Sources

- Dependent Sources
  - * CCCS → KIa
  - * CCVS → KV
  - * VCCS → KV
  - * VCVS → KV
- Independent sources
  - * Independent voltage source
  - * Independent current source

Independent voltage source :-

* It is a voltage generator whose o/p voltage absolutely remains constant whatever be the value of o/p current.

* It has zero internal resistance so that the p.d of source is 0.

* The power drawn by source is 0.

Independent current source :-

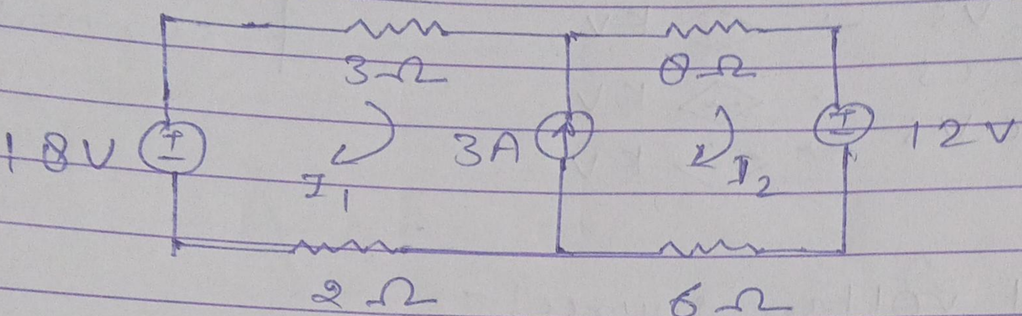
* It produces a constant current irrespective of the value of voltage across it.

* It has infinite resistance.

* It is capable of supplying infinite power.

Supermesh :-

When a current source is present b/w two meshes, we remove the branch having current sources and then the remaining loop is known as supermesh.



KVL eq^n at outer loop.

$$\boxed{18 - 3I_1 - 8I_2 - 12 - 6I_2 - 2I_1 = 0}$$

$$-5I_1 - 14I_2 = -6$$

$$\boxed{5I_1 + 14I_2 = 6} \quad \text{—} \ (1)$$

$$\boxed{I_2 - I_1 = 3} \quad \text{—} \ (2)$$

All the Network theorems are at starting of this notes.

Transient response and steady state response:-

Transient is present in the circuit when a circuit is subjected to any changes either by changing the source magnitude or any circuit element provided the circuit consist of energy storage elements like L and C because Inductor and capacitor does not allow the sudden change in current and voltage respectively.

In pure resistive circuit, there is no transient because it allow sudden change in both current & voltage.

- $t = 0^-$ means time instant just before switching operation. (under steady state)
- $t = 0$ is the exact instant of switching operation
- $t = 0^+$ means time instant just after switching operation
- $t = \infty$ steady state time after the switching operation.

Note:- $i_L(0^-) = i_L(0) = i_L(0^+)$

$V_c(0^-) = V_c(0) = V_c(0^+)$

Element	at $t = 0^+$	at $t = \infty$ (steady)
① Inductor	O.C	S.C $v_L = L\frac{di}{dt} = 0$
② capacitor	S.C	O.C $i_c = C\frac{dv}{dt} = 0$

Time constant :-

It is the time taken by the response to reach 36.7% of its initial value while discharging.

or

it is the time taken by the response to reach 63.2% of its final value while charging

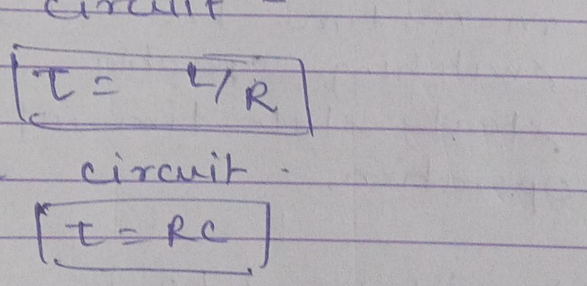
~~for~~ RL circuit -

$$\boxed{\tau = L/R}$$

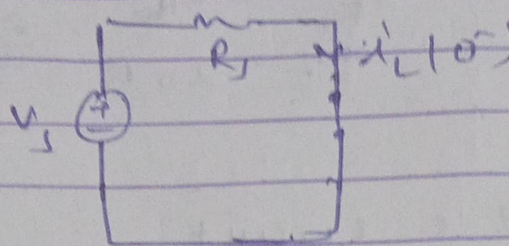
For R.C circuit.

$$\boxed{\tau = RC}$$

Source free L-R circuit :-

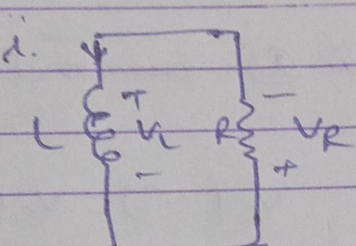


for t = 0^- (steady state) switch @ 1



$$i_L(0^-) = \frac{V_s}{R_s} = i_L(0) = i_L(0^+) = \boxed{I_0 = \frac{V_s}{R_s}}$$

for t > 0 switch @ 2



Applying KVL,

$$v_L + v_R = 0$$

$$L\frac{di}{dt} + iR = 0$$

$$L\frac{di}{dt} = -iR$$

$$\Rightarrow \int_{I_0}^{i(t)} \frac{di}{i} = \int_{t=0}^{t} -\frac{R}{L}\,dt$$

$$\boxed{i(t) = I_0 e^{-t/\tau}}$$

For t > 0

source free R-L ckt

~~where,~~ $\boxed{I_0 = \frac{V_s}{R_s}}$ $\boxed{\tau = L/R}$

$$v_L(t) = L\frac{di}{dt} = L\frac{d}{dt}\left(I_0 e^{-t/\tau}\right)$$

$$= L\frac{d}{dt}\left(I_0 e^{-\frac{R}{L}t}\right)$$

$$= \cancel{L} I_0 \left(\frac{-R}{\cancel{L}}\right) e^{-\frac{R}{L}t}$$

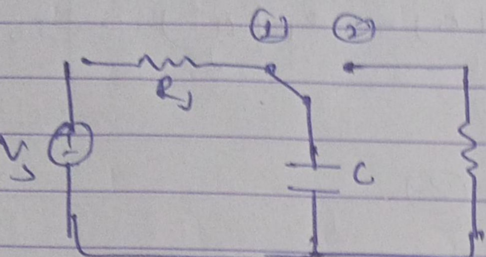
$$v_L(t) = -I_0 R\, e^{-\frac{R}{L}t}$$

By KVL, $V_L + V_R = 0$

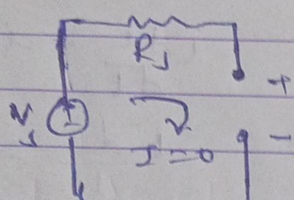
$V_R = -V_L$

$= I_0 R e^{-\frac{R}{L}t}$

(2) Source free R-C circuit.



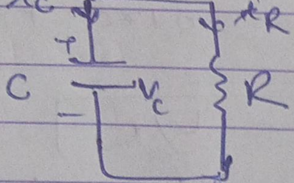
1) at $t = 0^-$ switch @ (1) under steady state.



$V_c(0^-) = V_c(0) = V_c(0^+) = V_s$

$= V_0$

(2) at $t > 0$ switch @ (2)



$i_c + i_R = 0$

$C\frac{dv_c}{dt} + \frac{v_c}{R} = 0$

$C\frac{dv_c}{dt} = -\frac{v_c}{R}$

$\Rightarrow \int_{V_0}^{V_c(t)} \frac{dv}{v_c} = \int_0^t -\frac{1}{RC}\, dt$

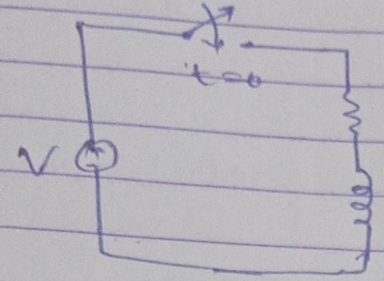
$\boxed{V_c(t) = V_0 e^{-t/\tau}}$

where,

$V_0 = V_c(0^-) = V_s$

$\tau = RC$

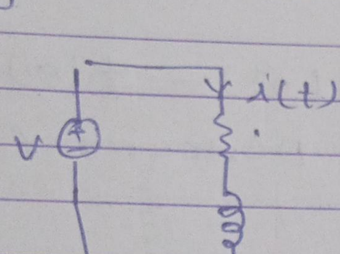
(3) R-L circuit with source



at $t=0^-$ → (switch is open)

$i_L(0^-) = i_L(0) = i_L(0^+) = 0$

for $t>0$



$V = V_R + V_L$

$V = iR + L\frac{di}{dt} \Rightarrow \frac{di}{dt} + \frac{R}{L}i = \frac{V}{L}$ — (1)

solving eqn (1)

$i(t) = \frac{V}{R} + \left(-\frac{V}{R}\right)e^{-\frac{R}{L}t}$

Alternative method to find current

$$\boxed{i_L(t) = i_L(\infty) + [i_L(0^+) - i_L(\infty)]e^{-t/\tau}}$$

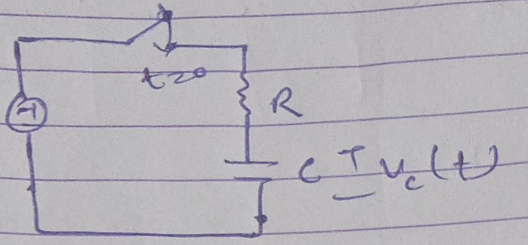
It is only valid for -

a) DC source

b) step i/p is connected to source → $Au(t)$

Note:- This can be used in both with source and source free.

4) R-C circuit with source.



at $t=0^-$ → switch open

$v_c(0^-) = v_c(0) = v_c(0^+) = 0\,V$

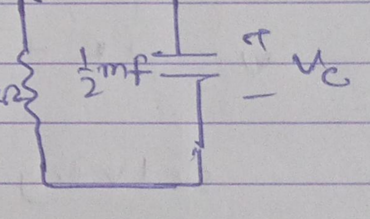
for $t>0$ -

$$V_c(t) = V_c(\infty) + [V_c(0^+) - V_c(\infty)]\, e^{-t/\tau}$$

valid only for - DC source & step input

Q.

In the following RC circuit $V_c(0) = 10\,V$ then find value of $V_c(t)$



Sol:- $V_c(0^-) = V_c(0) = V_c(0^+) = V_0$

$= 10\,V$

for $t>0$

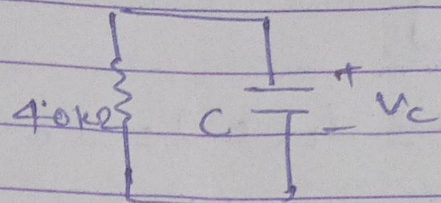
It is source free ckt

so, $V_c(t) = V_0\, e^{-t/\tau}$

$\tau = RC = \cancel{2}\times 10^3 \times \frac{1}{\cancel{2}} \times 10^{-3} = 1$ sec.

$V_c(t) = 10\, e^{-t/1} = 10\, e^{-t}$

Q. In the following ckt, $V_C(0^-) = 5V$. If $V_C(0.1s) = \frac{5}{e}V$ at $t = 0.1s$, then find C.



sol:- $V_C(0^-) = V_C(0) = V_C(0^+) = 5V = V_0$

$$V_C(t) = V_0 e^{-t/\tau}$$

$$\tau = RC = 40\times10^3 \times C = (4\times10^4 C)\ sec$$

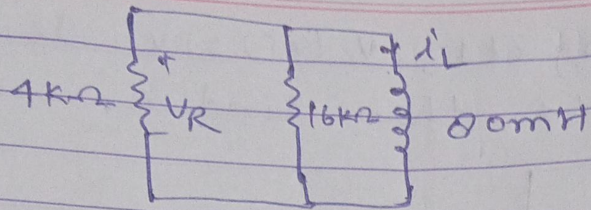
$$V_C(0.1) = \frac{5}{e} = 5e^{-\frac{0.1}{(4\times10^4)C}}$$

$$\frac{5}{e} = \frac{5}{e^{\frac{0.1}{(4\times10^4)C}}}$$

$$\frac{0.1}{(4\times10^4)C} = 1 \Rightarrow C = \frac{0.1}{4}\times10^{-4}$$

$$C = \frac{1}{4}\times10^{-5} = 0.25\times10^{-5}$$
$$= 2.5\times10^{-6}$$
$$= 2.5\mu F$$

Q. In following ckt. $i_L(0) = 10mA$, then find $V_R(t)$ for $t \geq 0$.



$R_{eq} = \frac{4\times16}{20}$

$= 3.2$

Sol:- $i_L(0^-) = i_L(0) = i_L(0^+) = I_0 = 10mA.$

$i_L(t) = I_0 e^{-t/\tau}$

$\tau = L/R_{eq} = \frac{\cancel{80}^{5}\times10^{-3}}{\frac{\cancel{16}}{5}\times10^{3}} = 25\times10^{-6}\,sec.$

$i_L(t) = 10\times10^{-3}e^{-t/25\times10^{-6}}$

$= 10\times10^{-3}e^{-\frac{t\times10^{6}}{25}}$

$= 10\times10^{-3}e^{-\frac{t\times10^{6}}{25}\times10^{4}}$

$= 10\times10^{-3}e^{-4\times10^{4}t}$

$V_L(t) = L\frac{di(t)}{dt} = 80\times10^{-3}\frac{d}{dt}(10\times10^{-3}e^{-4\times10^{4}t})$

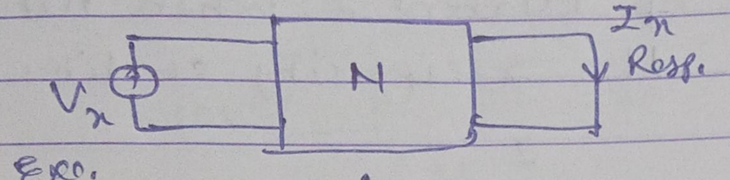
$= 80\times10^{-3}\times10\times10^{-3}\times(-4\times10^{4})\,e^{-4\times10^{4}t}$

$= 32\,e^{-4\times10^{4}t}.$

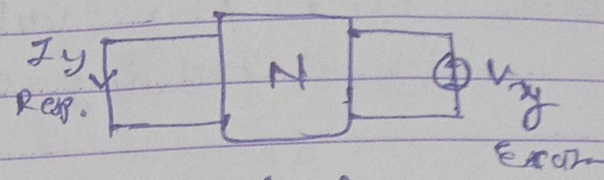
As, $V_R(t) = V_L(t) = 32\times e^{-4\times10^{4}t}$ [$\because$ they are connected in parallel.

Reciprocity theorem :-

In a linear bilateral ~~netw~~ single source network the ratio of response to excitation remains the same even when the positions of response and excitation are interchanged.



(a)



(b)

$$\boxed{\frac{I_x}{V_x} = \frac{I_y}{V_y}}$$

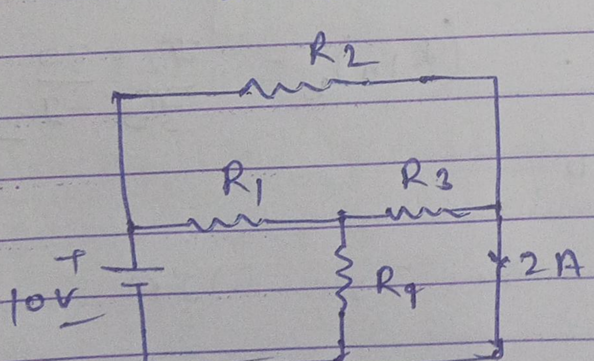
Reciprocity theorem is applicable when.

a) ratio of response to excitation is either Ω or Ω^{-1}

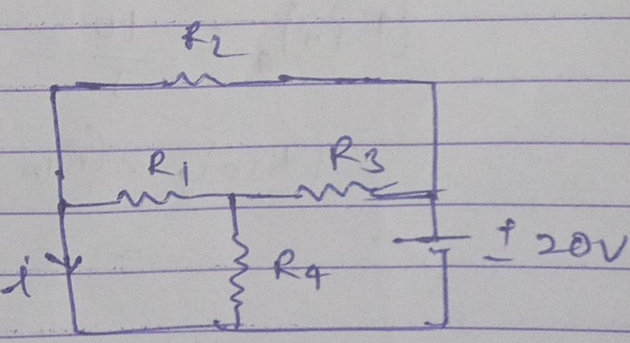
b) only one independent source is present in circuit

c) No dependent source is present in circuit

Q. Use data of fig(a) and find the current i in fig(b).



fig(a)



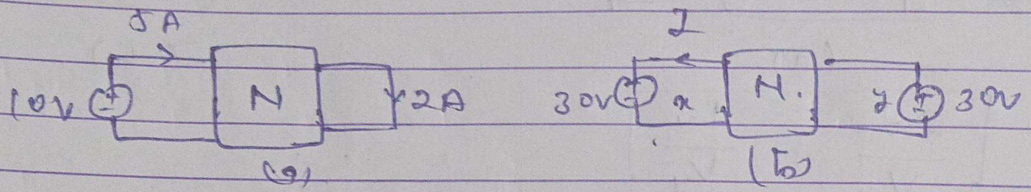
fig(b)

sol:- Using Reciprocity theorem,

$$\left.\frac{R_{es}}{E_{xe}}\right|_1 = \left.\frac{R_{es}}{E_{xe}}\right|_2$$

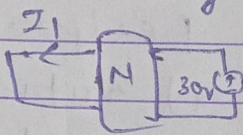
$$\frac{2}{\cancel{10}} = \frac{i}{\cancel{20}_2} \Rightarrow i = 4A.$$

Q.2:- find the value of current I when network is satisfying all the reciprocity condition.

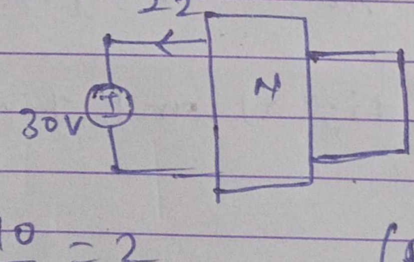


sol:- Case-1:- current due to 30V in branch y

$$\frac{2}{10} = \frac{I_1}{30} \Rightarrow I_1 = 6\ \text{Amp.}$$



Case-2:- current due to 30V in branch x



$(R_{in})_a = \frac{10}{5} = 2$. $(R_{in})_b = \frac{30}{-I_2}$

$(R_{in})_a = (R_{in})_b$ so

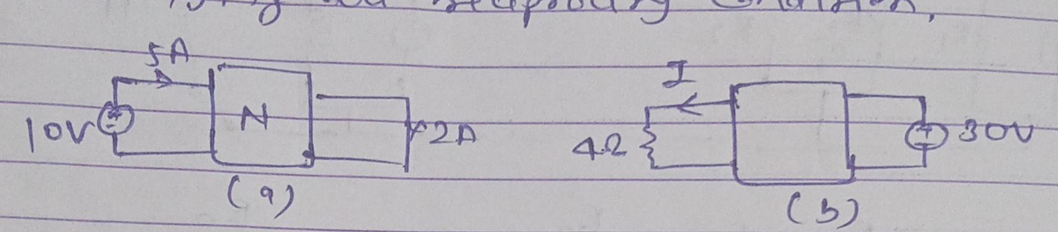
$$2 = \frac{30}{-I_2} \Rightarrow I_2 = -15A$$

from superposition theorem

$$I = I_1 + I_2$$

$$I = 6 + (-15) = -9\,A$$

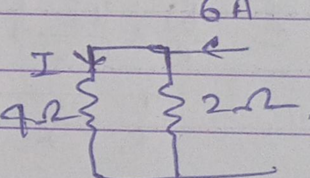
Q. Find the value of current I when network N is satisfying all reciprocity condition.



Sol:- Since it satisfies reciprocity condition so, let the current as response be I_r.

$$\frac{2}{10} = \frac{I_r}{30} \Rightarrow I_r = 6\,Am$$

$$R_{in} = \frac{10}{5} = 2\,\Omega$$



Using current divider rule

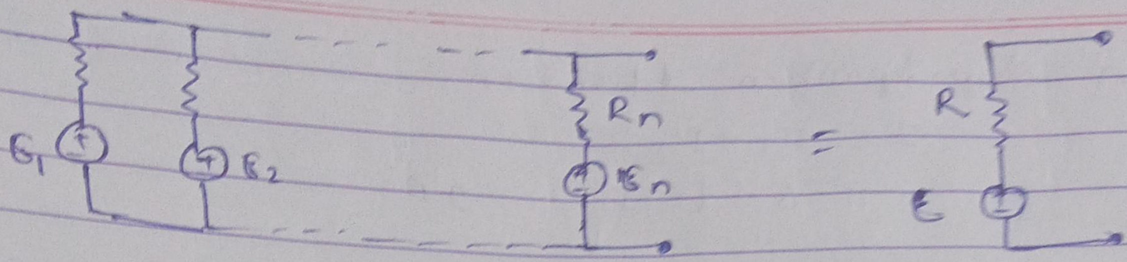
$$I = \frac{2 \times 6}{4+2} = 2\,A.$$

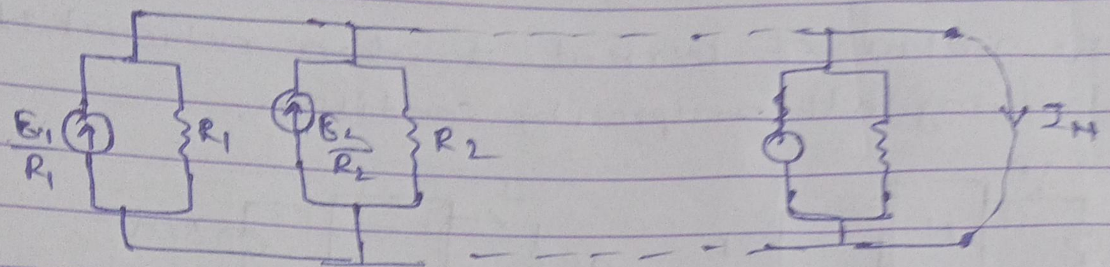
$$\boxed{I = 2A}$$

② **Millman's theorem:-**

If n voltages sources with voltages $E_1, E_2, E_3, \ldots E_n$ and internal resistance $R_1, R_2, R_3, \ldots R_n$ are connected in parallel, then these voltage sources can be replaced by a single voltage source E in series with resistance R.

case-1



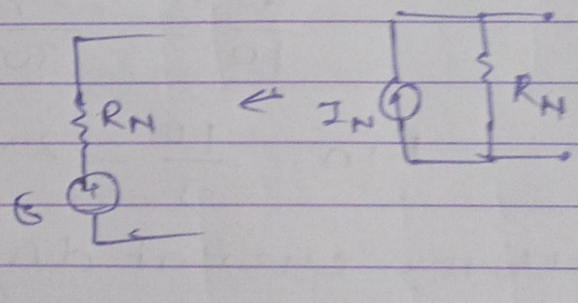


$$I_N = \frac{E_1}{R_1} + \frac{E_2}{R_2} + \frac{E_3}{R_3} + \cdots\cdots \frac{E_n}{R_n}$$

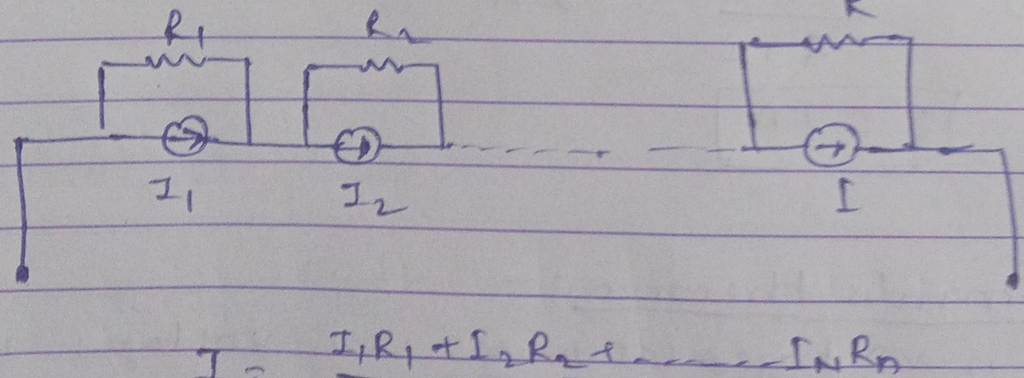
$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots\cdots \frac{1}{R_N}$$

$$E = I_N R_N$$

$$= \frac{\frac{E_1}{R_1} + \frac{E_2}{R_2} + \cdots \frac{E_n}{R_n}}{\frac{1}{R_1} + \frac{1}{R_2} + \cdots \frac{1}{R_n}}$$

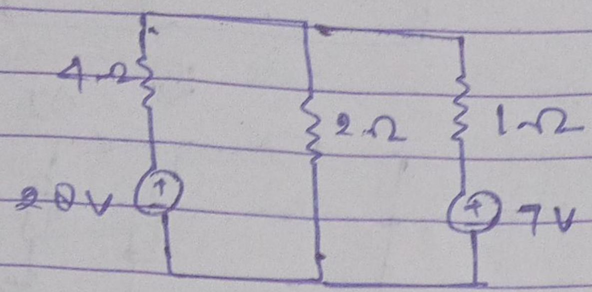


case-2



$$I = \frac{I_1R_1 + I_2R_2 + \cdots\cdots I_N R_n}{R_1 + R_2 + R_3 + \cdots R_n}$$

Q. Find the voltage across all the branches in the below given circuit.



Sol:-

$E_1 = 28V$ $\quad R_1 = 4\Omega$

$E_2 = 0V$ $\quad R_2 = 2\Omega$

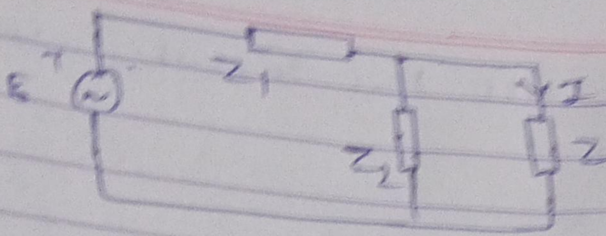
$E_3 = 7V$ $\quad R_3 = 1\Omega$

$$E = \frac{\frac{E_1}{R_1} + \frac{E_2}{R_2} + \frac{E_3}{R_3}}{1/R_1 + 1/R_2 + 1/R_3} = \frac{\frac{28}{4} + \frac{0}{2} + 7}{\frac{1}{4} + \frac{1}{2} + 1}$$

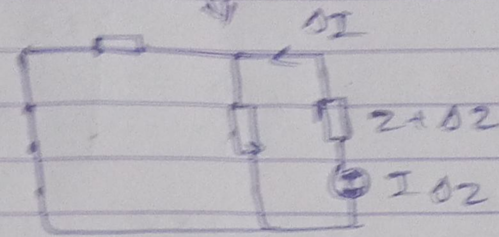
$$= 8\ V$$

Compensation theorem :-

"In a linear bilateral network with independent sources, if an impedance Z with current I thro it is changed to $Z+\Delta Z$, then the incremental cha in current due to this will be same as curren produced by a voltage source $I\Delta Z$ when connecte in series with new impedance $Z+\Delta Z$ in new network with all independent sources being turn -off."



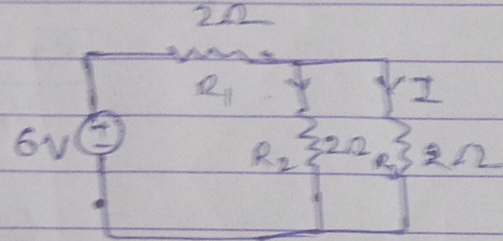
$\Delta I = I - I'$



Q. Find the change in current through the resistance R_3, when it is incremented to 3Ω.

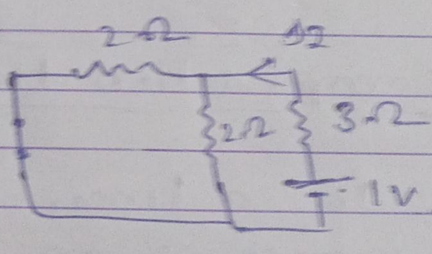
Sol:-

$\Delta R = (3-2) = 1\Omega$



$I_T = \dfrac{6}{3} = 2A.$

$\boxed{I = 1A}$



$\Delta I = \dfrac{1}{3+1} = 0.25A.$

Tellegen's theorem:-

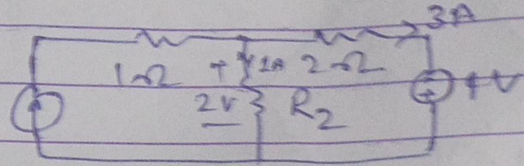
In any network, the sum of instantaneous power consumed by various elements in various branches is always equal to zero.

Total power delivered = total power absorbed.

$P_1 + P_2 + P_3 + \dots P_n = 0$

$V_1 I_1 + V_2 I_2 + \dots V_n I_n = 0$

Q. Determine the power supplied by current source.



Sol:-

$P_{4A} = ?$ $\quad P_{1\,ohm} = +(4)^2 1 = +16W$

$P_{R_2} = +(1)^2(2) = 2W$ $\quad P_{2\Omega} = +(3)^2 2 = 18W$

$P_{4V} = -12\ W$

$P_{4A} + 2 + 18 + 16 - 12 = 0$

$P_{4A} = 24\ W$

Maximum Power transfer theorem:-

To obtain the max. power from a network the resistance of the load must be equal to the thevenin's resistance of network".

for dc circuit.

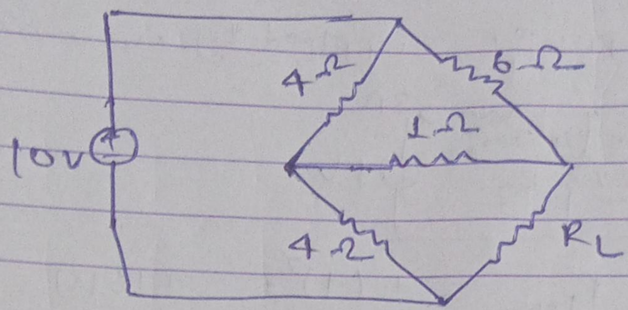
$$R_L = R_{th}.$$

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

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

$$\boxed{(P_L)_{max} = \frac{V_{th}^2}{4R_L}}$$

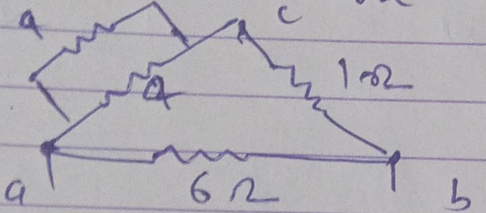
Q. Find R_L for which maximum power will be transferred to it.

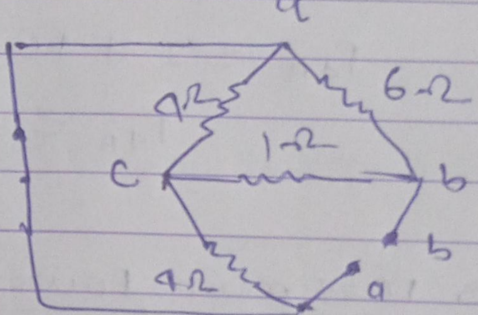


Sol :- for max power -

$R_L = R_{th}$.

calculations of R_{th}



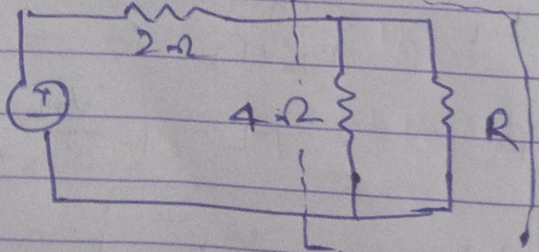


$$R_{th} = R_{ab} = \{(4 \| 4) + 1\} \| 6$$

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

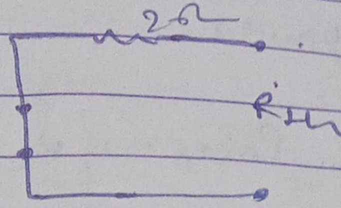
$$\boxed{R_L = 2\Omega}$$

. Find R for which max. power is transferred,



Sol:- calculation of R_{th}.

$R_{th} = 2\Omega$



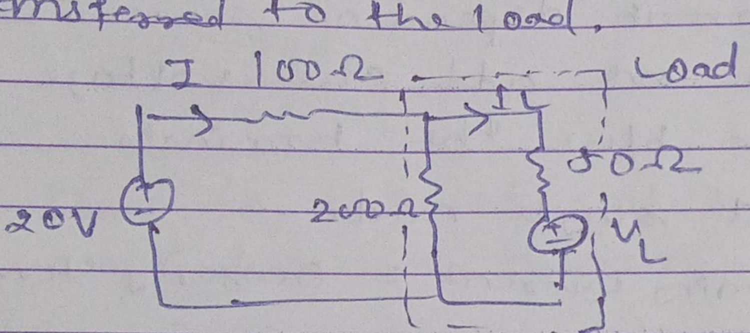
so, $R_L = 2\Omega$

Also, $R_L = \frac{4 \times R}{4 + R} = 2$

$4R = 8 + 2R$

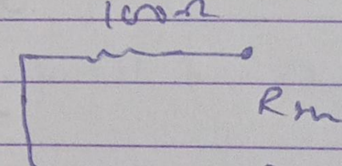
$2R = 8 \Rightarrow \boxed{R = 4}$

Q. find V_L for which the max. power will be transferred to the load.

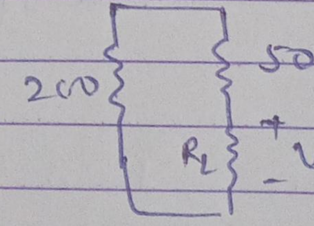


Sol:- Calculation of R_{th}

$R_{th} = 100\,\Omega$



So, $R_L = 100\,\Omega$



$\frac{\cancel{200}^{\,2} \times (50 + R_L)}{200 + 50 + R_L} = 1\cancel{00}$

$100 + 2R_L = 250 + R_L$

$\boxed{R_L = 150}$

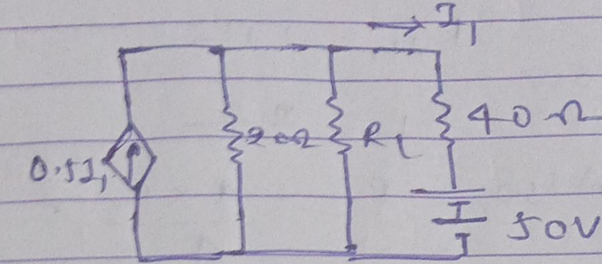
$I = \frac{\cancel{20}}{\cancel{200}_{\,10}} = \frac{1}{10}$

$I_L = \frac{I}{2} = \frac{1}{20}$

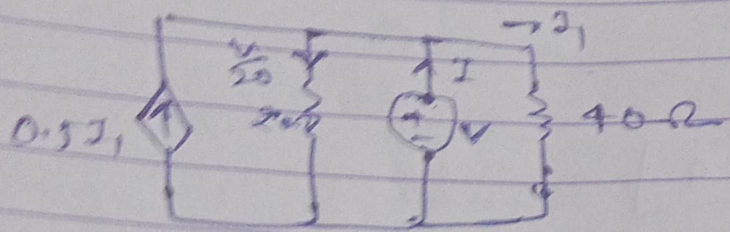
$V_L = I_L R_L = \frac{1}{\cancel{20}} \times 15\cancel{0}$

$= 7.5V.$

Q. Find the value of R_L if circuit is delivering max power



Sol:- $P_{max} \rightarrow R_L = R_{th}$.



In thevenin's ~~circuit~~ theorems, we have studied that if there is ~~current~~ dependent sources is getting involved then we add one voltage source or current source b/w the terminals.

considering a single node.

Incoming current = Outgoing current

$$0.5I_1 + I = \frac{V}{20} + I_1$$

$$-0.5I_1 + I = \frac{V}{20} \qquad I_1 = \frac{V}{40}$$

$$-0.5\left(\frac{V}{40}\right) + I = \frac{V}{20}$$

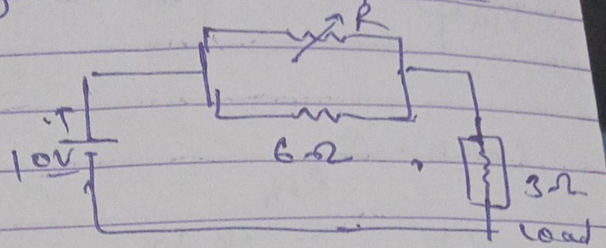
$$I = \frac{V}{20} + \frac{V}{80} = \frac{5V}{80}$$

$$I = \frac{V}{16}$$

$$\frac{V}{I} = 16 = R_{th}$$

$$R_{th} = R_L = 16\Omega$$

Q. In the circuit given below, find the value of R required for the transfer of maximum power ~~transfer~~ to load having resistance of 3Ω



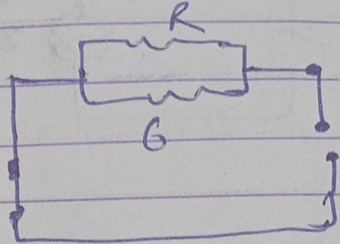
Sol:-

$R_L = R_{th}$

$R_L = 3\Omega$

$R_{th} = \frac{6R}{6+R} = 3$

$R_{th} = \frac{6R}{6+R}$



$\cancel{6R = 18 + 3R}$

$\cancel{3R = 18}$

$\cancel{\boxed{R = 6\Omega}}$

Here load is a fixed value so we can't apply max. power transfer theorem.

so, $P_{max} \longrightarrow I_L$ will be max.

I_L will be max when $\left(\frac{6R}{6+R}\right)$ will be 0.

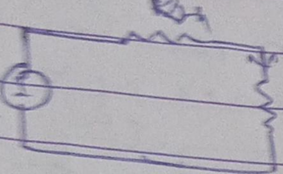
$$\frac{6R}{6+R} = 0 \Rightarrow \boxed{R = 0}$$

then, $I_L = \frac{10}{3} =$

Q. A practical dc source provides 20kW to a 50Ω lo[ad] and 20kW to a 200Ω load. find the max. power that can be drawn.

Sol:-

case-1

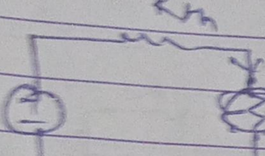


$$P_1 = 20\times10^3 = I_1^2(50)$$

$$I_1 = \sqrt{\frac{20\times10^3}{50}} = 20A.$$

Also, $I_1 = 20 = \dfrac{V_{th}}{R_{th}+50}$ — (1)

Case-2



$$P_2 = 20\times10^3 = I_2^2(2000)$$

$$I_2 = \sqrt{\frac{\cancel{20}\times1000}{\cancel{2000}\,10}} = 10\,A$$

$$I_2 = \frac{V_{th}}{R_{th}+2000} = 10 \quad \text{— (2)}$$

$$\cancel{V_{th}} - 20R_{th} = 1000$$
$$\underline{-\cancel{V_{th}} - 10R_{th} = 2000}$$
$$\quad + \qquad -$$
$$\cancel{-}10R_{th} = \cancel{-}1000$$
$$\boxed{R_{th} = 100}$$

$$V_{th} = 10(100+2000) = 3000V$$

$$P_{max} = \frac{V_{th}^2}{4R_{th}} = \frac{(3000\times3000)^2}{4\times100} = 22500W$$

$$= 22.5\,kW$$

max. Power transfer theorem for AC circuits:-

case-1:- when both R_L and X_L are variable.

for the max. avg. power transfer, the load impedance must be equal to the complex conjugate of thevenin's impedance.

$Z_L = R_L + jX_L$

$Z_{th} = R_{th} + jX_{th}$

$$\boxed{P_{max} \Rightarrow Z_L = Z_{th}^*}$$

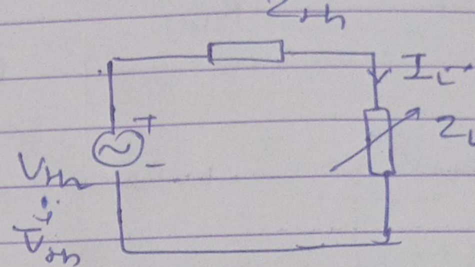
$Z_{th}^* = R_{th} - jX_{th}$.

On equating:

$R_L = R_{th}$ & $X_L = -X_{th}$

$\bar{V}_{th} \to V_{PP}$

$\bar{I}_{th} \to I_{P}$



$$\bar{I}_L = \frac{\bar{V}_{th}}{Z_{th} + Z_L}$$

$$= \frac{\bar{V}_{th}}{(R_{th} + jX_{th}) + (R_L + jX_L)}$$

$$= \frac{\bar{V}_{th}}{(R_{th} + R_L) + j(X_{th} + X_L)}$$

$P = \frac{1}{2}|I|^2 R_L$ when $\bar{V}_{th}$ & $\bar{I}$ corresponding to max. values is used.

$P = |I|^2 R_L$ when $\bar{V}_{th}$ & $\bar{I}$ corresponding rms value is used.

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

$$\frac{dP}{dX_L} = |V_{th}|^2 R_L \{(-1)((R_{th} + R_L)^2 + (X_{th} + X_L)^2\}^{-2} \times (2X_L + 2$$

$$= \frac{-2|V_{th}|^2 R_L (X_{th} + X_L)}{\{(R_{th} + R_L)^2 + (X_{th} + X_L)^2\}^2} = 0$$

$$X_{th} + X_L = 0 \Rightarrow \boxed{X_L = -X_{th}}$$

Similarly,

$$\frac{dP}{dR_L} = 0 \Rightarrow \boxed{R_L = R_{th}}$$

So, $\boxed{Z_L = R_{th} - jX_{th}}$

Case-2:- When R_L is variable and X_L is constant,

$\frac{dP}{dR_L} = 0$, on solving we get.

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

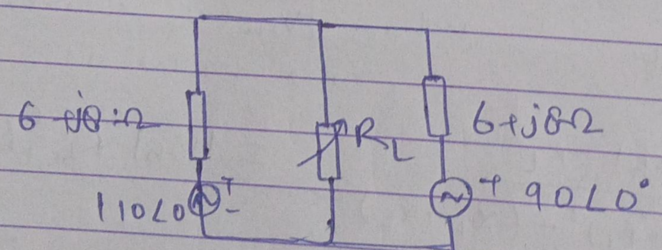
Case-3:- When, $Z_L = R_L$ {when load impedance is only resistive}

$$\frac{dP}{dR_L} = 0 \ \& \ X_L = 0$$

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

Q.

Find the max. that can be dissipated in load.



Sol:- Z_L is purely resistive so

$Z_L = R_L$ {It is case-3}

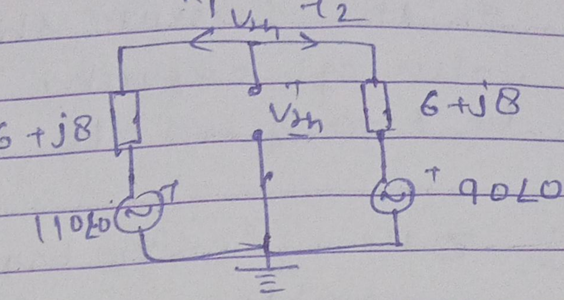
for max. power transfer.

$$Z_L = |Z_{th}| = \sqrt{R_{th}^2 + X_{th}^2}$$

$$P_{max} = |I|^2 R_L$$

Calculation of V_{th} :-

$i_1 + i_2 = 0$



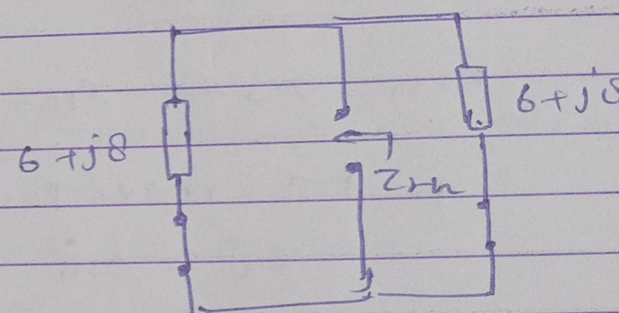
$$\frac{V_{th} - 110\angle 0^\circ}{6+j8} + \frac{V_{th} - 90\angle 0^\circ}{6+j8} = 0$$

$$\frac{2V_{th} - 200\angle 0^\circ}{6+j8} = 0 \Rightarrow 2V_{th} - 200\angle 0^\circ = 0$$

$$V_{th} = 100\angle 0^\circ \text{ V.}$$

$$\boxed{|V_{th}| = 100\text{ V}}$$

Calculation of Z_{th} :-



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

$$= \frac{(6+j8)\cancel{(6+j8)}}{12+j16}$$

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

$$= \frac{6+j8}{2} = 3+j4\ \Omega$$

$$|Z_{th}| = \sqrt{9+16} = 5\ \Omega = R_L$$

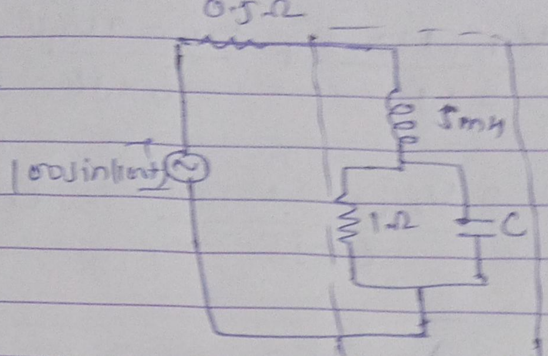
For max. power transfer, $|Z_{th}| = R_L$

$$|I| = \frac{|V_{th}|}{(|Z_{th}+R_L|)} = \frac{100}{|8+j4|}$$

$$= \frac{100}{\sqrt{80}}$$

$$P_{max} = |I|^2 R_L = \frac{10^4}{\cancel{80}_{16}} \times \cancel{5} = 625\text{ W}$$

Q. In the circuit shown below, ~~the~~ find the value of capacitor C required for max. power to be transferred to the load.

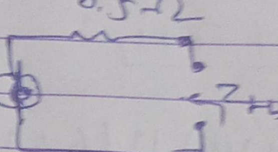


Sol:- Here, R_L & X_L both are variable

so, we will use case - 1

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

Calculation of Z_{th}



$$\boxed{Z_{th} = 0.5\ \Omega}$$

$R_{th} = 0.5\ \Omega \quad X_{th} = 0$

For max. pow. transfer

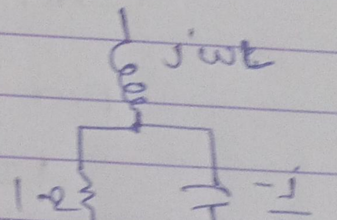
$Z_L = Z_{th}^*$

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

on comparing.

$R_L = R_{th} = 0.5 \qquad X_L = -X_{th} = 0$

Also



$$Z_L = j\omega L + \left[1 \parallel \left(-\frac{j}{\omega C}\right)\right]$$

$$= j\omega L + \left[\frac{-j/\omega C}{1 - j/\omega C}\right]$$

$$= j\omega L + \left[\frac{-j/\omega C\,(1 + j/\omega C)}{1 + \frac{1}{\omega^2 C^2}}\right]$$

$$= j\omega L + \frac{-j/\omega C + \frac{1}{\omega^2 C^2}}{1 + \frac{1}{\omega^2 C^2}}$$

$$Z_L = j\omega L - \frac{j/\omega C}{1+1/\omega^2C^2} + \frac{1/\omega^2C^2}{1+1/\omega^2C^2}$$

$$Re(Z_L) = \frac{1/\omega^2C^2}{1+\frac{1}{\omega^2C^2}} = R_L$$

$$\Rightarrow \frac{1}{1+\omega^2C^2} = \frac{1}{2}$$

$$1+\omega^2C^2 = 2 \Rightarrow \omega^2C^2 = 1$$

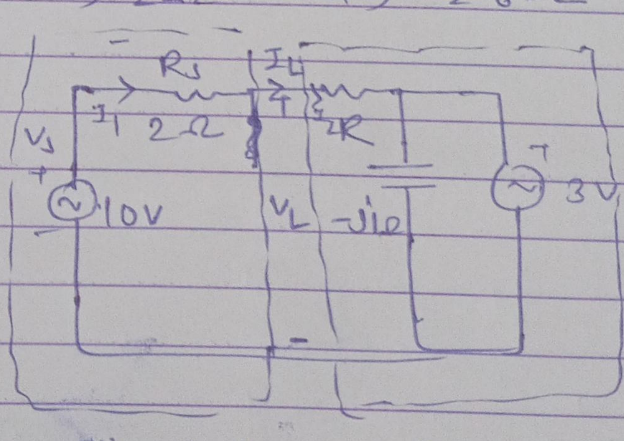
$$C^2 = \frac{1}{\omega^2} \Rightarrow \boxed{C = \frac{1}{B\omega}}$$

$$\boxed{C = \frac{1}{100}} = 10\times10^{-3} = 10\,mF$$

Q. Assuming both the voltage sources are in phase the value of R for which the max. power is transferred from circuit A to B is -

a) 0.8 b) 1.4 Ω c) 2 Ω d) 2.8 Ω

Sol.



Circuit A Circuit B

Circuit B is acting as load for circuit A

$P_L = V_L I_L$

$= V_L\left(\frac{V_s - V_L}{R_s}\right)$

$= \frac{1}{R_s}(V_sV_L - V_L^2)$

$P_{max} \Rightarrow \frac{dP}{dV_L} = 0 \Rightarrow \frac{1}{R_s}(V_s - 2V_L) = 0$

$\boxed{V_L = \frac{V_s}{2}}$ ⇒ cond^n for max power

$V_L = \frac{10}{2} = 5\,V$

$$i_1 = i_2$$

$$\frac{10-5}{2} = \frac{5-3}{R} \Rightarrow \frac{5}{2} = \frac{2}{R}$$

$$R = 4/5 = 0.8\,\Omega$$

$$\boxed{R = 0.8\,\Omega}$$