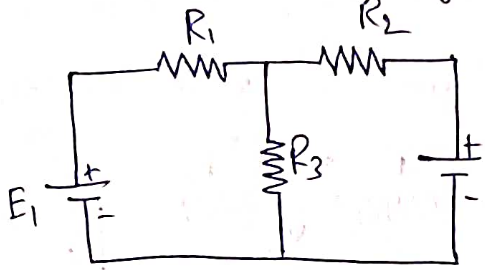
IV. Network Theorems

Superposition Theorem:-

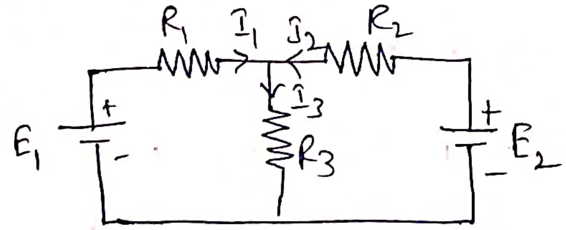
Statement:- In a linear bilateral resistive network containing two or more voltage sources, the resultant current in any branch is the algebraic sum of the currents that would be produced by each voltage source acting alone, all other voltage sources are being replaced by their internal resistances.

Proof:- consider the circuit shown bellow to findout the current flowing through various branches.



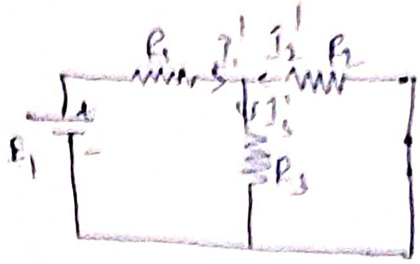
Step1:- Identify the number of brances in the given ckt and mark the resultant current directions in each branch.

let I_1, I_2 and I_3 are the resultant currents shown bellow.



Step2:- consider voltage source E_1 and replacing the voltage source E_2 by its internal resistance or short ckt the voltage source E_2

then determine the currents in each branch as I_1', I_2' and I_3' respectively



Total Resistance $R_{T_1} = R_1 + \frac{R_2 R_3}{R_2 + R_3}$

Total current produced by source $E_1 = I_1' = \frac{E_1}{R_{T_1}}$

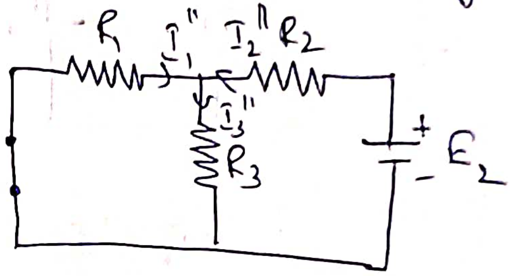
By the current divider Rule

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

current through $R_3 = I_3' = I_1' \frac{R_2}{R_2 + R_3}$

Step3:- consider the voltage source E_2 and short circuit the voltage source E_1, then determine the current in each branch cosider as I_1'', I_2'' and I_3'' respectively.

Total resistance $R_{T_2} = R_2 + \frac{R_1 R_3}{R_1 + R_3}$



Total current produced by source E_2, $I_2'' = \frac{E_2}{R_{T_2}}$

By current devider rule,

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

current Through R_3, $I_3'' = I_2'' \frac{R_1}{R_1 + R_3}$

Step6:- Now applying superposition theorem to combine the results in order to find out the resultant current in various branches.

Resultant current in Resistor R_1, $I_1 = I_1' - I_1''$
Resultant current in Resistor R_2, $I_2 = I_2' - I_2''$
Resultant current in Resistor R_3, $I_3 = I_3' + I_3''$

Applications:-

1. This Theorem is applicable to all linear networks i.e. circuit consisting of resistors or impedances in which ohm's law is valid.
2. This Theorem is used to determine the current in any branch of a network containing two or more than two voltage sources or current sources or both voltage and current sources.

Steps for solving super position Theorem:-

1. Identify the number of branches in given ckt, and mark the current directions.
2. Take only one independent source of voltage/current and deactivate the other independent voltage/current sources.

   i.e short circuit the voltage source and open circuit the current source.

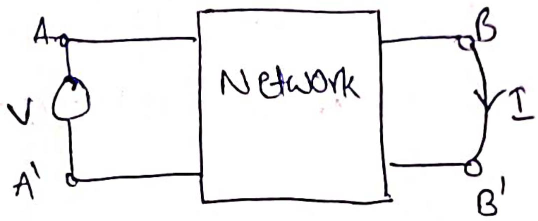
3. Then calculate the each branch current
3. Repeate the above step for each of the independent source.

4. To determine the net branch current using superposition Theorem, by adding currents obtained in step1 and step2 for each branch.

Reciprocity Theorem:-

Statement:- The Reciprocity Theorem states that for a linear, bilateral single source network the ratio of excitation to response is constant even when their positions are interchanged.

Explanation:- consider the network shown bellow, AA' denotes input terminals and BB' denotes output terminals.



* The application of voltage V across AA' produces current I at BB'.
* Now if the positions of the source and responses are interchanged, by connecting the voltage source across BB', the resultant current I will be at terminals AA'.
* According to the reciprocity theorem, the ratio of response to excitation is the same in both cases.

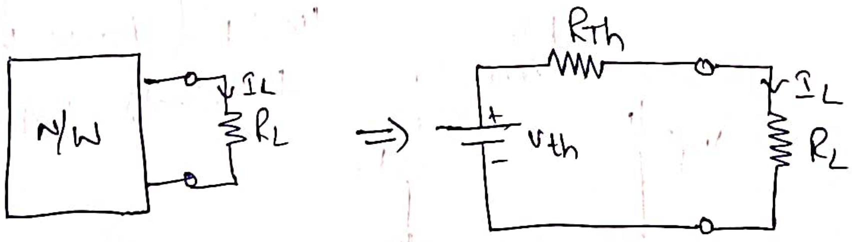
Steps for solving Reciprocity Theorem:-

1. Identify the branches between which reciprocity is to be established.

2. Find the current in the branch when excitation and response are not interchanged.
3. Find the current in the branch when excitation and response are interchanged.
4. It may observed that the currents obtained in step 2 & 3 are identical to each other.

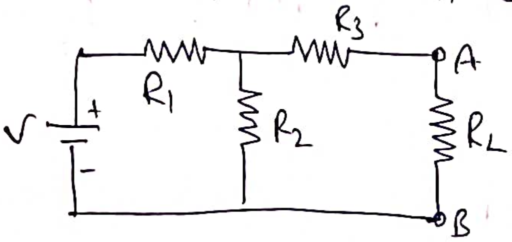
Thevenin's Theorem:-

Statement :- It states that "Any two terminal linear bilateral network containing a number of voltage sources and resistances can be replaced by an equivalent circuit consisting of a voltage source (V_{th}) in series with a resistance R_{Th}" and load Resistance R_L.



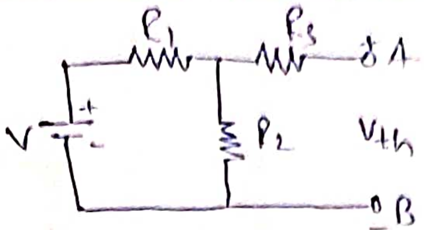
Explanation:-

1. Consider a network as shown bellow



2. For finding load current through R_L, first remove the load resistor R_L from the network, and calculate open ckt voltage V_{th} across points A and B as shown bellow figure.

$$V_{th} = I_2 R_2$$

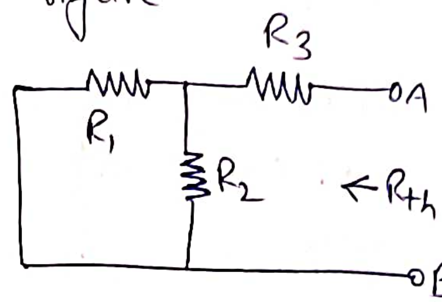


$$I_2 = \frac{V}{R} = \frac{V}{R_1+R_2}$$

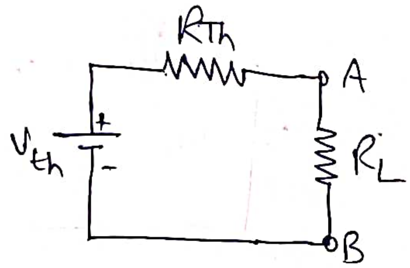
$$\therefore V_{th} = \left(\frac{V}{R_1+R_2}\right) R_2$$

3. For finding series resistance R_{Th}, replace the voltage source by a short circuit and calculate resistance between points A and B as shown bellow figure

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



4. Draw the thevenin's equivalent circuit and connect the load Resistance back to its terminals at A and B.



5. Determine the current flowing through R_L by applying ohm's law

$$I_L = \frac{V_{Th}}{R_{Th}+R_L}.$$

6. The potential drop across the load will be

$$V_L = \left(\frac{V_{th}}{R_{Th}+R_L}\right) R_L.$$

Steps for Solving Thevenin's Theorem:-

1. Remove the load Resistance R_L..
2. Find the open circuit voltage V_{Th} across points A and B.
3. Find the resistance R_{Th} as seen from points A and B.
4. Replace the network by a voltage source V_{Th} in series with Resistance R_{Th}.
5. Determine current through R_L and voltage across R_L.

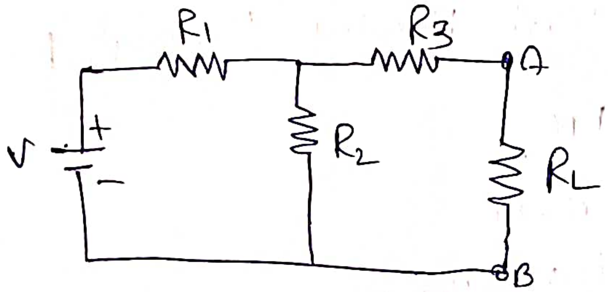
$$I_L = \frac{V_{Th}}{R_{Th}+R_L} \quad \text{and} \quad V_L = \left(\frac{V_{Th}}{R_{Th}+R_L}\right) R_L$$

Norton's Theorem:-

Statement:- It states that "Any two terminal linear bilateral network containing a number of voltage sources and resistances can be replaced by an equivalent circuit consisting of a current source I_N in parallel with a resistance R_N".

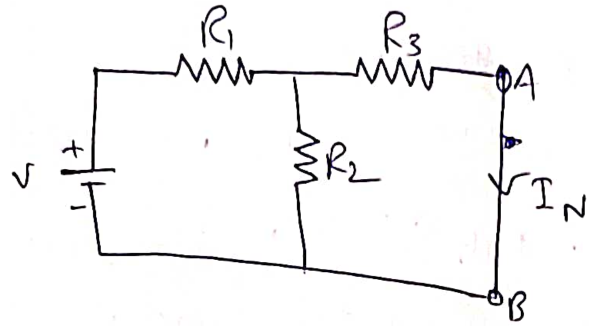
Explanation:-

1. Consider a simple network as shown bellow.



2. For finding load current R_L, first remove the load resistance R_L from the network.

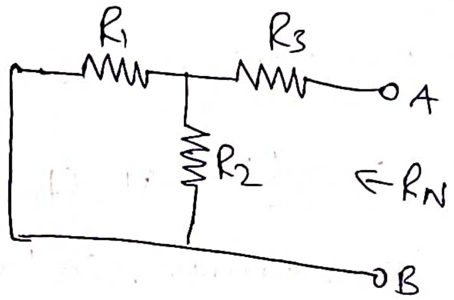
and calculate short circuit current I_{SC} or I_N



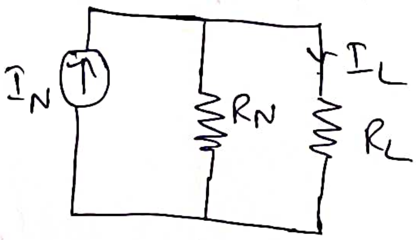
$$I_N = \frac{V}{R_{eq}}$$

3. For finding parallel resistance R_N, replace the voltage source by a short circuit and calculate resistance b/w points A and B

$$R_N = R_3 + \frac{R_1 R_2}{R_1 + R_2}$$



4. Draw the Norton's equivalent circuit and connect the load Resistance R_L



5. Determine the current flowing through R_L

$$I_L = I_N \frac{R_N}{R_N + R_L}$$

Steps for solving Norton's Theorem:-

1. Remove the load resistance R_L and put a short ckt across the terminals.

2. Find the short-circuit current I_{sc} or I_N.
3. Find the resistance R_N as seen from point A and B.
4. Replace the network by a current source I_N in parallel with resistance R_N.
5. Determine current through R_L by current division rule

$$I_L = I_N \cdot \frac{R_N}{R_N + R_L}$$

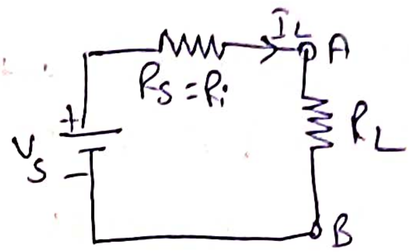
Maximum Power Transfer Theorem:-

Statement:- It states that "Maximum power in a circuit can be transferred from a source to load when the load resistance is equal to the internal resistance of the source".

let V_s = source voltage

$R_i = R_s$ = Internal or Source Resistance

R_L = Load Resistance



Current supplied to the load, $I_L = \frac{V_s}{R_s + R_L}$

Power drawn by the load,

$$P_L = I_L^2 R_L$$

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

Power taken by the load will be maximum if $\frac{d(P_L)}{dR_L} = 0$

$$\therefore \frac{d}{dR_L}\left[\frac{V_s^2 R_L}{(R_s + R_L)^2}\right] = 0$$

$$(R_s+R_L)^2 V_s^2 \times 1 - V_s^2 R_L [2(R_s+R_L)\times 1] = 0$$

$$V_s^2 [(R_s+R_L)^2 - 2R_L(R_s+R_L)] = 0$$

$$(R_s+R_L)^2 - 2R_L(R_s+R_L) = 0$$

$$R_s^2 + R_L^2 + 2R_LR_s - 2R_L(R_s+R_L) = 0$$

$$R_s^2 + R_L^2 + 2R_LR_s - 2R_LR_s - 2R_L^2 = 0$$

$$R_s^2 - R_L^2 = 0$$

$$R_s - R_L = 0$$

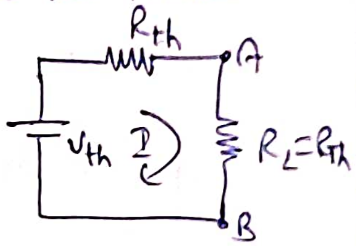
$$\therefore R_L = R_s \text{ (or)}$$

$$R_L = R_i$$

i.e Load resistance = Internal resistance

Hence, the maximum power will be transferred to the load when load resistance is equal to the source resistance.

Steps for solving the Maximum power Transfer Theorem:-



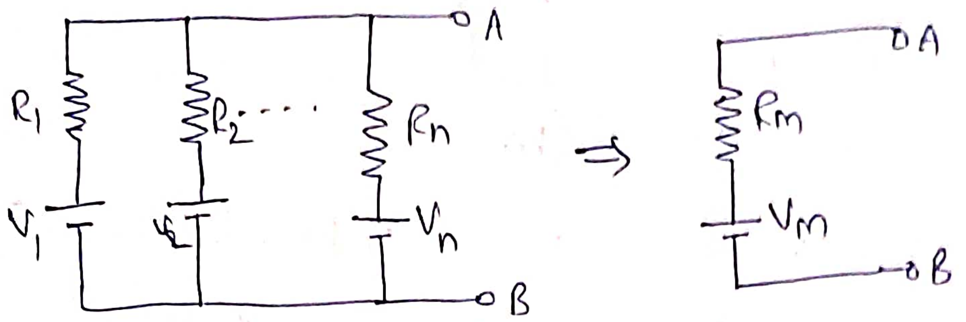
1. Remove the variable load resistor R_L
2. Find the open circuit voltage V_{th} across A and B
3. Find the resistance R_{Th} as seen from points A & B
4. Find the resistance R_L for maximum power transfer
   $R_L = R_{Th}$
5. Find the Maximum power

$\left(\because \begin{matrix} V_{th} = V_s \\ R_{th} = R_s \end{matrix}\right)$ $\quad I_L = \dfrac{V_{Th}}{R_{Th}+R_L} = \dfrac{V_{th}}{2R_L} \quad (\because R_{th} = R_s = R_L)$

$$P_{max} = I_L^2 R_L = \frac{V_{th}^2}{(2R_L)^2} = \frac{V_{th}^2}{4R_L} = \frac{V_s^2}{4R_L}$$

Milliman's Theorem:-

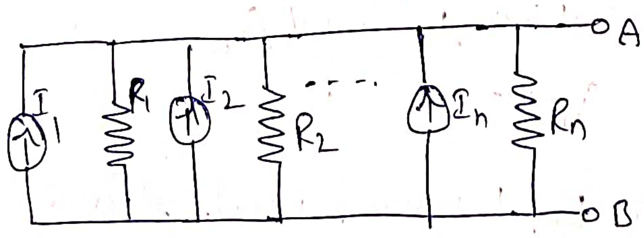
Statement:- It states that "If there are n voltage sources $V_1, V_2, \ldots, V_n$ with internal resistances $R_1, R_2, \ldots, R_n$ respectively connected in parallel then these voltage sources can be replaced by a single voltage source V_m and a single series resistance R_m."



where
$$V_m = \frac{V_1G_1 + V_2G_2 + \cdots + V_nG_n}{G_1 + G_2 + \cdots + G_n}.$$

and
$$R_m = \frac{1}{G_m} = \frac{1}{G_1 + G_2 + \cdots G_n}$$

Explanation:- By source transformation, each voltage source in series with a resistance can be converted to a current source in parallel with a resistance as shown bellow.



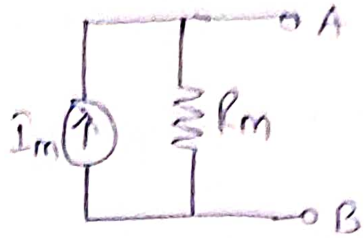
Equivalent Network

Let I_m be the resultant current of the parallel current source and R_m be the equivalent resistance as shown bellow

$I_m = I_1 + I_2 + \cdots + I_n$

$= \frac{V_1}{R_1} + \frac{V_2}{R_2} + \cdots + \frac{V_n}{R_n}$

$= V_1G_1 + V_2G_2 + \cdots + V_nG_n$



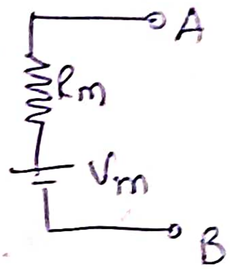
$\frac{1}{R_m} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_n}$

$G_m = G_1 + G_2 + \cdots + G_m$

By using Source Transformation, the paralled circuit can be converted into a series circuit as shown bellow

$V_m = I_m R_m$

$V_m = \frac{I_m}{G_m} = \frac{V_1G_1 + V_2G_2 + \cdots + V_nG_n}{G_1 + G_2 + \cdots + G_n}$



Milliman's equivalent n/w.

Steps for solving Millman's Theorem:-

1. Remove the Load Resistance R_L
2. Find Millman's voltage across points A and B

$$V_m = \frac{V_1G_1 + V_2G_2 + \cdots + V_nG_n}{G_1 + G_2 + \cdots + G_n}$$

3. Find the Resistance R_m between points A and B

$$R_m = \frac{1}{G_1 + G_2 + \cdots + G_n}$$

4. Replace the network by a voltage source V_m in series with the resistance R_m.

5. Find the current through R_L using ohms law.

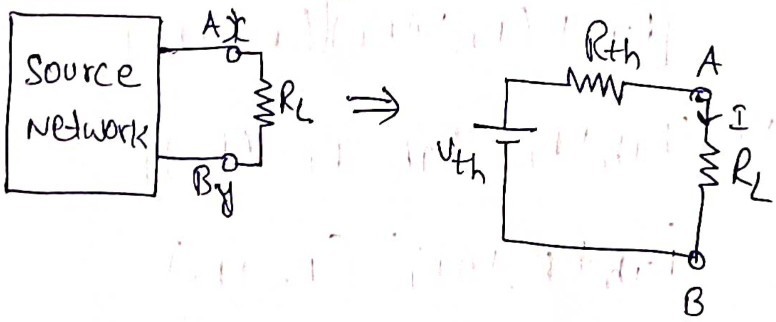
$$I_L = \frac{V_m}{R_m + R_L}$$

Compensation Theorem:-

Statement:- It states that "In any linear bilateral active network, If any branch carrying a current I has its resistance R changed by ΔR, the resulting changes that occur in the other branches are the same as thouse which would have been produced by an opposing voltage source of value V_c ($I\Delta R$) introduced into the modified branch."

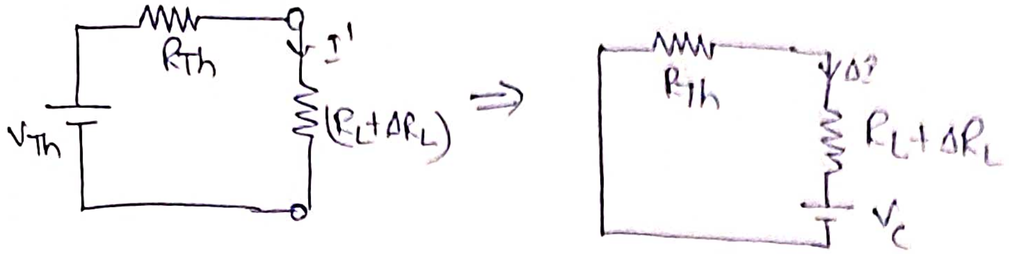
Explanation:-

Let us Assume a load R_L be connected to a dc source net work whose Thevenin's equivalent voltage and resistance as V_{th} and R_{th} as shown bellow.



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

Let the load resistance R_L be changed to $(R_L + \Delta R_L)$. Since the rest of the circuit remains unchanged, The Thevenin equivalent network remains the same as shown bellow



Here $$I' = \frac{V_{Th}}{R_{Th}+(R_L+\Delta R_L)}$$

The change of current being termed as ΔI,

$$\Delta I = I' - I$$

$$= \frac{V_{Th}}{R_{Th}+(R_L+\Delta R_L)} - \frac{V_{Th}}{R_{Th}+R_L}$$

$$= \frac{V_{Th}(R_{Th}+R_L) - V_{Th}(R_{Th}+(R_L+\Delta R_L))}{[R_{Th}+(R_L+\Delta R_L)](R_{Th}+R_L)}$$

$$= \frac{V_{Th}[(R_{Th}+R_L) - (R_{Th}+(R_L+\Delta R_L))]}{[R_{Th}+(R_L+\Delta R_L)](R_{Th}+R_L)}$$

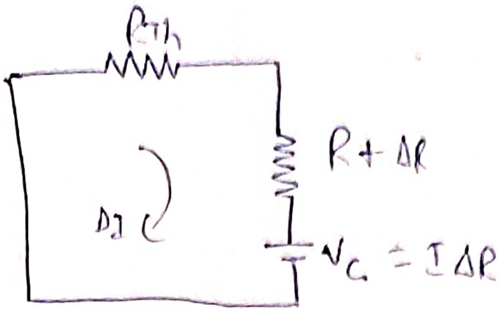
$$= \frac{V_{Th}[(R_{Th}+R_L - R_{Th} - R_L - \Delta R_L)]}{[R_{Th}+R_L+\Delta R_L](R_{Th}+R_L)}$$

$$= -\left(\frac{V_{Th}}{R_{Th}+R_L}\right)\frac{\Delta R_L}{R_{Th}+R_L+\Delta R_L}$$

$$= -\frac{I\Delta R}{R_{Th}+R_L+\Delta R_L}$$

$$= -\frac{V_c}{R_{Th}+R_L+\Delta R_L}$$

where $V_c = I \Delta R$ and is called the compensation voltage



Thus it has been proved that, with change of branch resistance, branch current is changed and the change is equivalent to an ideal compensating voltage source in series with the branch opposing the original current, all other sources in the network being replaced by their internal resistances.

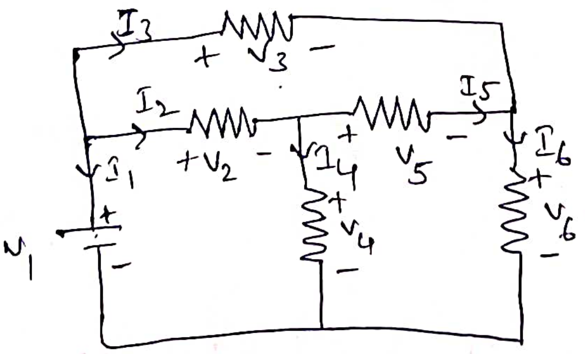
Tellegen's Theorem:-

statement:- It states that "the algebraic sum of the powers in all branches of the network at any instant is zero".

$$\sum_{k=1}^{n} V_k I_k = 0$$

This condition is valid for the network which obeys kirchhoff's voltage and current laws.

Explanation:- Consider a network shown bellow.



Network illustrating Tellegen's Theorem

According to Tellegen's Theorem

$$\sum_{k=1}^{n} V_k I_k = 0$$

$$\therefore \quad \sum_{k=1}^{6} V_k I_k = V_1 I_1 + V_2 I_2 + V_3 I_3 + V_4 I_4 + V_5 I_5 + V_6 I_6$$

$$= V_1 I_1 + (V_1 - V_4) I_2 + (V_1 - V_6) I_3 + V_4 I_4 + (V_4 - V_6) I_5 + V_6 I_6$$

$$\sum_{k=1}^{6} V_k I_k = V_1 (I_1 + I_2 + I_3) + V_4(-I_2 + I_4 + I_5) + V_6(-I_3 - I_5 + I_6) \rightarrow (1)$$

Applying KCL at Node 1,

$$I_1 + I_2 + I_3 = 0$$

Applying KCL at Node 4,

$$I_2 = I_4 + I_5 \Rightarrow -I_2 + I_4 + I_5 = 0$$

Applying KCL at Node 6,

$$I_5 + I_3 = I_6 \Rightarrow -I_3 - I_5 + I_6 = 0$$

from Equation (1)

$$\therefore \sum_{k=1}^{6} V_k I_k = V_1(0) + V_4(0) + V_6(0)$$

$$= 0$$

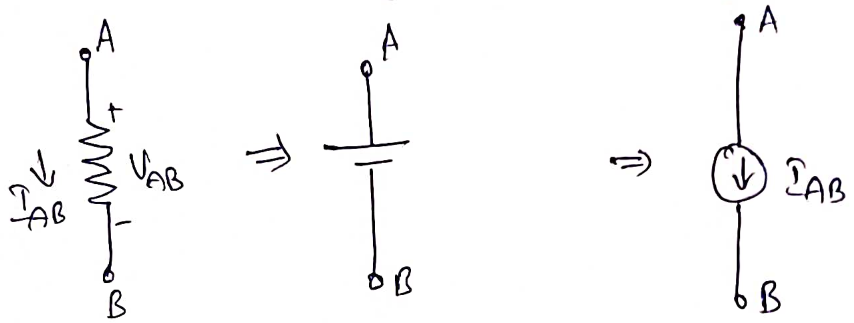
$$\therefore \sum_{k=1}^{6} V_k I_k = 0$$

Hence, Tellegen's Theorem is verified.

Substitution Theorem:-

Statement:- The voltage across and current through any branch of a dc bilateral network being known, this branch can be replaced by any combination of elements that will make the same voltage across and current through the chosen branch.

Explanation:- Any branch can be replaced by any combination of elements that will have the same voltage across it and same current through it as the original branch.



Branch of a n/w whose V_{AB} and I_{AB} are know

Branch replaced by a voltage source V_{AB}

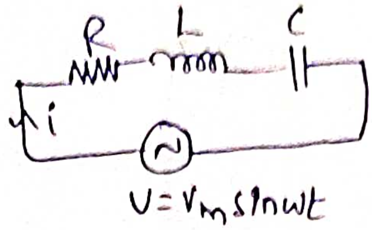
Branch replaced by a current source I_{AB}

Steps for solving substitution Theorem:-

1. Find the branch voltage and branch current in the n/w
2. Replace the branch by an independent voltage source and find the voltage and current in the n/w.
3. Replace the branch by an independent current source and find the voltage and current in the n/w.

Resonance:-

Consider the series RLC circuit as shown figure. The impedance of the circuit is



$$Z = R + jX_L - jX_C$$
$$= R + j(X_L - X_C)$$

At Resonance, the circuit is purely Resistive.

$$X_L - X_C = 0$$
$$X_L = X_C$$
$$\omega_0 L = \frac{1}{\omega_0 C}$$
$$\omega_0^2 = \frac{1}{LC}$$
$$\omega_0 = \frac{1}{\sqrt{LC}} \Rightarrow f_0 = \frac{1}{2\pi\sqrt{LC}}$$

where f_0 is called the resonant frequency of the circuit.

1. power factor:

$$\text{Power factor} = \cos\phi = \frac{R}{Z}$$

At Resonance $Z = R$

$$\text{power factor} = \frac{R}{R} = 1$$

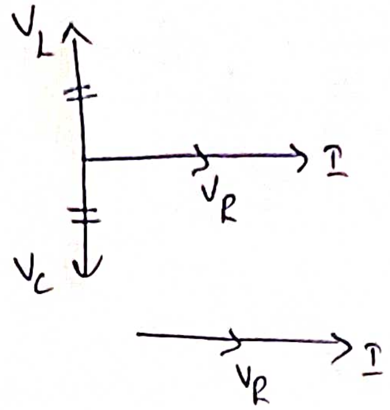
2. Current:- since impedance is minimum, the current is Maximum at Resonance. Thus, the circuit accepts more current and as such, an RLC circuit under Resonance is called an acceptor circuit.

$$I_0 = \frac{V}{Z} = V/R$$

3. Voltage At Resonance

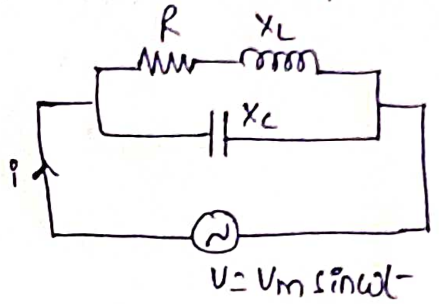
$$\omega_0 L = \frac{1}{\omega_0 C}$$
$$\omega_0 L I_0 = \frac{1}{\omega_0 C} I_0$$
$$V_{L0} = V_{C0}$$

4. Phasor diagram:-



Parallel Resonance:-

Consider a parallel circuit consisting of a coil and capacitor as shown bellow figure.



The impedances of two branches are

$Z_1 = R + jX_L$

$Z_2 = -jX_C$

$$Y_1 = \frac{1}{Z_1} = \frac{1}{R + jX_L} = \frac{R - jX_L}{R^2 + X_L^2}$$

$$Y_2 = \frac{1}{Z_2} = \frac{1}{-jX_L} = \frac{j}{X_C}$$

Admittance of the circuit $Y = Y_1 + Y_2$

$$= \frac{R - jX_L}{R^2 + X_L^2} + \frac{j}{X_C}$$

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

At resonance, the circuit is purely resistive.

$\therefore$ The condition for resonance is

$$\frac{X_L}{R^2 + X_L^2} - \frac{1}{X_C} = 0$$

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

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

$$\omega_0 L \frac{1}{\omega_0 C} = R^2 + \omega_0^2 L^2$$

$$\frac{L}{C} = R^2 + \omega_0^2 L^2$$

$$\omega_0^2 L^2 = \frac{L}{C} - R^2$$

$$\omega_0^2 = \frac{1}{LC} - \frac{R^2}{L^2}$$

$$\omega_0 = \sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}$$

$$f_0 = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}$$

where f_0 is called the resonant frequency of the circuit

if R is very small as compared to L then

$$\omega_0 = \frac{1}{\sqrt{LC}}$$

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

Dynamic impedance of a parallel circuit:-

At resonance, the circuit is purely resistive.

The real part of admittance is $\frac{R}{R^2+X_L^2}$

Hence, the impedance at resonance is given by

$$Z_D = \frac{R^2+X_L^2}{R}$$

At resonance, $R^2 + X_L^2 = X_L X_C = \frac{L}{C}$

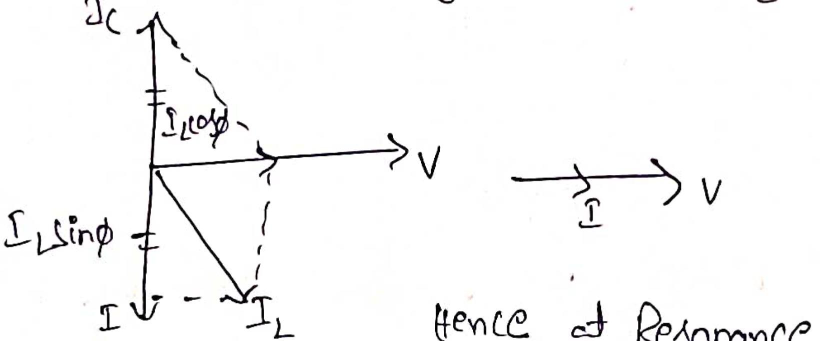
$$Z_D = \frac{L}{CR}$$

Current: Since impedance is maximum at resonance, the current is minimum at resonance.

$$I_0 = \frac{V}{Z_D} = \frac{V}{\frac{L}{CR}} = \frac{VCR}{L}$$

Phasor Diagram: At resonance, power factor of the circuit is unity and the total current drawn by the circuit is in phase with the voltage.

This will happen only when $I_C = I_L \sin\phi$



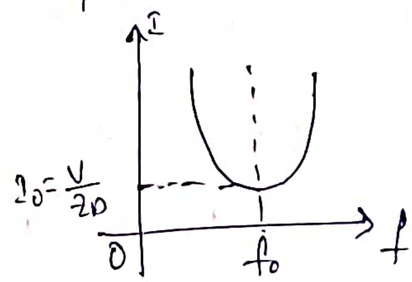
Hence, at Resonance

$I_C = I_L \sin\phi$

and $I = I_L \cos\phi$

Band Width:- The bandwidth of a parallel resonant circuit is defined in the same way as that for a series resonant circuit.

The figure shows the resonance curve of a parallel resonant circuit.



Quality factor:- It is a measure of current magnification in a parallel resonant circuit.

$$Q_0 = \frac{\text{current Through Inductor or capacitor}}{\text{current at Resonance}} = \frac{I_{C0}}{I_0}$$

Substituting values of I_{Co} and I_0,

$$Q_0 = \frac{\frac{V}{X_{Co}}}{\frac{VCR}{L}} = \frac{\frac{1}{X_{Co}}}{\frac{CR}{L}} = \frac{\omega_0 C}{\frac{CR}{L}} = \frac{\omega_0 L}{R}$$

neglecting the resistance R, the resonant frequency ω_0 is given by $\omega_0 = \frac{1}{\sqrt{LC}}$

$$\therefore Q_0 = \frac{\left(\frac{1}{\sqrt{LC}}\right)L}{R} = \frac{1}{R}\sqrt{\frac{L}{C}}$$

Expression for Band width for series connection:-

Generally, at any frequency ω,

$$I = \frac{V}{Z} = \frac{V}{\sqrt{R^2+(X_L-X_C)^2}} = \frac{V}{\sqrt{R^2+\left(\omega L-\frac{1}{\omega C}\right)^2}} \rightarrow (1)$$

at half-power points

$$I = \frac{I_0}{\sqrt{2}}$$

But $I_0 = V/R$

$$\therefore I = \frac{V}{\sqrt{2}R} \rightarrow (2)$$

equate Eqn (1) & Eqn (2)

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

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

. Squaring Both the sides

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

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

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

$$\omega^2 \pm \frac{R}{L}\omega - \frac{1}{LC} = 0$$

$$\omega = \pm \frac{R}{2L} \pm \sqrt{\frac{R^2}{4L^2} + \frac{1}{LC}}$$

For low values of R, the term $\left(\frac{R^2}{4L^2}\right)$ can be neglected in comparison with the term $\frac{1}{LC}$.

Then ω is given by, $\omega = \pm \frac{R}{2L} \pm \sqrt{\frac{1}{LC}} = \pm \frac{R}{2L} \pm \frac{1}{\sqrt{LC}}$

Then ω is given by, $\omega = \pm \frac{R}{2L} \pm \sqrt{\frac{1}{LC}} = \pm \frac{R}{2L} \pm \frac{1}{\sqrt{LC}}$

The resonant frequency for this circuit is given by

$$\omega_0 = \frac{1}{\sqrt{LC}}$$

$$\omega = \pm \frac{R}{2L} + \omega_0 \quad \text{(considering only +ve sign of } \omega_0\text{)}$$

$$\omega_1 = \omega_0 - \frac{R}{2L}$$

and $\omega_2 = \omega_0 + \frac{R}{2L}$

$$f_1 = f_0 - \frac{R}{4\pi L}$$

and $f_2 = f_0 + \frac{R}{4\pi L}$

Band width $= \omega_2 - \omega_1 = R/L$

or Band width $= f_2 - f_1 = R/2\pi L$

Quality factor for Series Resonance:-

It is measure of voltage magnification in the series resonant circuit. It is also a measure of selectivity or sharpness of the series resonant circuit.

$$Q_o = \frac{\text{voltage across inductor or capacitor}}{\text{Voltage at resonance}} = \frac{V_{Lo}}{V} = \frac{V_{Co}}{V}$$

Substitude values of V_{Lo} and V,

$$Q_o = \frac{I_o X_{Lo}}{I_o R} = \frac{X_{Lo}}{R} = \frac{\omega_o L}{R} = \frac{1}{\omega_o C R}$$

Substitude value of ω_o,

$$Q_o = \frac{\left(\frac{1}{\sqrt{LC}}\right) L}{R} = \frac{1}{R}\sqrt{\frac{L}{C}}$$

Comparison of series and parallel Resonant circuit:-

Parameter	Series circuit	Parallel circuit
current at resonance	$I = V/R$ and is maximum	$I = \frac{VCR}{L}$ and is minimum
Impedance at Resonance	$Z = R$ and is Minimum	$Z = \frac{L}{CR}$ and is Maximum
power factor	unity	unity
Resonant frequency	$f_o = \frac{1}{2\pi\sqrt{LC}}$	$f_o = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}$
Q-factor	$Q = \frac{2\pi f_o L}{R}$	$Q = \frac{2\pi f_o L}{R}$