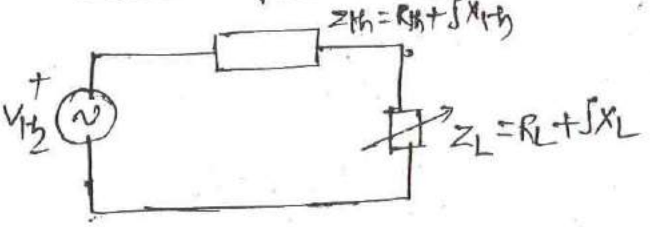
Ans:- $R = 0{\cdot}8\,\Omega$ ...

load $R_{eq} = 2\Omega \Rightarrow I = \frac{10}{4} = 2{\cdot}5A$

$-10 + 2(2{\cdot}5) + R(2{\cdot}5) + 3 = 0$

$\Rightarrow R = 0{\cdot}8\,\Omega$ ...

Maximum Power Transfer Theorem :- (AC)



$$i = \frac{V_{th}}{(R_L + R_{th}) + j(X_L + X_{th})}$$

$$i = \frac{V_{th}}{\sqrt{(R_L + R_{th})^2 + (X_L + X_{th})^2}}$$

$$P_L = i^2 R_L$$

$$= \frac{V_{th}^2 \cdot R_L}{\left[(R_L + R_{th})^2 + (X_L + X_{th})^2\right]} \rightarrow (1)$$

Case (i):-

Both R_L & X_L are variable:-

1. Differentiate eqn (1) w.r.to R_L & equated to zero.
2. Differentiate eqn (1) w.r.to X_L & equated to zero.

we obtain a condn with result of 1st diffn & 2nd diffn,

$$R_L + jX_L = R_{th} - jX_{th}$$

$$\boxed{Z_L = Z_{th}^*}$$

By substituting this into eqn (1), we get

$$\boxed{P_{max} = \frac{V_{th}^2}{4R_L}}$$

$$\boxed{\eta = 50\%}$$ //...

case (ii) :-

Only R_L is variable (X_L is constant) :-

* Differentiate eqn (1) w.r.to R_L & equated to zero.

$$\boxed{R_L = \sqrt{R_{th}^2 + (X_L + X_{th})^2}}$$

(or)

$$\boxed{R_L = Z_{th} + jX_L = R_{th} + j(X_L + X_{th})}$$

here $\boxed{R_L > R_{th}}$

$\eta = 50\%$
$\eta > 50\%$
$\eta < 50\%$

Let check it?

$R_L = 10\Omega$
$R_{th} = 8\Omega$

$\Rightarrow \eta = \frac{10}{10+(8)}$

$= \frac{10}{18} > 50\%$ ...

$$\boxed{\therefore \eta > 50\%}$$ //...

Note: $\% \eta = \frac{R_L}{R_L + R_s} \times 100$ ← valid for both AC & DC.

Since In efficiency calculation only Active Power is consider. There is no reactive component

case (iii) :-

Load impedence is only Resistive :- ($X_L = 0$)

$$P_L = \frac{V_{th}^2 R_L}{(R_L + R_{th})^2 + X_{th}^2} \rightarrow (2)$$

Differentiate eq(2) w.r.to R_L & equated to zero.

$$\boxed{R_L = |Z_{th}|}$$ //...

(or)

$$\boxed{R_L = \sqrt{R_{th}^2 + X_{th}^2}}$$ //... → Always R_L is greater.

$R_L = 10$
$R_{th} = 8$ $\Rightarrow \eta > 50\%$

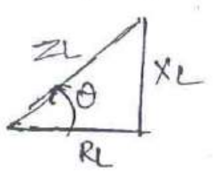
$\left\{\eta \begin{matrix} = \\ > \\ < \end{matrix} 50\%\right\}$ lets check it

so $\boxed{\eta > 50\%}$

Case (iv) :— $Z_L = R_L + jX_L$ ...

Load impedence angle $= \tan^{-1}\left(\frac{X_L}{R_L}\right) = \text{constant}$

Both R_L & X_L are variable, but load impedence angle is constant.



$R_L = Z_L \cos\theta$

$X_L = Z_L \sin\theta$

$$P_L = \frac{V_{th}^2 R_L}{(R_L+R_{th})^2 + (X_L+X_{th})^2}$$

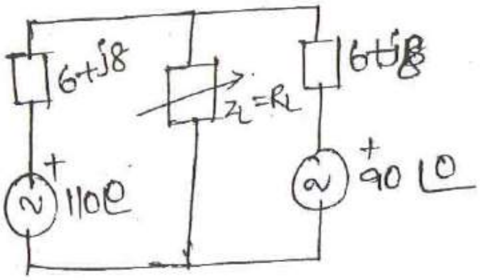
$$= \frac{V_{th}^2 Z_L \cos\theta_L}{(Z_L\cos\theta_L + R_{th})^2 + (Z_L\sin\theta_L + X_{th})^2} \rightarrow (3)$$

Here Z_L only variable, θ_L = constant already we are discuss.

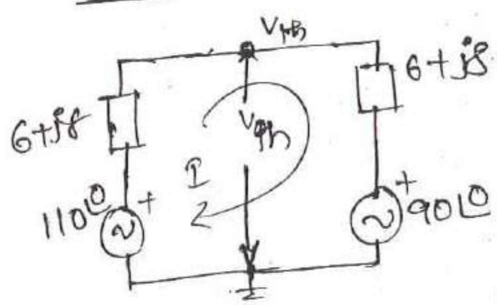
Differentiate eqn (3) w.r.to Z_L & equated to zero.

$$\boxed{Z_L = Z_{th}} \quad ***$$

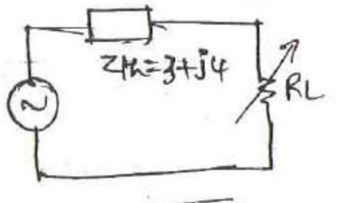
(Pb) Find Maxm Power dissippation in the load impedance.



Thevenin's equ. ckt :—



sol :— note :- $R_L = |Z_{th}|$



$$\frac{V_{th}-110}{6+j8} + \frac{V_{th}-90}{6+j8} = 0$$

$\Rightarrow V_{th} = 100\angle 0$ ...

$Z_{th} = \frac{6+j8}{2}$

$= 3+j4$

$R_L = \sqrt{R_{th}^2 + X_{th}^2}$

$= \sqrt{9+16}$

$= 5\Omega$

$Z_{th} = (6+j8) \parallel (6+j8)$

$$\frac{6+j8}{2} \Leftarrow \frac{(6+j8)(6+j8)}{2(6+j8)}$$

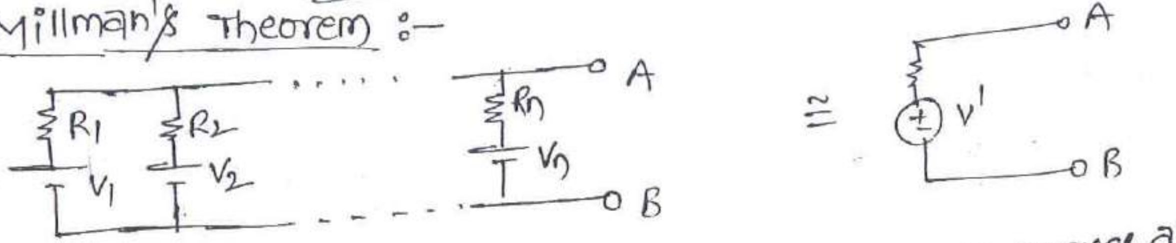
$= 3+j4$ ...

$$= \frac{\cancel{36-64+96j}}{\cancel{12+j16}}$$

$$(i_L) = \frac{100\angle 0}{3+j4+5} = \frac{100\angle 0}{\sqrt{8^2+4^2}}$$

$$P_L = (i_L)^2 R_L$$
$$= \underline{625\,W}\ldots$$

Millman's Theorem :-



$R' = R_{th}$ → Procedure of R' & R_{th} is same. i.e all sources are deactivate.

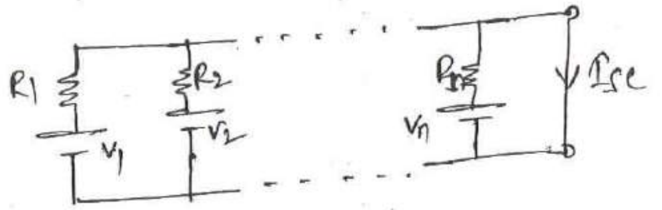
$$\frac{1}{R'} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots + \frac{1}{R_n} \Rightarrow \boxed{R' = \frac{1}{\frac{1}{R_1}+\frac{1}{R_2}+\cdots+\frac{1}{R_n}}}$$

$$\Rightarrow \boxed{R' = \frac{1}{G_1+G_2+\cdots+G_n}}$$

Now

$$V' = I' R'$$

$V_{OC} = I_{SC} R_{th}$

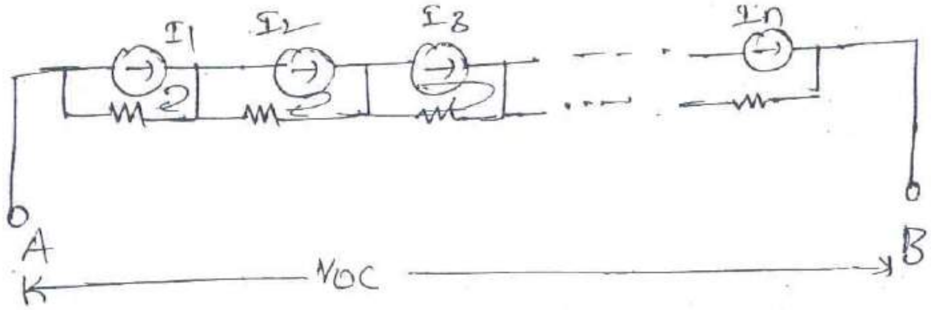


$$I_{SC} = I' = \frac{V_1}{R_1} + \frac{V_2}{R_2} + \cdots + \frac{V_n}{R_n}$$

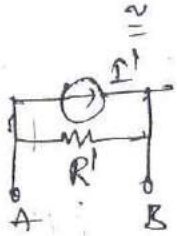
$$I_{SC} = V_1 G_1 + V_2 G_2 + \cdots + V_n G_n$$

$$\boxed{\therefore V' = \frac{\frac{V_1}{R_1}+\frac{V_2}{R_2}+\cdots+\frac{V_n}{R_n}}{\frac{1}{R_1}+\frac{1}{R_2}+\cdots+\frac{1}{R_n}}} \quad \text{(or)} \quad \boxed{V = \frac{V_1G_1+V_2G_2+\cdots+V_nG_n}{G_1+G_2+\cdots+G_n}}$$

That means in millman's theorem also indirectly we are concentrate on thevenin's & Norton's.



$\cong$



$\underline{R' = R_{th}}$ → Deactive all current sources i.e open all current sources,

$$\boxed{R' = R_1 + R_1 + \cdots + R_n}$$ //...

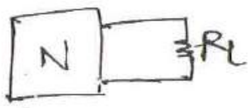
$$I' = \frac{V'}{R'}$$

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

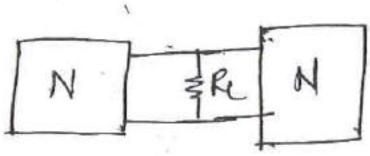
$$V_{oc} = I_1R_1 + \underline{I_2R_2} + \cdots + I_nR_n$$

$$\boxed{\therefore\ I' = \frac{I_1R_1 + I_2R_2 + \cdots + I_nR_n}{R_1 + R_2 + R_3 + \cdots + R_n}}$$ //...

(Pb)
When a complex N/w of '$\underline{N}$' is connected to load res^n, Power dis^n in the Resistor is $\underline{\text{'P' watts}}$.



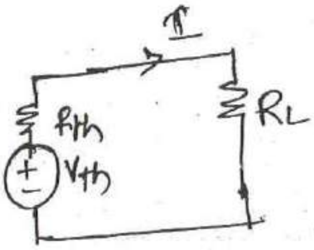
When Two identical complex N/ws of 'N' are connected to same load res^n find power dis^n in the load res^n.



(a) P (b) 2P (c) 4P (d) P (or) 4P

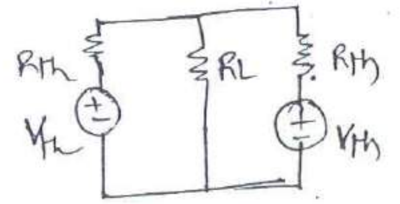
sol:- Any complex N/w can be write by using Thevenin's (or) norton's Theorem.

Now by using Thevenin's ↗

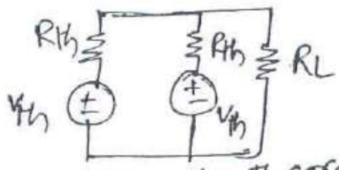


$$I = \frac{V_{th}}{R_{th} + R_L}$$

$$P = I^2 R_L = \left(\frac{V_{th}}{R_{th} + R_L}\right)^2 R_L \rightarrow (1)$$

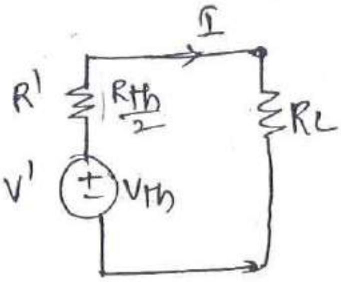


$\Rightarrow$



By using millman's theorem

$$V' = \frac{\frac{V_{th}}{R_{th}} + \frac{V_{th}}{R_{th}}}{\frac{1}{R_{th}} + \frac{1}{R_{th}}} \; \xi \ldots = \frac{\frac{V_{th}}{R_{th}}(1+1)}{\frac{1}{R_{th}}[1+1]} = V_{th} \; // \ldots$$



$$R' = \frac{1}{\frac{1}{R_{th}} + \frac{1}{R_{th}}} = \frac{R_{th}}{2}$$

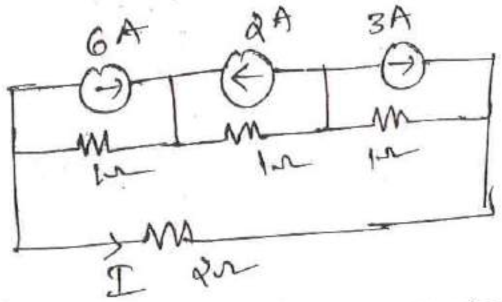
$$I = \frac{V_{th}}{\frac{R_{th}}{2} + R_L} = \frac{2V_{th}}{R_{th} + 2R_L} \; // \ldots$$

$$P = I^2 R = \left(\frac{2V_{th}}{R_{th} + 2R_L}\right)^2 R \quad \rightarrow (2)$$

By comparing Eq(1) & Eq(2) $\Rightarrow$

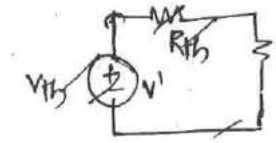
Eq(1) $\neq$ Eq(2), so option a ✗
2Eq(1) $\neq$ Eq(2) " " b ✗
" " c ✗
Eq(2) = 4Eq(1), so Ans is (d) ✓

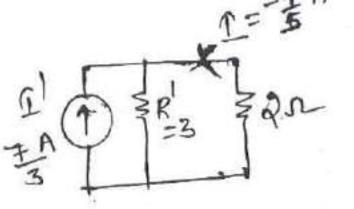
(pb)



find I?

Sol:-





$$I' = \frac{(6)(1) - (2)(1) + (3)(1)}{1+1+1} = \frac{7}{3} \; // \ldots$$

$$R' = R_1 + R_2 + R_3 = 1+1+1 = 3$$

$$I = -\left(\frac{7}{3}\right) \times \frac{3}{3+2}$$

$$I = -\frac{7}{5} \text{ A} \; // \ldots$$

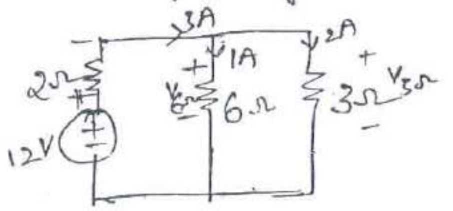
Tellegen's Theorem :-

Tellegen's theorem ~~can~~ applied states that algebraic sum of powers in any circuit at any instant is equal to zero. Tellegen's theorem (linear, Non linear, unidirectional, bidirectional, Time varient & Time invarient elements).

Mathematical expression for Tellegen's theorem

$$\boxed{\sum_{K=1}^{n} V_K i_K = 0} \; // \ldots$$

(P6) Verify Tellegen's Theorem ?



Sol:- $I_T = \frac{12}{4} = 3A$

$I_{6\Omega} = \frac{3\times3}{9} = 1A$

$I_{3\Omega} = 2A$

$\therefore P_{2\Omega} = (3)^2(2) = 18W$ (absorb)

$P_{6\Omega} = (6)(1^2) = 6W$ (absorb)

$P_{3\Omega} = (2)^2(3) = 12W$ (absorb)

$P_{12V} = (12)(3) = 36W$ (deliver)

$\therefore$ $P_{deliver} = 36W$

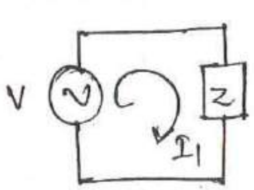
$P_{absorb} = 36W$

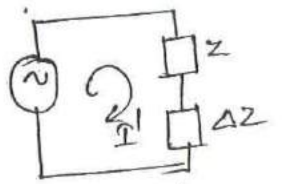
Hence Tellegen's Theorem is verified.

NOTE:- For verification of the Tellegen's Theorem KVL & KCL eqns are used.

*** NOTE:- Tellegen's theorem works based on the Principle of Law of Conservation of Energy.

Compensation Theorem :-



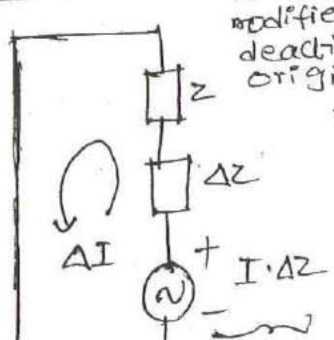


$I = \frac{V}{Z}$ $\qquad$ $I^1 = \frac{V}{Z+\Delta Z}$

Change in current $\Rightarrow \Delta I = I - I^1$ (CW, CW; so CW)

modified ckt :-

To draw the modified ckt deactive all original sources



compensation emf (or) opposing emf

where $\left(\begin{matrix} I > I^1 \\ I < I^1 \end{matrix}\right)$ lets check.

let $z = 3+j4$

(i) $\Delta z = j2$

$(z+\Delta z)\uparrow \Rightarrow I^1\downarrow$

(ii) $\Delta z = -j3$

$\therefore (z+\Delta z)\downarrow \Rightarrow I^1\uparrow$

so I & I^1 relation depends on change in impedance.

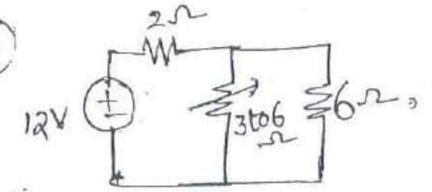
so $\boxed{\Delta I = |I - I^1|}$ //...

The compensation emf circulates the current in ACW.

$\Delta I = -\frac{I\Delta Z}{Z+\Delta Z}$ //...

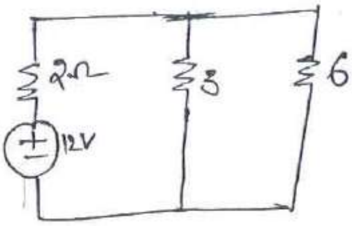
since actually from I & I^1, ΔI CW, but here ACW, so -ve sign is taken.

(13)



find change in Current in the 2Ω & 6Ω resistor when Resistance in the variable branch is changed from 3 to 6Ω.

Sol:- step(1):- find original Current circulating in the variable branch.

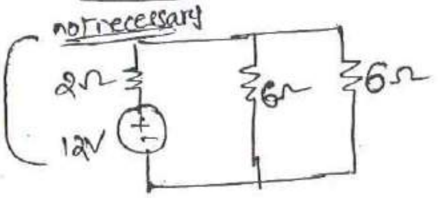


$I_T = \frac{12}{R_{eq}} = \frac{12}{4} = 3A$...

$I_{3\Omega} = \frac{3 \times 6}{3+6} = 2A$

step(2):- find compensation EMF.

not necessary

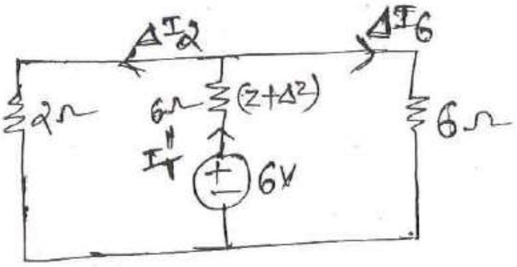


$I' = \frac{12}{R_{eq}} = \frac{12}{(6||6)+2} = \frac{12}{5} = 2.4A$

Now compensation emf $= I(\Delta Z) = (2)(6-3) = 6V$...

Step (3):- Develope modified circuit.

While developing modified ckt deactivate all the original sources & connect the compensation emf in series to variable branch.



$R_{eq} = (6||2) + 6 = \frac{12}{8} + 6$...

$I_T' = \frac{6}{R_{eq}}$

$\Delta I_2 = I_T' \cdot \frac{6}{6+2}$

$= \frac{6}{R_{eq}} \times \frac{6}{6+2}$

$= \frac{6}{(12/8+6)} \times \frac{6}{8}$

$= \frac{36}{12+48} = \frac{36}{60} = \frac{6}{10} = 0.6$

$\Delta I_6 = I_T' \cdot \frac{2}{2+6}$

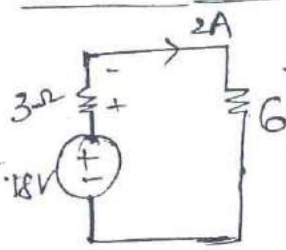
$= \frac{6}{(\frac{12}{8}+6)} \cdot \frac{2}{8}$

$= 0.2A$

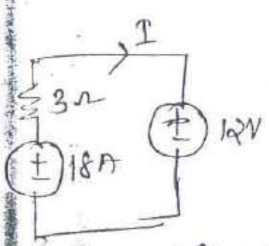
$I_T' = 0.8A$...

NOTE:- In the bridge Circuits to obtain Null deflection in the Galvonometer Compensation Theorem is used.

Substitution Theorem:-



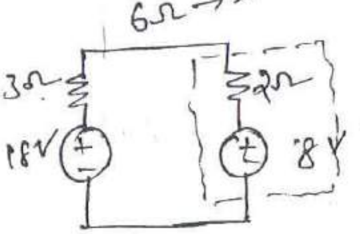
$\Rightarrow$



$I = \frac{18-12}{3} = 2A$ ...

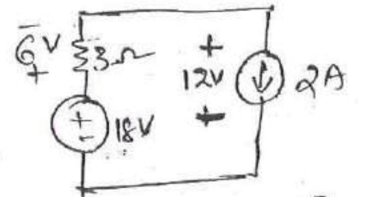
6Ω resistor is replaced by equ voltage (drop) & vice versa.

$6\Omega \rightarrow 2\Omega + 4\Omega$



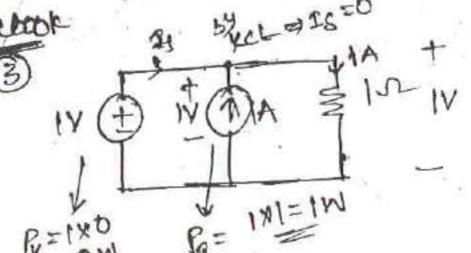
$I = \frac{18-8}{6} = 2A$ ...

resistance is replaced by its equ current source



Workbook Page (3)

Q:1

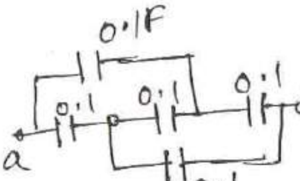


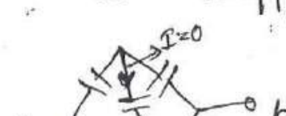
$P_V = 1 \times 0 = 0W$, $P_I = 1 \times 1 = 1W$

$P_R = I^2 R = 1^2 \times 1 = 1W$

Ans :- b

Q:2 $C_{eq} = \frac{0.1}{2} + \frac{0.1}{2} = 0.1F$ since bridge balance.

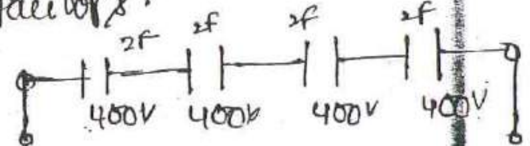




Q:3:-

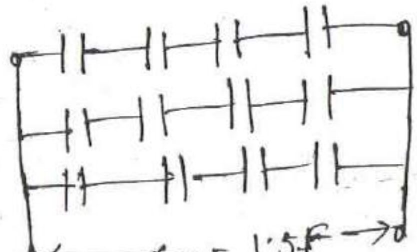
each capacitor rating, 2μF & 400V

for getting 1600V we require 4 series Capacitors.



$C_{eq} = 0.5$

for getting 1.5F we connect 3 parallel connections.



& V = 1600V

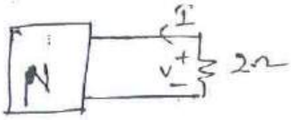
Ans : (a)

12 Capacitors required.

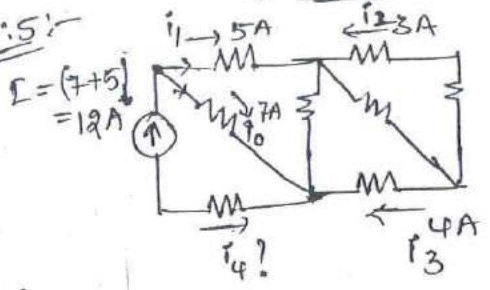
Q:4 $v = 4I - 9$

$-2I = 4I - 9$

$\Rightarrow \underline{I = 1.5\text{ A}}$

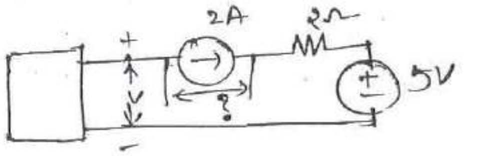


Q:5:-



$\underline{i_4 = -12A}$ ...

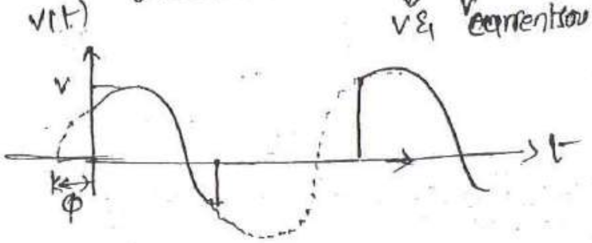
Q:6



In this ckt voltage across current source is unknown. there by it is not possible to find out V_4.

One eqn, Two unknowns, is not possible.
V & $V_{\text{current source}}$.

Q⑦



Sol: $V_{avg} = \frac{1}{2\pi}\left[\int_0^{\pi} V_m \sin(\omega t+\phi)\, d\omega t + \int_{\pi}^{2\pi} 0\right]$

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

$= \underline{\frac{V_m \cos\phi}{\pi}}$ ...

Q:⑧

$i^2R = 18W \rightarrow ①$

$\frac{v^2}{R} = 4.5 \rightarrow ②$

since $\boxed{v = I}$ → given in pblm

$\frac{i^2}{R} = 4.5 \rightarrow ③$ from ① & ③ $\Rightarrow$

$i^2 R = 18W$

$(4.5R)R = 18W$

$R^2 = \frac{18}{4.5}$

$\Rightarrow R = \sqrt{4} = \underline{2\,\Omega}$ ...

$\therefore i^2 = (4.5)(2)$

$= 9$

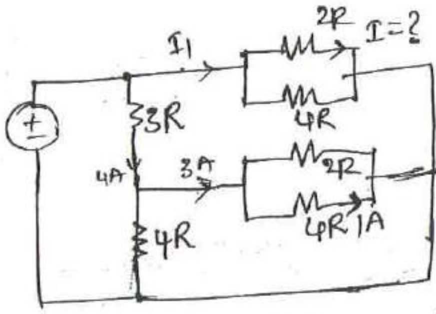
$i = \sqrt{9} = \underline{3\,A}$ ..

Q:⑨

$\frac{P_{dc}}{P_{ac}} = \frac{I_{avg}^2 \cdot R}{I_{rms}^2 R}$

$= \frac{\left(\frac{2I_m}{\pi}\right)^2}{\left(\frac{I_m}{\sqrt{2}}\right)^2} = 8/\pi^2$

Q:⑩



1:2
2:1

$I_{2R} = 2A$

$\underline{I_T = 3A}$.

$I \cdot \left(\frac{4}{\left(\frac{4\times 2}{4+2}\right)+4}\right) = 3$

$I\left[\frac{4\times 3}{4+12}\right] = 3$

$\Rightarrow I = \frac{3\times 16}{4\times 3} = 4A$

$$\frac{I\left(\frac{2\times4}{2+4}\right)}{\left(\frac{8}{6}\right)+\frac{9}{3}} = 4$$

$$I = \frac{(4)\left(\frac{8+18}{6}\right)}{\left(\frac{8}{6}\right)}$$

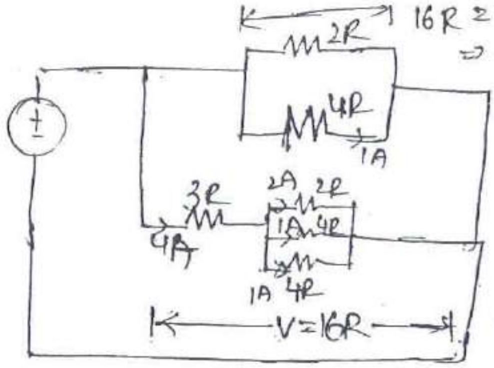
$$= \frac{4(26)12}{8}$$

$$I = 13A$$

$I_1 = 13 - 4 = 9A$

$\therefore I_{2R} = 9 - 1 = 8A \ldots$

(or)



$16R \geq V$
$\Rightarrow I = \frac{V}{2R}$
$= \frac{16R}{2R}$
$= 8A$

Q:12

$$I = \sqrt{(12)^2 + (16)^2}$$
$$= \sqrt{144+256}$$
$$= 20A$$

Q:11

sol:- $R = 10\Omega$; $|X_L| = 20\Omega$, $|X_C| = 20\Omega$

$V_{rms} = 200$ Volts

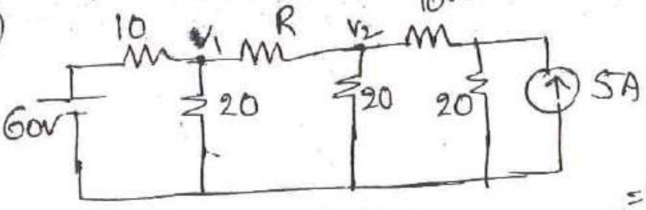
$Z = R + j(X_L - X_C) = R + j(20-20) = R$

$Z = R = 10\Omega$

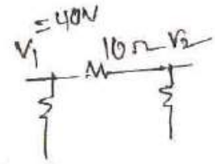
$$I = \frac{V}{Z} = \frac{V}{R} = \frac{200}{10} = 20A$$

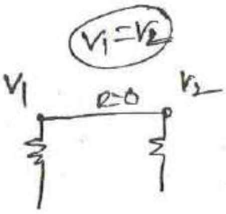
$V_C = -jX_C$
$= (20)(20)\angle{-90}$

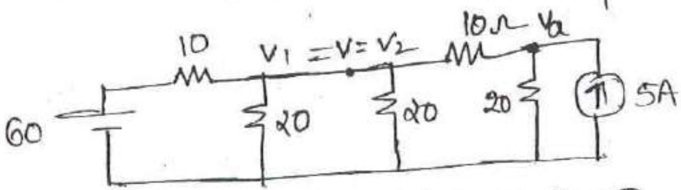
Q:13



sol:- $V_1 = 40$ when $R = 10\Omega$
when $R = 0 \Rightarrow V_2 = ?$







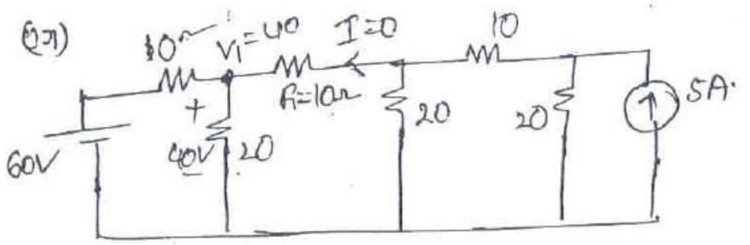
$$\frac{V-60}{10} + \frac{V}{20} + \frac{V}{20} + \frac{V - V_a}{10} = 0$$

$$\frac{V_a}{20} + \frac{V_a - V}{10} = 5$$

$$\frac{V_a}{20} + \frac{V_a}{10} - \frac{V}{10} = 5$$

$\frac{V_i}{10} = 5$

(27)



for first loop :- $-60 + 10I + 40 = 0$

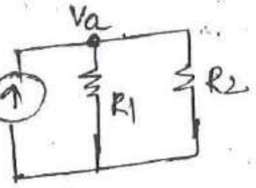
$\Rightarrow I = 2A$

so $R = 10\Omega$ (or) 0Ω (or) 100Ω any value, $I = 0$.

so $V = 40V$....

Q(14)

sol:



$I = \frac{V_a}{R_1} + \frac{V_a}{R_2}$

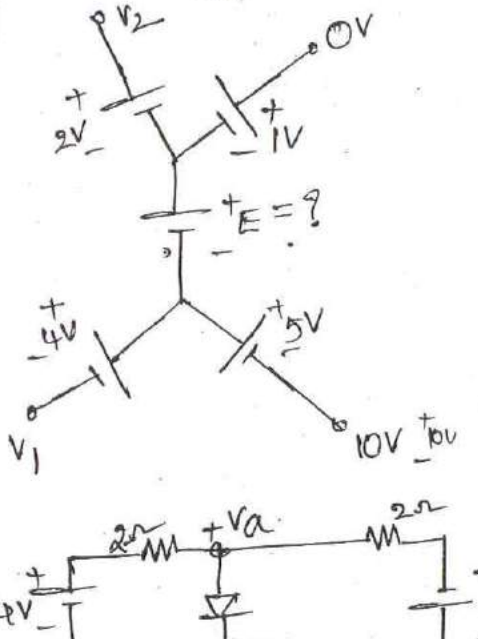
$I = \frac{2V_a}{2R_1} + \frac{2V_a}{2R_2}$ should be double....

Q: (16)

$I_L = e^{at} + e^{bt}$

$V = L\frac{di_L}{dt} \Rightarrow V = ae^{at} + be^{bt}$...

Q: (17)



find E = ?

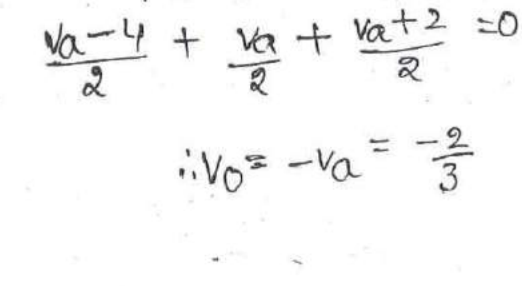
sol:- $-V_1 - 4 + 5 + 10 = 0$

$\Rightarrow V_1 = 11V$....

$0 + 1 + E + 5 + 10 = 0$

$E = -16V$....

Q: (18)

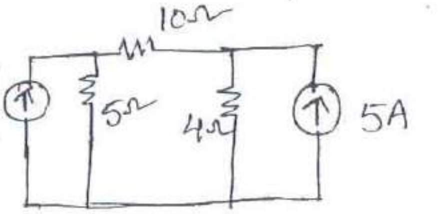


$v_0 = ?$

sol:- $\frac{V_a - 4}{2} + \frac{V_a}{2} + \frac{V_a + 2}{2} = 0 \Rightarrow V_a = \frac{2}{3}$

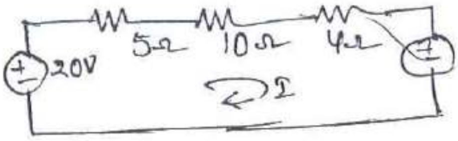
$\therefore V_0 = -V_a = -\frac{2}{3}$

Q:(19)



Find P_{dis} in 5Ω ?

sol:-

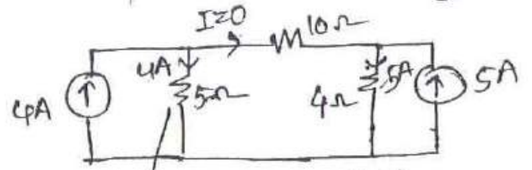


$I = \frac{+20-20}{4+10+5} = 0$ //...

so $I_{10\Omega} = 0$ ...

from this we can say $I_{5\Omega} = 0$
$\Rightarrow P = 0$

But this Analysis is wrong. source Transformation therem is obtained only for R_L, not for R_{int}.



$P = 4^2 \times 5 = 80W$ ...

By using source Transformation response is obtained in the load resistor, but not in the internal resistor.

Q:(20)

sol:- $-24 + 1i - 2V_b + 3i + 4i = 0$

$-24 + 1i - 2(3i) + 3i + 4i = 0 \Rightarrow i = 4A$ ...

$\Rightarrow V_b = 12V$

Q(21)

sol:- $V_{6\Omega} = 50 \times \frac{6}{13}$; $V_{7\Omega} = 50 \times \frac{7}{13}$

$\therefore V_R = 50 \times \frac{7}{13}$

$\therefore 4A = \frac{50 \times 7/13}{R} \Rightarrow R = 3.5\Omega$ (12.5)

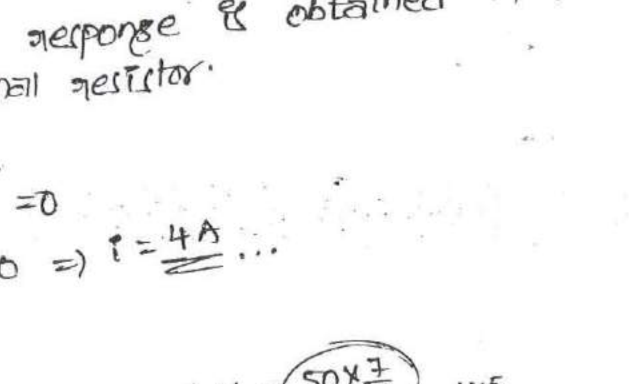
Q:(22)

When impedences of equal values transformed from Δ to Y, impedence decreased by 3 times.

Q:(23) Ans : d

Q:(24) —

Q:(25)



$\frac{dq}{dt} = i$

$\Rightarrow q = \int_0^{5\mu s} i\, dt$

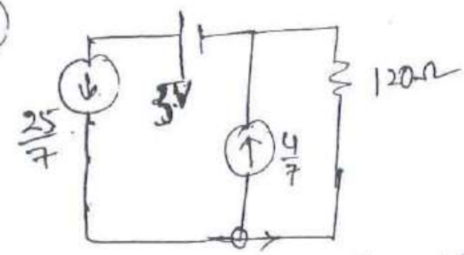
0 to 3μs :- $\frac{1}{2} ab = \frac{1}{2}(3)(5) = 7.5\,\mu C$

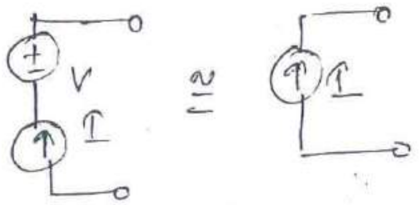
3 to 4μs :- shape is trepizoidal. so $= \frac{1}{2}(5+3)1$
$= 4\,\mu C$

4 to 5μs :- $= \frac{1}{2}(1)(1) + (1)(3)$
$= 0.5 + 3 = 3.5$ ..

Total Charge:
$7.5 + 4 + 3.5$
$= 15\,\mu C$ ..

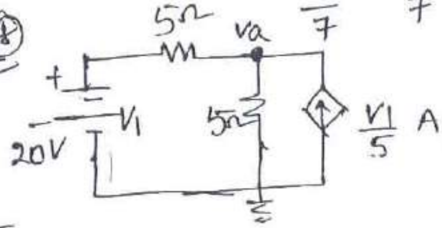
Q (26)





$$\frac{25}{7} - \frac{4}{7} = \frac{21}{7} = 3A.$$

Q: (28)



$\longrightarrow P = V_a \times \left(\frac{V_1}{5}\right)$

$= 20 \times 4 = 80W$ · Delivers

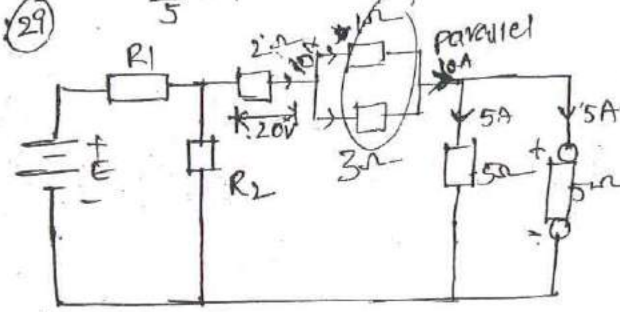
Sol:-

$$\frac{V_a - 20}{5} + \frac{V_a}{5} = \frac{V_1}{5}$$

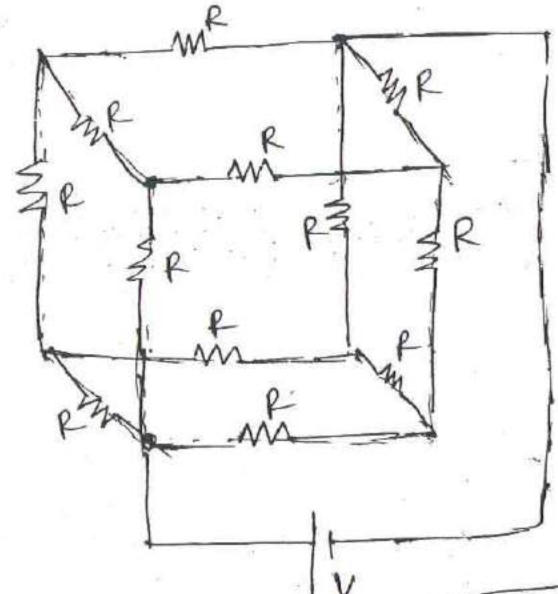
Since $V_1 = 20$ $\Rightarrow$ $\underline{\underline{V_a = 20V}}$

$\frac{V_1}{5} = 4$

Q (29)



Q: (30)



$\boxed{R_{eq} = \frac{5}{6} R}$ $\boxed{L_{eq} = \frac{5}{6} L}$

$\boxed{C_{eq} = \frac{6}{5} C}$

Sol:-

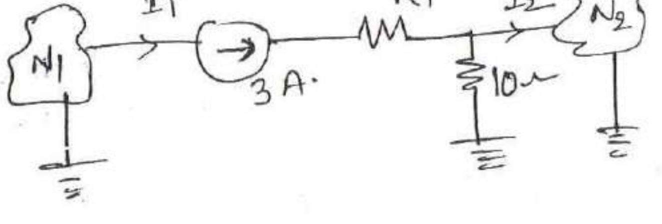
$V_{20\Omega} = 20V$

$\cancel{V_x}\ \frac{9}{9+2} = 20V$

$\Rightarrow \cancel{V_x} = \frac{20(11)}{9} = V_{R_2}$

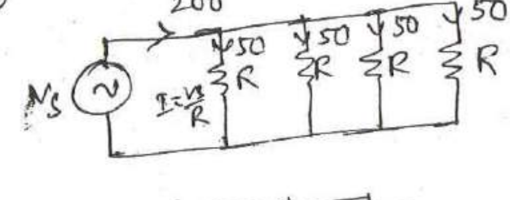
Now $V_{9\Omega} = \frac{20(11)}{9} \cdot \cancel{(9)}$

Q (32)

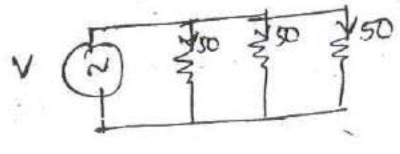


For any value of R
$\underline{\underline{I_2 = 2A}}$

Q (33)



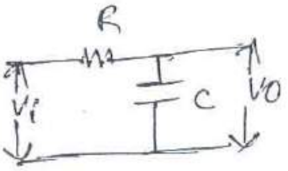
I_{branch} = remains uneffected.



why don't we current source here?

reason:- our practical system source is voltage source not current source. so always we are taking voltage source. if current source is taken it will changes.

Q: 34



Sol: $V_i(t) = \sqrt{2}\sin 1000t$

$RC = 1\,ms$

$$\frac{V_0(s)}{V_i(s)} = \frac{1}{RCs+1}$$

$$= \frac{1}{(1\times10^{-3})j\omega+1}$$

$$V_0(s) = V_i(s)\cdot\frac{1}{10^{-3}j\omega+1}$$

$$= V_i(s)\frac{1}{10^{-3}j(1000+1)}$$

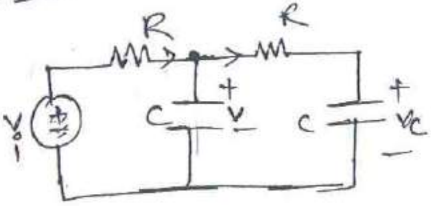
$$= V_i(s)\,\frac{1}{1+j1}$$

$$= V_i(s)\,\frac{1}{\sqrt{2}}\angle -45^\circ$$

$$V_0(t) = \cancel{\frac{\sqrt{2}}{\sqrt{2}}}\sin(1000t-45^\circ)$$

$$= \sin(1000t-45^\circ)$$

Q: 35



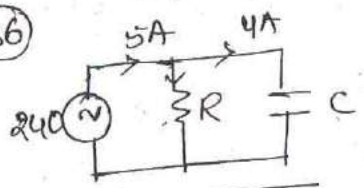
$$V_i = V + V_R \to ①$$

$$V = V_R + V_C \to ②$$

$$V = i\cdot R + V_C$$

$$V = RC\cdot\frac{dV_C}{dt} + V_C$$

Q: 36



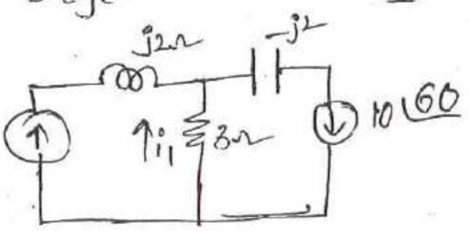
$$5 = \sqrt{I_R^2 + I_C^2}$$

$$I_R = 3A$$

$$\therefore I_R = \frac{240}{R} \Rightarrow R = \frac{240}{3} = 80\,\Omega$$

Q: 37 bridge balance when $R_L = 2\Omega$

Q: 38



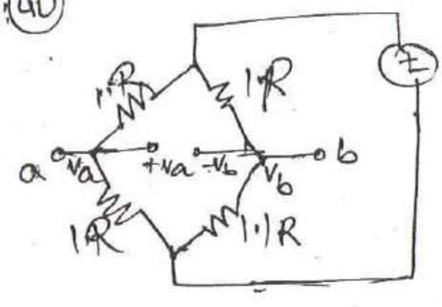
$$I_1 + 5\angle 0 = 10\angle 60$$

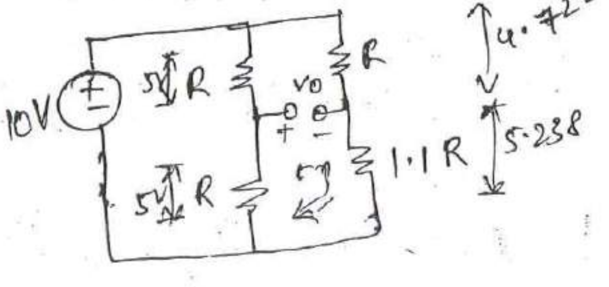
$$\Rightarrow I_1 = 10\angle 60 - 5\angle 0$$

$$= \cancel{10}^{5}\left(\frac{1}{2}\right) + j10\sin(60) - \cancel{5}$$

$$= \frac{10\sqrt{3}}{2}\angle 90$$

Q: 40

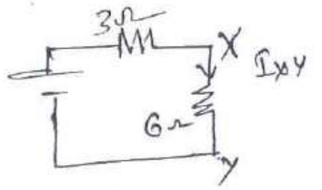


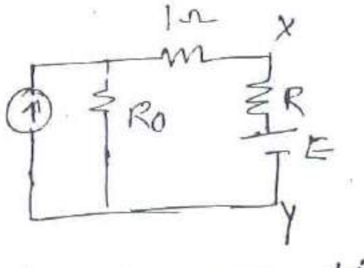


$$-5 + V_0 + 5.238 = 0$$

$$\Rightarrow V_0 = -0.238\ V$$

Q(41)





$I_{xy} = \frac{18}{6+3} = 2A$

$V_{xy} = 6 \times 2 = 12V$

$V_{xy} = RI_{xy} + E$

$12 = 2R + E$ ....

(1) $E = 2V, R = 5\Omega$
satisfies the condition

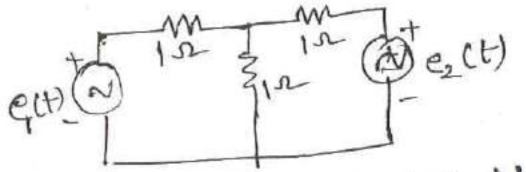
(2) $E = 4V, R = 4\Omega$

(3) $E = 6V, R = 3\Omega$

(4) $E = 10V, R = 1\Omega$

Ans: (c)

Q(42)



$e_1(t) = \sqrt{3}\cos(\omega t + 30^\circ)$

$e_2(t) = \sqrt{3}\sin(\omega t + 60^\circ)$

Sol:-

$e_1(t) = \sqrt{3}\cos(\omega t + 30^\circ)$

$e_2(t) = \sqrt{3}\cos(\omega t + 60^\circ - 90^\circ)$

$$\frac{v_1 - e_1(t)}{1} + \frac{v_1 - e_2(t)}{1} + \frac{v_1}{1} = 0$$

$$\Rightarrow V_1 = \frac{e_1 + e_2}{3} = \frac{\sqrt{3}}{3}\left[\cos(\omega t + 30^\circ) + \cos(\omega t - 30^\circ)\right]$$

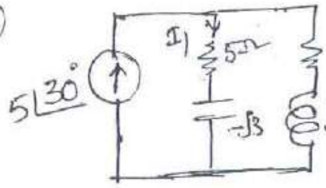
$$= \frac{1}{\sqrt{3}}\left[\cos\omega t \cdot \left(\frac{\sqrt{3}}{2}\right) - \cancel{\sin(\omega t)\left(\frac{1}{2}\right)} + \cos(\omega t)\left(\frac{\sqrt{3}}{2}\right) + \cancel{\sin\omega t\left(\frac{1}{2}\right)}\right]$$

$$= \frac{1}{\sqrt{3}}\left[\frac{2\sqrt{3}}{2}\cos\omega t\right] = \cos\omega t \cdot \text{volts} \ldots$$

Q(43)

By using superposition theorem

Q: (44)



Sol:- $I_1 = 5\angle 30^\circ\left(\dfrac{(5+j3)}{5-j3+5+j3}\right)$

$= \frac{1}{2}\angle 30\,[\,5+j3)$

$= \frac{1}{2}\angle 30\,[\,\frac{1}{2}]\,(\frac{1}{2}+j\frac{\sqrt3}{2}]\,(5+j3)$ ....

$V_{AB} = I_1 \cdot Z_1$

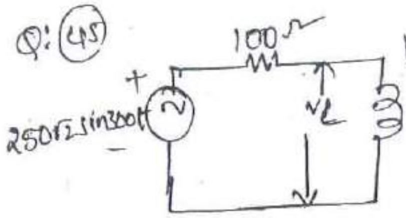
$= \left(\frac{1}{4}+\frac{j\sqrt3}{4}\right)(5+j3)\cdot(5-j3)$

$= \left(\frac{1}{4}+j\frac{\sqrt3}{4}\right)(25+9)$

$= 34\left(\frac{1}{4}+\frac{j\sqrt3}{4}\right)$

$= 17\angle 30^\circ$ ....

Q: (45)



Sol:- $V = \sqrt{V_R^2 + V_L^2}$

$\frac{250\sqrt2}{\sqrt2} = \sqrt{V_R^2 + (150)^2}$

$V_{R_{rms}} = 200\,V$ ....

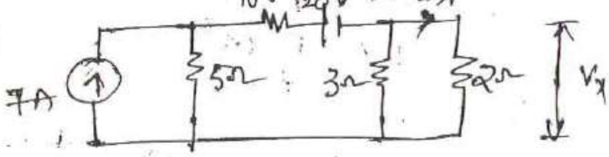
$I = \frac{V_R}{R} = \frac{200}{100} = 2A$ ....

$V_L = I X_L \Rightarrow 150 = 2(\omega L)$

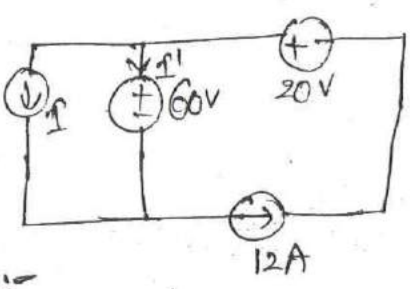
$150 = 2(300 L)$

$L = \frac{1}{4} = 0.25\ H$

Q: (46)



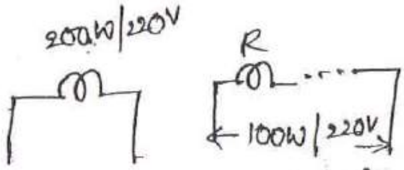
(47) (pb)



Sol:- $I + I' = 12$

$I = 12 - I'$

(48)



$R = \frac{V^2}{R}$

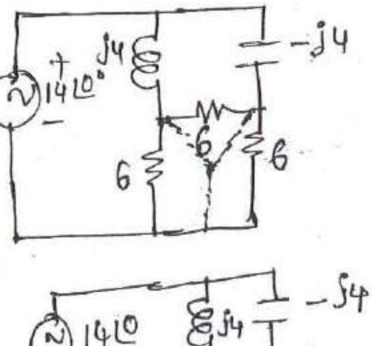
$R = \frac{(220)^2}{200}$

$=$

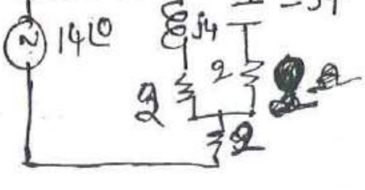
$R_{eq} = \frac{V_{eq}^2}{P_{eq}}$

$= \frac{(220)^2}{100}$

(49)



Sol:-



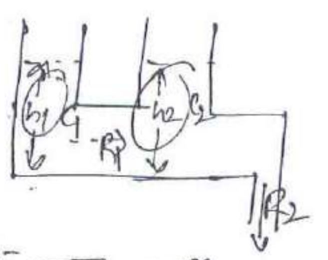
$I = ?$

$$Z_{eq} = 2 + \frac{(2+j4)(2-j4)}{(2+j4)+(2-j4)}$$

$$Z_{eq} = 7\angle 0$$

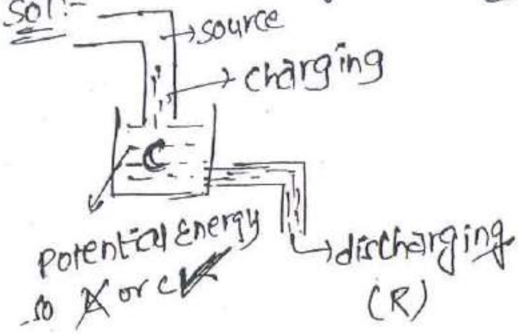
$$I = \frac{14\angle 0}{7\angle 0} = 2\angle 0$$

Q(50) (b)

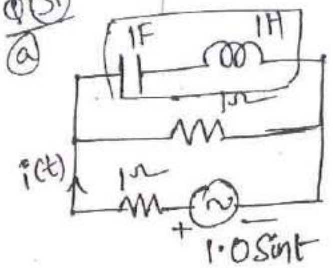


Ans:- (d)

Sol:-



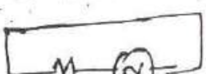
Q(51) (a)



Sol:-

$$Z_1 = j(X_L - X_C)$$
$$= j(\omega L - 1/\omega C)$$
$$= j(1-1)$$
$$= 0$$

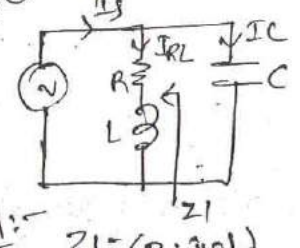
i.e short



$$i = \frac{V}{R_{eq}} = \frac{(1/\sqrt{2})}{1}$$

$$= 1/\sqrt{2}$$

Q: (52) (b)



$V_s = 1\angle 0$

$I_s = 1\angle\frac{2\pi}{4}$ A

$I_{RL} = \sqrt{2}\angle -\pi/4$

Sol:- $Z_1 = (R + j\omega L)$

$$Z_1 = \frac{V_s}{I_{RL}} = \frac{1\angle 0}{\sqrt{2}\angle -\pi/4}$$

$$= \frac{1}{\sqrt{2}}\angle \pi/4$$

$$= \frac{1}{\sqrt{2}}\left[\frac{1}{\sqrt{2}} + \frac{j}{\sqrt{2}}\right]$$

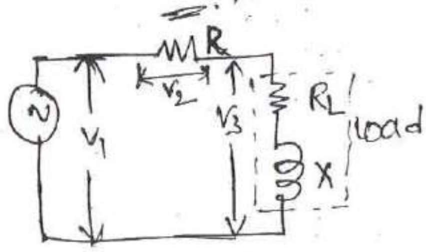
$$= \frac{1}{2} + \frac{j}{2} = R + jX_L$$

$R = \frac{1}{2}\,\Omega$; $X_L = 1/2$

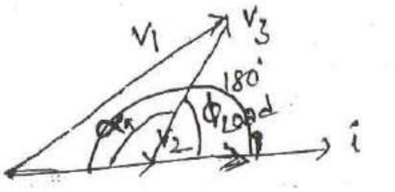
$I_{RL} = \sqrt{2}\angle -\pi/4$

$$\therefore P = I_{RL}^2 \cdot R = (\sqrt{2})^2 \cdot 1/2$$
$$= 1\,W$$

Q(53)



Sol:-



$$V_1 = \sqrt{V_2^2 + V_3^2 \mp 2V_2V_3\cos\alpha}$$

$$220 = \sqrt{122^2 + 136^2 - 2(122)(136)\cos\alpha}$$

$$\alpha = 116.91$$

$\cos(63.08) = 0.45$

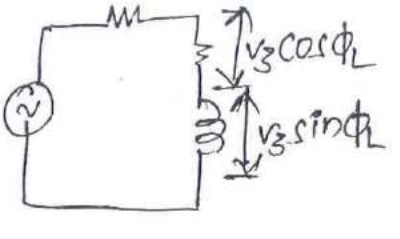
$$\phi_{load} = 180 - 116.91 = 63.08$$

$R_L = 5\Omega$

$V_3 \angle \phi_L = V_3 \cos\phi_L + j V_3 \sin\phi_L$

$V_3\cos\phi_L$ → Active compn → R_L

$jV_3\sin\phi_L$ → reactive component → jX_L

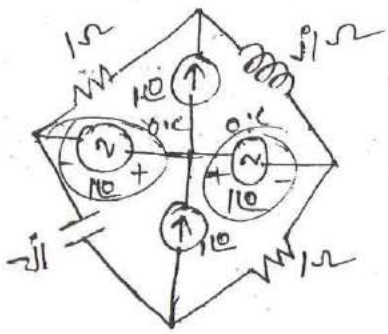


$$\text{Power} = \frac{(V_3\cos\phi_L)^2}{R_L}$$

$$= \frac{[136 \times \cos(63.08)]^2}{5}$$

$$= \frac{(136\times(0.45))^2}{5} = 750\,W$$

Q:55



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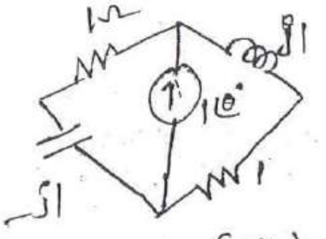


Current is same i.e. entering = leaving so voltage sources O.C.
(or) bridge balance. so diagonal elements are O.C...

$$I_L = \frac{(1\angle 0)(1-j1)}{(1+j1)+(1-j1)}$$

$$I_L = \frac{1-j1}{1+1} = \frac{1-j1}{2}$$

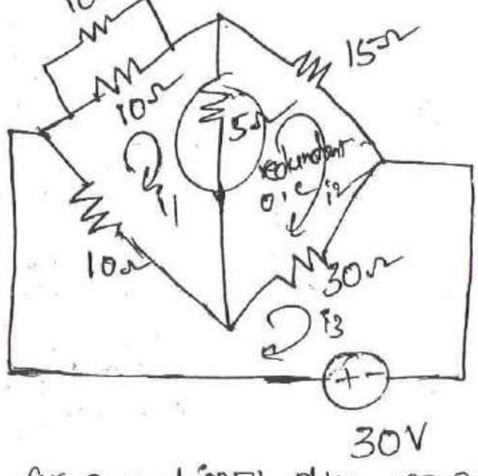
$$= \frac{(1+j1)(1-j1)}{2(1+j1)}$$

$$= \frac{\cancel{2}}{\cancel{2}(1+j1)}$$

$$I_L = \left(\frac{1}{1+j1}\right)A$$

conventional

Q:1 :-



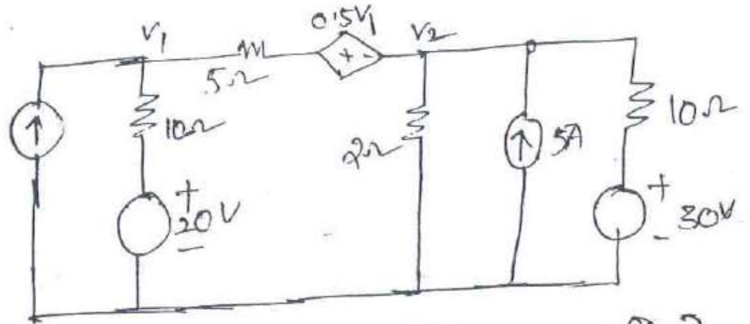
Sol:- $Z_1 Z_4 = Z_2 Z_3$

so 5Ω branch redundent.

$I_{5\Omega} = 0$ ...

for conventional pblm we go for mesh-Analysis for obtaining marks.

Q:②



sol:-

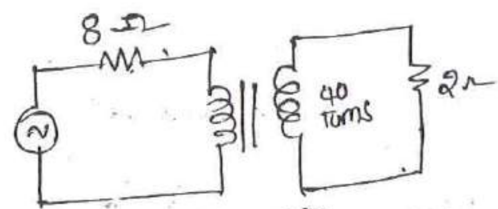
$$\frac{V_1-20}{10} + \frac{V_1 - V_2 - 0.5V_1}{5} = 2 \rightarrow ①$$

$$\frac{V_2 - V_1 + 0.5V_1}{5} + \frac{V_2}{2} + \frac{V_2 - 30}{10} = 5 \rightarrow ②$$

from ① & ②
$V_1 =$
$V_2 =$

Page NO: (24)

Q:1
sol:-



Ideal T/F ...

$\boxed{R_1 = R_2 / k^2}$

$8 = (2)\left(\frac{N_1}{N_2}\right)^2$

$4 = \left(\frac{N_1}{40}\right)^2$

$N_1^2 = (40)^2 \cdot 4$

$\boxed{N_1 = 80}$ //...

(or)

$I_1^2 R' = I_2^2 \cdot R$

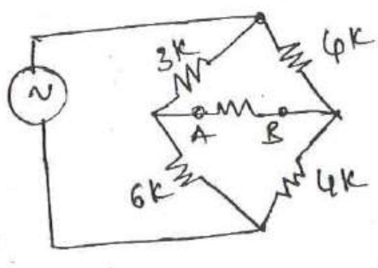
$R' = \left(\frac{I_2^2}{I_1^2}\right) \cdot R$

$R' = \left(\frac{N_1}{N_2}\right)^2 \cdot R$

$8 = \left(\frac{N_1}{40}\right)^2 (2)$

$\Rightarrow N_1 = 80$

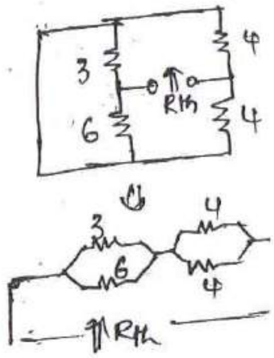
Q:②:-



$R_{th} = (3 \| 6) + (4 \| 4)$

$= \frac{3 \times 6}{3+6} + 2$

$= 4K\Omega$ ....



Q③ 1st statement → valid
2nd " → valid
} but both are independent statements

Ans: (B)

Q④

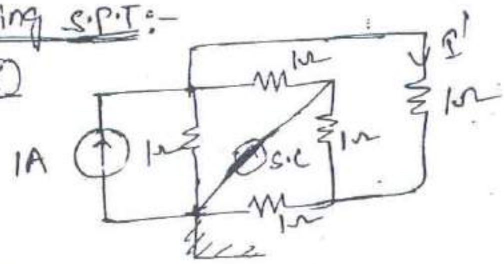
Req in both ckts is same since 'I' same. SO

$$\left[\frac{1}{32R} + \frac{1}{16R} + \frac{1}{8R}\right] = \left[\frac{1}{4R} + \frac{1}{2R} + \frac{1}{R}\right] + R_0$$

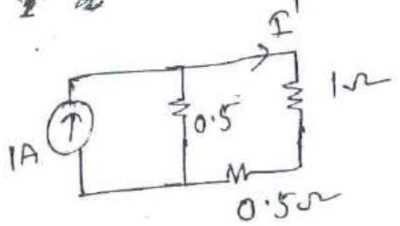
$$\Rightarrow R_0 = 4R \; .....$$

Q(5) By using S.P.T:-

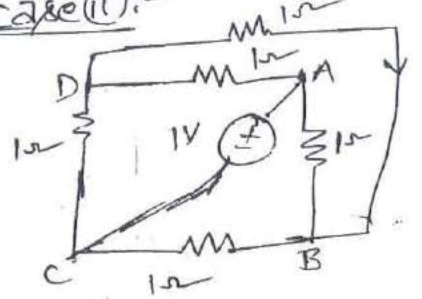
case(i)



$\Rightarrow$



case(ii):-



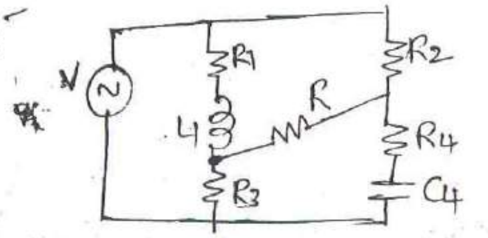
$I'' = 0$

since bridge balance.

$I' = 1 \times \frac{0.5}{0.5+0.15} = \underline{0.25}$ ...

$\therefore I = I' + I'' = 0 + 0.25 = \underline{0.25A}$ ...

Q(6):-



given $I_R = 0$

so bridge is balanced.

$(R_1 + j\omega L_1)\left(R_4 - \frac{j}{\omega C_4}\right) = R_2 R_3$

$\Rightarrow j\omega L_1 R_4 - \frac{j R_1}{\omega C_4}$ is the img part.

so compare both sides img parts

$\Rightarrow \omega L_1 R_4 - \frac{R_1}{\omega C_4} = 0$

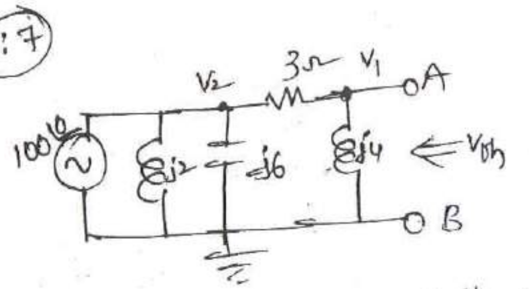
$\omega L_1 R_4 = \frac{R_1}{\omega C_4}$

$\underline{\qquad}$ ....

$\Rightarrow \frac{\omega L_1}{R_1} = \frac{1}{R_4 \omega C_4}$

$\underline{\qquad}$ ...

Q:7



$\underline{V_2 = 100\angle 0}$ ... —(1)

$\frac{V_{th} - V_2}{3} + \frac{V_{th}}{j4} = 0$ —(2)

$\frac{100\angle 0}{j2} + \frac{100\angle 0}{(-j6)} + \frac{100\angle 0 - V_{th}}{3} = 0$

$\Rightarrow V_{th} = \underline{\qquad}$ ...

(or) By voltage devider rule.

$V_{th} = 100\angle 0 \cdot \frac{(j4)}{3 + j4} = j16(3 - j4)$

$\Rightarrow$ ...

Q:(8) $P = \left(\pm\sqrt{P_1} \pm P_2 \pm \sqrt{P_3}\right)^2$

$P_{max} = \left(\sqrt{18} + \sqrt{50} + \sqrt{98}\right)^2$ ...

$= 450W$

for min power you have to take like this. subtract all from max power.

$P_{min} = \left(\sqrt{98} - \sqrt{50} - \sqrt{18}\right)^2$ ...

$= 2W$

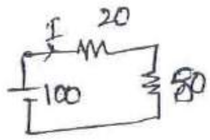
Q:(9)

$V_{OC} = 100V$

$I_{SC} = 5A$

$R_L = 80\Omega$

$\frac{V_{OC}}{I_{SC}} = R_{th} = \frac{100}{5} = 20\Omega$

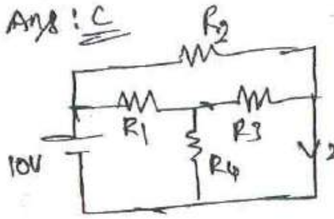


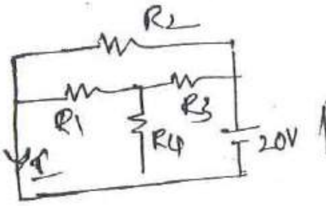
$\frac{100}{80+20} = 1.00A$ ...

$= 1.00A$

Q:(10) Ans : C

Q:(11)



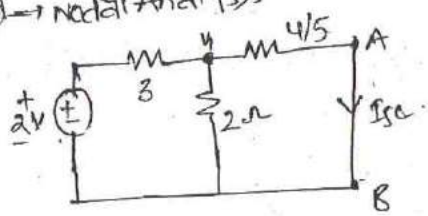


$\boxed{I = 4A}$

Q:(12) Ans : C

Q:(13),(14) → Nodal Analysis

Q(15)



$\frac{V_1 - 2}{3} + \frac{V_1}{2} + \frac{V_1}{4/5} = 0$

$\Rightarrow \frac{V_1}{3} - \frac{2}{3} + \frac{V_1}{2} + \frac{5V_1}{4} = 0$

$\Rightarrow V_1 =$ ...

$\frac{V_1}{4/5} = I_{SC} =$

$R_{eq} = \frac{4}{5} + (2 \| 3)$

$V_{2\Omega} = \frac{(2)(2)}{5}$

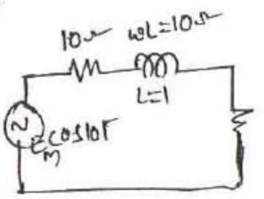
$I_{SC} = (?)$

$\therefore I_{SC} = \frac{(2)(2)}{5} \Big/ 4/5$

$= 1A$ ...

Ans (d) ...

Q:(16)



$R_L = |Z_{th}| = \sqrt{10^2 + 10^2} = 14.14\Omega$

Q:(18) (b)

Q:(19) $V = \frac{(10)\frac{1}{6} + (10)\frac{1}{4}}{\frac{1}{6} + \frac{1}{4}}$

$= 7V$ ...

$R' = \frac{1}{1/6 + 1/4} = 2.4\Omega$

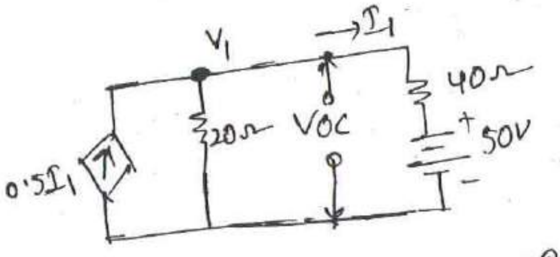
Q:(17)

Sol:

$P_{max} = \frac{(12)^2}{4 \times 2} = \frac{\cancel{12} \times 12}{\cancel{4} \times 2} = 18W$ ...

Q:(20)

$\frac{V_{OC}}{I_{SC}} = ?$



$\frac{V_1 - 50}{40} + \frac{V_1}{20} = 0.5I_1$

but $I_1 = \frac{V_1 - 50}{40}$

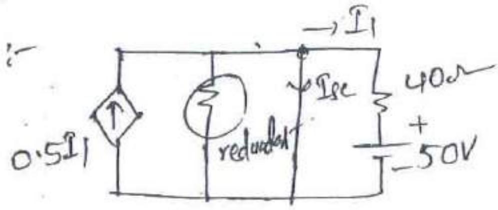
$\Rightarrow \left[0.5\frac{V_1 - 50}{40}\right] + (0.5)\left(\frac{V_1 - 50}{40}\right) + \frac{V_1}{20} * = 0.5\left[\frac{V_1 - 50}{40}\right]$

$\left(\frac{V_1 - 50}{40}\right)0.5 + \frac{V_1}{20} = 0$

$\Rightarrow V_1 =$ ...

$= V_{OC}$

I_{sc} :-



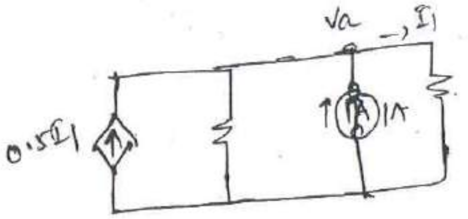
$0.5I_1 = I_{sc} + I_1$

$\Rightarrow I_{sc} = -I_1$

$I_1 = \frac{50}{40} = 1.25A \Rightarrow I_{sc} = -1.25A$

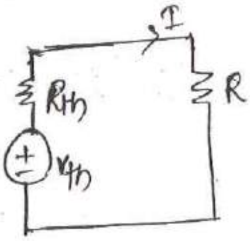
$\frac{V_{OC}}{I_{SC}} = R_{th}$

(or)



Q:(21) Ans:- C

Q:22



$I = \frac{V_{th}}{R_{th}+R} \rightarrow (1)$

from given data

$R=0 \Rightarrow 3 = \frac{V_{th}}{0+R_{th}} \rightarrow (1)$

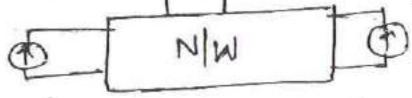
$R=2 \Rightarrow I = \frac{V_{th}}{1+R_{th}} = 1.5 \rightarrow (2)$

from (1) & (2)

$V_{th} = 6V;\ R_{th} = 2\Omega$

$I = \frac{V_{th}}{R_{th}+1} = 6/3 = 2A$ ...

Q:(23)



case(ii)

$I_1 = -8, I_2 = 4$

$V = 0$

$-8K_1 + 4K_2 = 0 \rightarrow (2)$

Case(i) $I_1 = 8, I_2 = 12$

$V = 80$

$8K_1 + 12K_2 = 80 \rightarrow (1)$

from (1) & (2) $K_1 = 2.5$

$K_2 = 5$

$I_1 = I_2 = 10$

$V = ?$

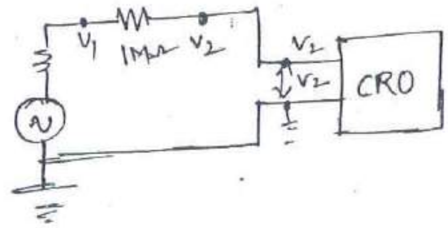
$10K_1 + 10K_2 = V$

$\Rightarrow V = 75V$ ...

Q:(24) C

Q:(25) C

Q: 26



$V_1 = 5$ V
$V_2 = 3$V

$I = \frac{V_1 - V_2}{1M} = \frac{5-3}{1M\Omega} = \underline{2\mu A}$...

voltage across CRO = V_2

$\Rightarrow R = \frac{3}{2} = 1.5 \underline{M\Omega}$...

Q: 27 a

Q: 28 d

Q: 29 $I_L = \frac{10}{1+1} = 5A$

$I_L = I_C\left(\frac{RC}{RC+1}\right)$

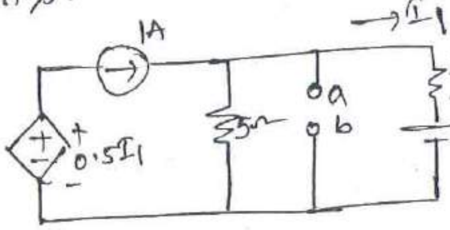
$5 = \frac{I_C RC}{RC+1}$

$\underline{Ans: (b)}$..

Q: 30 Tellegen's theorem

Q: 31 Ans: c

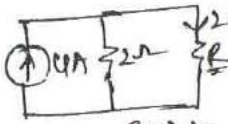
Q: 32



$1 = \frac{V_{th}}{5} + \frac{V_{th} - 10}{5} \Rightarrow \underline{V_{th} = 7.5V}$

$\underline{Ans: (b)}$

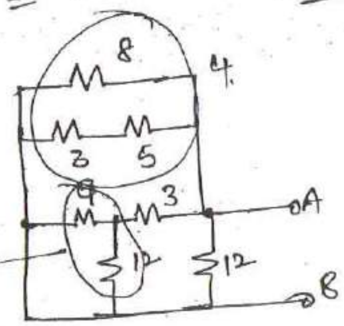
Q: 33 Ans (b)



$\underline{R = 2\Omega}$

Q: 34 $\underline{Ans:- b}$

Q: 35

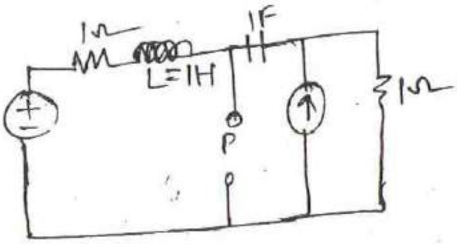


$\Rightarrow \underline{R_{th} = 2\Omega}$

Q: 36 Ans:- (d)

Q: 37 Ans :- (d)

Q: 38



~~Since ...~~

$\Rightarrow Z_{th} = (1+SL) \parallel (1+\frac{1}{CS})$

$= \frac{(1+S)(1+\frac{1}{S})}{(1+S)+(1/S+1)} = 1$

$\underline{Ans\ (a)}$...

Q: 39

case (i)

$E = E_1,\ I = 0 \rightarrow V = 5 = V_{O.C}$

case (ii) :-

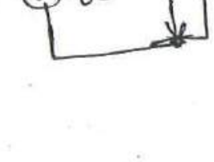
$E = 0,\ I = 1A;\ V = 5$

all the sources are deactivated w.r.to second side V & I both are known

$\Rightarrow R_{th} = \frac{V}{I} = 5\Omega$

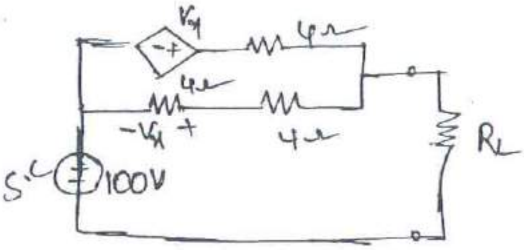
case (iii) :

$E = E_1,\ I \rightarrow 5\Omega$

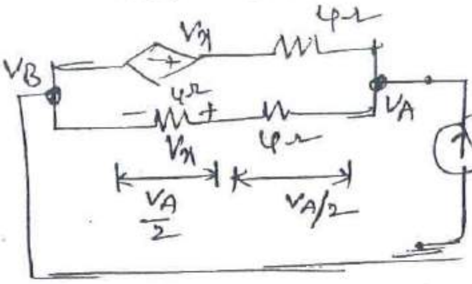


$\underline{V = 2.5V}$

Q: (40)



⇒ w.r.to R_L branch 1 & branch 2 are parallel. So take current source with 1A



$$\frac{V_A - V_x}{4} + \frac{V_A}{8} = 1 \rightarrow (1)$$

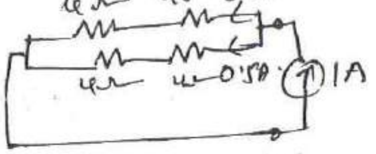
since ⇒ $\boxed{V_A = \frac{V_x}{2}}$

⇒ (1) ⇒ $V_A = \underline{4V}$..

$V_{AB} = V_A - V_B = 4 - 0 = \underline{4V}$

$R_{th} = \frac{V_{AB}}{I_s} = \frac{4}{1} = 4Ω$...

(or) By substitution theorem

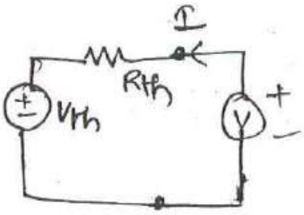


⇒ $V_{AB} = 4V$

$I_s = 1A$

$R_{th} = \frac{4}{1} = 4Ω$

Q: (41)



$$I = \frac{V - V_{th}}{R_{th}}$$

$IR_{th} = V - V_{th}$

$V = V_{th} + IR_{th} \rightarrow (1)$

from given data

$I = 0.2V - 2$

$V = \frac{I}{0.2} + \frac{2}{0.2}$

$= \underline{10 + 5I} \rightarrow (2)$

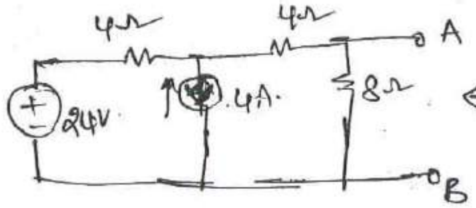
from (1) & (2)

$R_{th} = 5Ω$

$V_{th} = 10V$

Q: (42) Ans: (c)

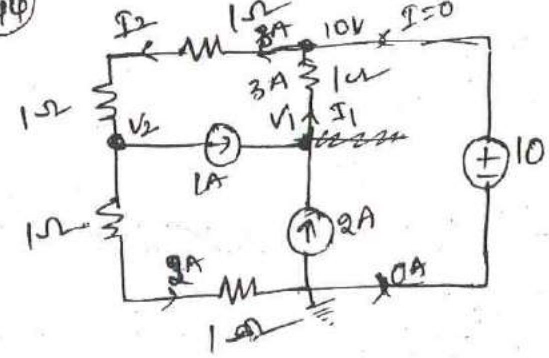
Q: (43)



← $R_{th} = 4Ω$

$\underline{I_N = 5A}$ Ans: (a)

Q: (44)



$$\frac{V_1 - 10}{1} = 2 + 1$$

$\underline{V_1 = 13V}$

$\therefore I_1 = \frac{13 - 10}{1} = \underline{3A}$..

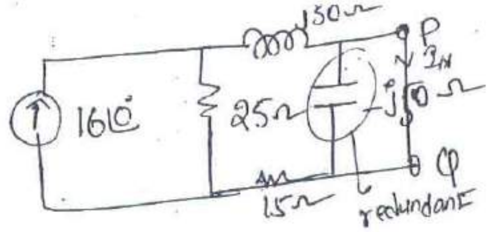
$$\frac{V_2 - 10}{2Ω} + \frac{V_2}{2} + 1 = 0$$

$V_2[1] = 4V \Rightarrow \underline{V_2 = 4V}$...

Ans:- (a)

$I_2 = \frac{10 - 4}{2} = \underline{3A}$...

Q(45)



$$I_N = 16\angle 0 \left[\frac{25}{25+15+j30}\right]$$

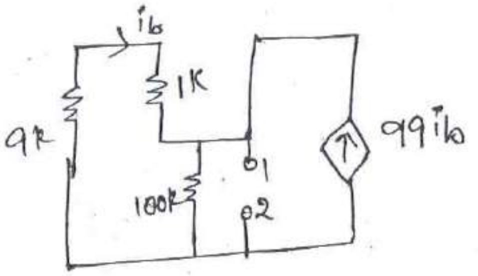
$$= \frac{16\angle 0 \; [40-j30]\, 25}{(40)^2+(30)^2}$$

$$= \frac{16\angle 0 \times 25 \; (40-j30)}{100(25)}$$

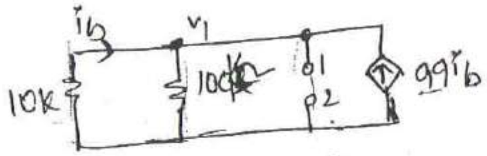
$$= \underline{6.4 - j4.8} \quad \text{Ans (a)}$$

Q:(46) Ans: (a)

Q:(47)



⇓



$R_{th} = \frac{V_{oc}}{I_{sc}}$ $\quad V_{oc} \Rightarrow ?$

$$\frac{V_1}{10K} + \frac{V_1}{100K} = 99 i_b \Rightarrow V_1(10)+V_1 = 99\times 100 i_b$$

$$V_1 = \frac{99\times100 i_b}{11}$$

$$= 99\left[\frac{-V_1}{\cancel{10}}\right]$$

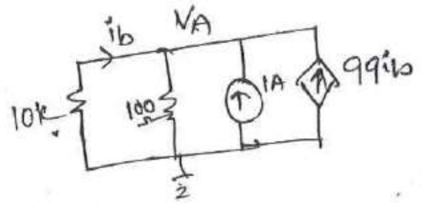
$$\frac{V_1}{\cancel{10}} + \frac{V_1}{\cancel{100}}$$

$$V_1[1.1] = -V_1(99)$$

$$V_1 = \frac{1}{100.1} = \underline{0.001}\ V = V_{oc}$$

$$I_{sc} = \underline{99 i_b} + i_b = 100 i_b$$

$$\therefore \frac{V_{oc}}{I_{sc}} = \frac{\frac{V}{\cancel{100.1}}}{100 i_b} = \frac{\frac{\cancel{99}\,9 \times \cancel{100 i_b}}{\cancel{11}}}{\cancel{100 i_b}} = \underline{9\ k\Omega}$$



Same pblm 100kΩ is replaced by 100Ω.

$$\frac{V_1}{10} + \frac{V_1}{0.1K} = 99 i_b + 1$$

$$\Rightarrow \quad i_b = \frac{-V_A}{10\times10^3}$$

$$\underline{V_A = 50}$$

$$\therefore R_{th} = \frac{V_{AB}}{I_{sc}} = \frac{50}{1} = \underline{50\Omega}$$

Conventional:-

Q:2 $\quad V_{th} = \frac{108}{31}$ volts ; $R_{th} = \frac{96}{31}\ \Omega$

Q:3) $\quad V_{th} = 5\sqrt{2}\sin 100t$

$Z_{th} = (5-j100)K\Omega$

$i = \underline{0.049\ mA}$

Q:4) $\quad V_{th} = 72.11\angle 3.18$

$Z_{th} = 3.77\angle 68.8$

$i_L(t) = 11.2\angle -30.11$

$P_L = \underline{505.8}$

Q:6) $\quad V_{th} = 1.83\angle 46.02$

$Z_{th} = 8.38\angle -69.2$

$I_N = 0.219\angle 115.25$

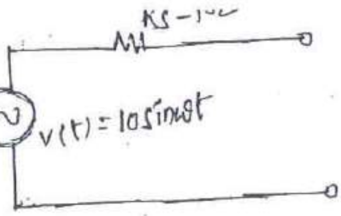
Q:7) $\quad V_{th} = 0$

$R_{th} = \frac{5+2\alpha}{3}$

Q(5)
sol:-

$V = 10\sin(2P \times 10^6 t)$

$R_{int} = 1\Omega$



(ii) $P_{max} = ?$

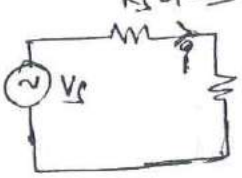
$$P_{max} = \frac{V_S^2}{4R_L}$$

$$\Rightarrow P_{max} = \frac{(10/\sqrt{2})^2}{4(1)} = \frac{100}{8} = 12.5\,W$$

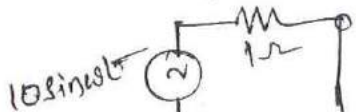
$R_L = R_S = 1\Omega$

(i) ~~$P_{max} = \frac{12.5}{\sqrt{2}}$~~

(iii)



for max power the load resis = 0.

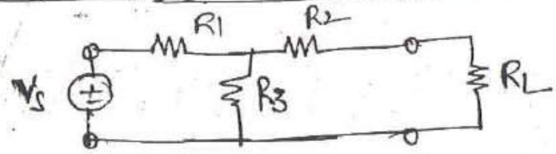


$$P = \frac{(10/\sqrt{2})^2}{4(1)} = 50W$$

since current same & elements same. so power also same

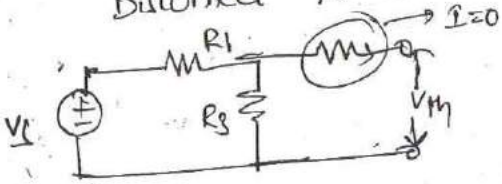
$$P_T = 12.5 + 12.5 = 25W$$

Proof of Thevenin's Theorem:-



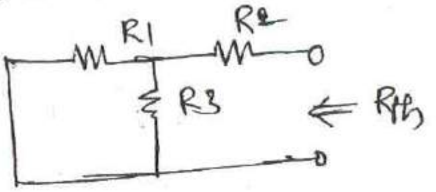
case(i):- (V_{th})

Disconnect the load resistor and find the voltage across load resistor.



$$V_{th} = V_S \cdot \frac{R_3}{R_1+R_3} \rightarrow (1)$$

case(ii):- Deactivate all independent sources.



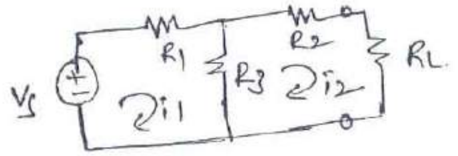
$$R_{th} = (R_1 \| R_3) + R_2$$
$$= \frac{R_1 R_3}{R_1+R_3} + R_2$$

case(iii):- develope Thevenin's equivalent circuit. ste

$$I_L = \frac{V_{th}}{R_{th}+R_L} \rightarrow (3)$$

Substitute eq(1) & eq(2) in eq(3), we can get a new equation

$$\boxed{I_L = \frac{V_S R_3}{R_2R_1 + R_2R_3 + R_3R_1 + R_LR_3}} \rightarrow (4)$$



$V_S = (R_1+R_3)I_1 - R_3 I_2 \rightarrow (5)$

$0 = (I_2 - I_1)R_3 + R_2 I_2 + R_L I_2 \rightarrow (6)$

From (6) $\Rightarrow$ $I_1 = \dfrac{(R_2+R_L+R_3)\,I_2}{R_3} \rightarrow (7)$

Sub (7) in (5), we get

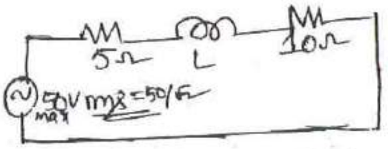
from (5) $\Rightarrow$ $V_S = \left[(R_1+R_3)\dfrac{(R_2+R_L+R_3)}{R_3} - R_3\right] I_2 \rightarrow (8)$

$\Rightarrow I_2 = \dfrac{V_S[R_3]}{R_2R_1 + R_2R_3 + R_3R_1 + R_3R_L} \rightarrow (8)$

from the above calculation it is concluded that load current of eq (4) & eq (8) are equal. Hence Thevenin's theorem is proved.

Page No (48)

Q:(1)



$I^2 \cdot R_5 = P \Rightarrow 10 = I^2 \cdot R$

$\Rightarrow I = \sqrt{\dfrac{10}{5}} = \sqrt{2}\ A$

$Z = \dfrac{V}{I} = \dfrac{50/\sqrt{2}}{\sqrt{2}} = 25\Omega$

Equi Resistance $= 15\Omega$

$\therefore P.F = \dfrac{R}{Z} = \dfrac{15}{25} = \dfrac{3}{5} = 0.6$

Q:(2)

Sol: $v = 200\sin(2000t + 50^\circ)$

$i = 4\cos(2000t + 13.2)$

$\Rightarrow v = 200\cos(2000t - 40^\circ)$

'i' is lead by v. so R & C.

Ans (d) R & C.

$RLC \rightarrow (X_C > X_L)$

(or)

$v = 200\sin(2000t + 50)$

$i = 4\sin(2000t + (13.2+90))$

Q:(3)

$X_L = 1000\Omega$

$X_C = 1000\Omega$

$R = 0.1\Omega$

$f_0 = 10\,MHz$

$B.W = \dfrac{R}{2\pi L} = f_2 - f_1$ & also known that

$Q = \dfrac{f_0}{f_2 - f_1} \Rightarrow f_2 - f_1 = \dfrac{f_0}{Q}$

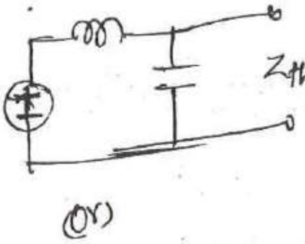
Now $Q = \dfrac{X_L}{R} = \dfrac{1000}{0.1}$

$Q = 10^4$

$\therefore f_2 - f_1 = \dfrac{10 \times 10^6}{10^4} = 1000$

$= 1\,kHz$

Q:(4)



$Z_{th} = \infty$

$\downarrow$

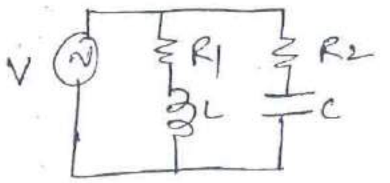
for ideal current source $Z_{th} = \infty$.

(or)

by s.c the source, it will form a Tank ckt

$Z_{dy} = \infty$. $\quad \omega_0 = 1/\sqrt{LC} = \dfrac{1}{\sqrt{\frac{1}{16} \times 1}} = 4\,rad/sec$

Q: In the ckt shown at what value of R_1 & R_2 circuit resonant for all frequencies.



Sol:

$$B_L = B_C$$

$$\frac{X_L}{R_1^2+X_L^2} = \frac{X_C}{R_2^2+X_C^2}$$

$$\frac{\omega L}{R_1^2+(\omega L)^2} = \frac{(1/\omega C)}{R_2^2+(1/\omega C)^2}$$

$$\frac{1}{\frac{R_1^2}{\omega L}+\omega L} = \frac{1}{R_2^2\cdot\omega C+1/\omega C}$$

To satisfy $B_L = B_C$ coefficients of ω should be same.

ω coeff^n $\Rightarrow L = R_2^2 C$ $\Rightarrow \boxed{R_2^2 = \frac{L}{C}}$; $\frac{1}{\omega}$ coeff^n $\Rightarrow \frac{R_1^2}{L} = 1/C$ $\Rightarrow \boxed{R_1^2 = L/C}$

$$\boxed{\therefore R_1^2 = R_2^2 = \frac{L}{C}} \ **$$

Q:(5)

$$R_1^2 = R_2^2 = \frac{L}{C}$$

$$\Rightarrow 16 = \frac{1}{C} \Rightarrow C = 1/16\ F$$

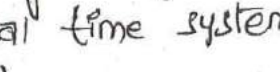
Q:(6) $\boxed{X_C = X_L}$

~~240 + 240 + (1)240~~ .

Q:(7) Statement → valid

Self resonant is possible at high freq^n, but real time applications $f = 50$ Hz (low)

whenever interturn Cap^{n}s present selfres^n present



Ans (b)

Note :- for the inductor it present at high freq^n, & there is a possibility to get self resonance at High freq^n. But in the real time system inductor is operated at Normal freq^n (low freq^n).

Q:9

$$Y(S) = \frac{S^2 + 0.5S + 100}{5S}$$ → for calculation simple (or) for parallel we go for Y'

$$Y(S) = \frac{S}{5} + \frac{0.5}{5} + \frac{20}{S}$$

$$B_C = \frac{1}{X_C} = \frac{1}{\left(\frac{1}{SC}\right)} = SC$$

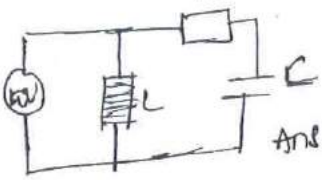
$$B_L = \frac{1}{SL}$$

$$\therefore \boxed{C = \frac{1}{5}}$$

$$\boxed{L = 1/20}$$

$$\boxed{R = \frac{1}{0.1} = 10}$$

Q:10



Ans: (C)

(1) Find eqn Impedence

(2) Equate Imaginary part to zero.

Q:11 B. (a)

Q:12

$$H(S) = \frac{10^6}{S^2 + 20S + 10^6} = \frac{V_0(S)}{V_i(S)}$$

Voltage ratio means Indirectly series RLC. Since voltage division is possible in series only.

$$\left(D^2 + \frac{R}{L}D + \frac{1}{LC}\right) i = 0$$

$$\frac{R}{L} = 20 ; \quad \frac{1}{LC} = 10^6$$

B.W = 20

$$\omega_2 - \omega_1 = 20$$

$$\omega_0^2 = 10^6$$

$$\Rightarrow \omega_0 = 10^3$$

$$\Rightarrow Q = \frac{\omega_0}{\omega_2 - \omega_1}$$

$$= \frac{100\cancel{0}}{2\cancel{0}} = 50 \ldots$$

Q(13):

sol:

$$R = 20\Omega$$

$$I = i_{rms}\angle{-45^\circ}$$

$$V_L = 2V_C$$

$$\cancel{I}X_L = 2\cancel{I}X_C$$

$$\Rightarrow X_C = \frac{X_L}{2} \rightarrow (1)$$

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

$$1 = \frac{X_L - X_C}{R} \Rightarrow$$

$$X_L - X_C = 20$$

$$X_L - \frac{X_L}{2} = 20$$

$$\boxed{X_L = 40\Omega}$$

$$X_C = 20\Omega$$