Date:- 21/9/06

Circuit Elements and Kirchhoff's laws.

* Resistance:- The property of material to ~~resistance~~ restric the flow of electrons is called resistance and denoted by 'R' (—www—).
* units:- The unit of resistance is ohm (Ω) according to ohms law $I = \frac{V}{R}$ (or) $i = \frac{v}{R}$.

$$\therefore V = R.\frac{dq}{dt} ; \; i = \frac{V}{R} = Gv.$$

* The power observed by resister is given by
$$P = Vi = (iR)i = i^2R.$$
* Energy last in resistance in time 'T' is given by $W = \int_0^t P.dt = Pt = i^2Rt = \frac{V^2}{R}t.$

* Inductance Parametre:- If current is made to cause trough an Inductor, an electro magnetic field is formed. A change in the magneitude of current changes the electro magnetic field Increase in current expands the fields and decrease in current reduces the fields there fore the change in current produss change in electro magnetic field which induces a voltage across the coil. According to farada's law of electro magnetic induction.

$$V = L\frac{di}{dt}$$

Power absorbed by the radiation.

$$P = Vi = Li\frac{di}{dt}$$

Energy stored in an inductor

$$W = \int_0^t P.dt = \int_0^t Li\frac{di}{dt}dt = \frac{1}{2}Li^2$$

I:- The induced voltage across an Inductor is zero if the current through it is constant. That means an inductor acts as short circuit to D.C

II:- In a fixed inductor the current can not change abruptly.

III:- Pure inductor never dissipates energy, only stores energy.

Capacitances Parametre:- Any two conducting surfaces seperated by an insulating medium exhibit property of a capacitor the conducting surface are called electrodes and insulating medium is called di- electric. A capacitor stores energy in the form of an electric field

$$C = \frac{Q}{V} \text{ (or) } C = \frac{q}{v}$$

$$C = \frac{dv}{dt} \cdot P = vi = vc \cdot \frac{dv}{dt}$$

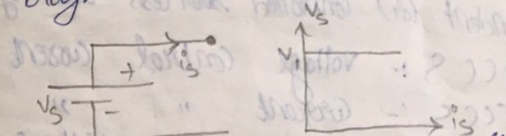
Energy stored in a capacitor

$$W = \int P.dt = \int vc \cdot \frac{dv}{dt} dt = \frac{1}{2} C V^2$$

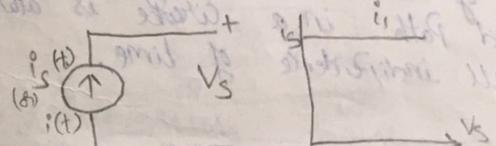
* The capacitor acts as open circuit to DC
* In a fixed capacitance the voltage can not change abruptly.
* The capacitance can store finet amount of energy even if the current trough it is zero.
* A pure capacitor never decipates energy but only stores it.

Energy Sources:-

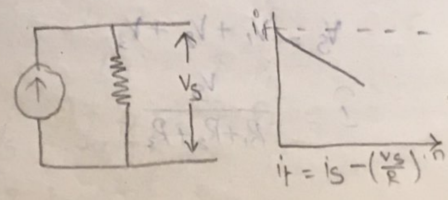
* A/C to their terned voltage - current characteristics electrical energy sources are characterised in to ideal voltage sources and ideal current sources. further they can be divided in to independent and dependent sources.
* An Ideal voltage source is a two terminal element in which the voltage V_s is complete independent of the current is trough its terminals.



* An ideal constant current sources is two ~~termo~~ terminal elements in which current i_s is completly independent of the voltage V_s across its terminals.

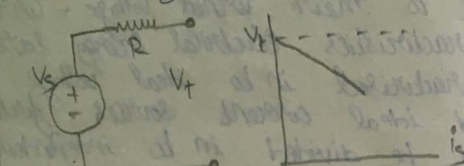


Practical current sources:-



$$i_t = i_s - \left(\frac{V_s}{R}\right)$$

Practical voltage sources:-

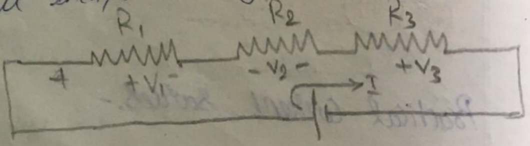


Dependent sources:- Source voltage ~~or~~ current is not fixed it is dependent on the voltage of current existing at the some other location in the circuit.

Dependent (or) Controlled sources are of the following

Dependent (or) Controlled sources are of the following
1) VCCS :- voltage control current sources.
2) CCCS :- current " " "
3) CCVS :- " " voltage "
4) VCVS :- Voltage " " "

Krichoff's law:- It states that algebraic sum of all branch voltage arround any closed path in a circuite is always zero in all indipendence of time.



$$V_S = V_1 + V_2 + V_3$$

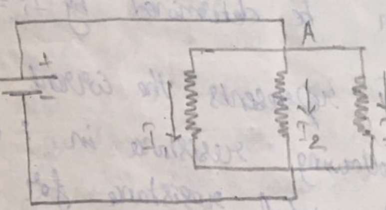
$$I = \frac{V_S}{R_1 + R_2 + R_3}$$

The total powers suppliyed by the sources any series resistive circuit is equal to the sum of power in each resiter in series.

$$P_S = P_1 + P_2 + P_3 + \ldots P_n$$

$$P_S = V_S I = I^2 R_T = \frac{V_S^2}{R_T}$$

Krichoff's current law:- It states that sum of currents entering in to the node is equal to the sum of current leaving node.



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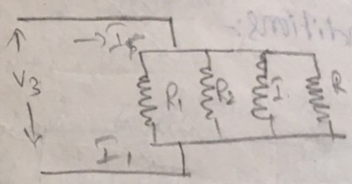


$$I_1 = I_T \frac{R_2}{R_1 + R_2}$$

$$I_2 = I_T = \frac{R_1}{R_1 + R_2}$$

$$V_S = I_1 R_1 = I_2 R_2$$

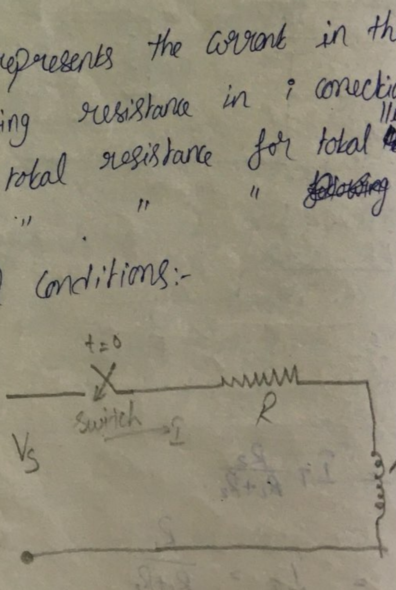
$$I_T = I + I_2$$

$$I_T = \frac{V_s}{R_T} = \frac{V_s}{R_1 R_2}(R_1+R_2) = ?$$

In general if the circute consists of 'n' braches the current in any branch can be determined by $I_i = \frac{R_T}{R_i + R_T} \cdot I_T$

I_i represents the current in the branch following resistance in i conection. R_T is the total resistance for total lle and R_T is the " " ~~following~~ Branch

Intial Conditions:-



Intial Conditions in networks:- Intial (or) final conditions must be known to evaluate the arbiterary constants that show up in the general solution of deferential Eq we can have the knowledge of the behaviour of the elements at the instants of switching.

At the refrences time $t=0$ one (or) more switches opperate assume that switches act in zero time. to defferenciate b/w the time immediatly before and immediatly after the operation of switch we will use '−' and '+' this conditions existing just before the switch is operated will be designated as $i(0^-)$, $v(0^-)$, $i(0^+)$, $v(0^+)$ Etc;

Initial conditions and elements:-

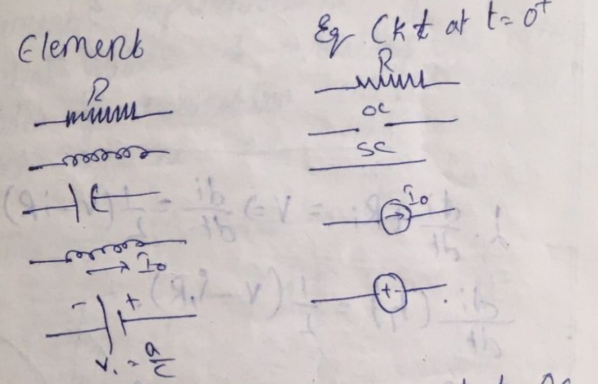
1) The resistor:- in the ideal resister $v = iR$ if a step input of voltage applied to a resistor net work the current will have same uniform altere by the scale factor $1/R$ the current trough a resistor will change instentaneously

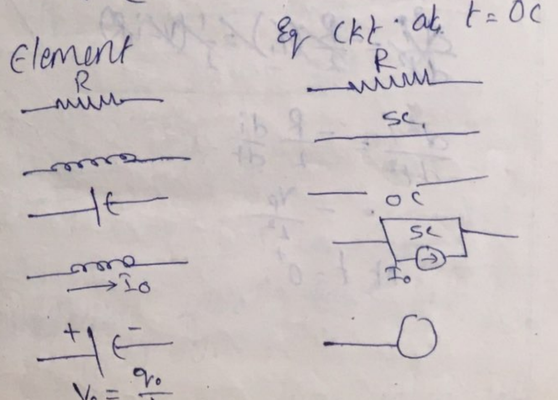
If the voltage changes instantaneously and vise ~~vesa~~ versa.

Inductor:- The current can not change instantaneously in a system of constant inductance conceqwently, closing a switch connect a inductor to a source of Energy will not cause current to flow at intial instant. at the initial instance the inductor acts as if it work open circuite ~~integrated as~~ independent at the voltage at terminal. If the current of value I_0 close the inductor at the instants switching takes place the current will continue to flow. But the incident for intial for conductor can be taught as current source as a I_0.

Capacitor:- Voltage can not change instantaneously in a capacitor. with an uncharged capacitor is connected to an Energy source a current will flow instateneously, the capacitor being electrivalent to short circuite. with an intial charge in the system the capacitor is equivalent to a voltage source of value $V_0 = \frac{Q_0}{C}$.

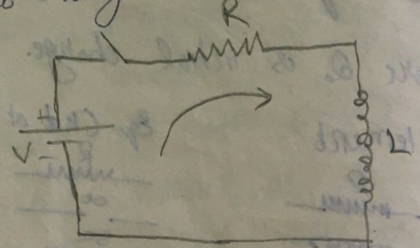
where Q_0 is intial charge.





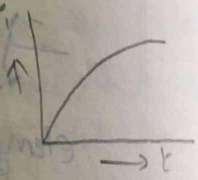
Geometical Inter pilation

Consider the differential Eq that discribes an RL Circute Connected to a Constant voltage source.



$$L\cdot\frac{di}{dt}+Ri = V \Rightarrow \frac{di}{dt} = \frac{1}{L}(V - iR)$$

$$\frac{di}{dt}(t_1) = \frac{1}{L}(V - i_1R).$$



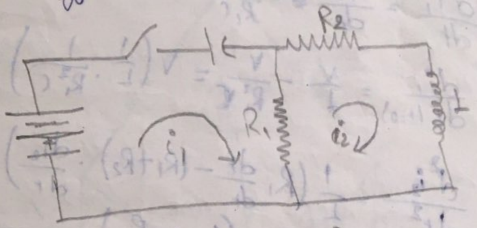
$$\cancel{\frac{d^2i}{dt^2} = -\frac{R}{L}(t_1) = \frac{1}{L}(V - i_1R)}$$

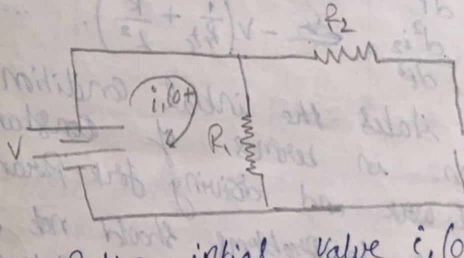
$$\frac{d^2i}{dt^2} = -\frac{R}{L}\frac{di}{dt}$$

$$= -\frac{V_R}{L^2}$$

At $t = 0^+$

The Procedure for Evelvating intial Conditions we usally Solve first for the intial values of the Variables currents, Voltages, Charges and charges for derivatives and the first step is by drawing an equivalent circute for $t = 0^+$ based on the Equivalent element representations in Solving for intial values of derivatives the detials and order of manicolation will be different for each different net work





$i_2(0+) = 0$

$i_1(0+) = \frac{V}{R_1}$

By inspection intial value $i_1(0+) = \frac{V}{R_1}$

$i_2(0+) = 0.$

The first step in solving intial values of derivatives is to write to indent diferential

Eq from kriffo's law in to either a loop (or) node. which gives the required quantities more directly.

$$\frac{1}{C}\int i_1 dt + R_1(i_1 - i_2) = V \Rightarrow \frac{i_1}{C} + R_1\frac{di_1}{dt} - R_1\frac{di_2}{dt} = 0$$

$$R_1(i_2 - i_1) + R_2 i_2 + L.\frac{di_2}{dt} = 0$$

$$\frac{di_2}{dt} = \frac{1}{L}\left(R_1 i_1 - (R_1 i_1 - (R_1 + R_2) i_2\right).$$

$$\frac{di_2}{dt}$$

$$\frac{di_1}{dt} = \frac{di_2}{dt} - \frac{i_1}{R_1 C}$$

$$\frac{di_1}{dt}_{(t=0)} = \frac{V}{L} - \frac{V}{R_1^2 C} = V\left(\frac{1}{L} - \frac{1}{R_1^2 C}\right)$$

$$\frac{d^2 i_2}{dt^2} = \frac{1}{L}\left(R_1\frac{di}{dt} - (R_1 + R_2)\cdot\frac{di_2}{dt}\right)$$

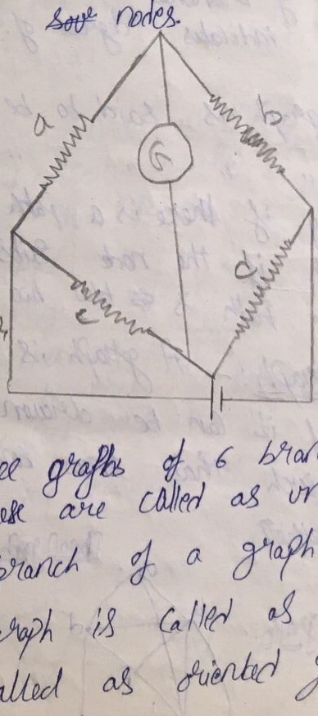
$$\frac{d^2 i_2}{dt^2} = -V\left(\frac{1}{R_1 L C} + \frac{R}{L^2}\right).$$

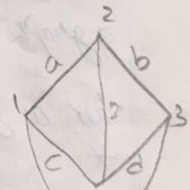
each states the initial condition have been given. in terms of constants (net work and driving fork Parameters) solutions to problems should not be given in terms of derivative or integral expressions

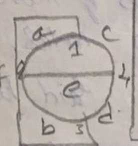
Methods of analysing circuits:-

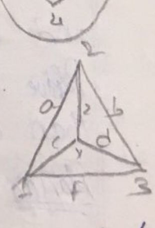
In N.A all the Elements in a network & must satisfy krichoff's laws beside their own characteristics based on this laws, we can form a no of Eq these Eq can be easily written by converting the network in to a graph.

Net work:- It is a interconnection of elements in various branches at different nodes.

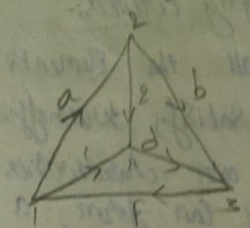








The three graphs of 6 branches and four nod. these are called as undirected if Every branch of a graph have a direction then graph is called as directed graph also called as oriented graph



A node and branch ~~or~~ incident to the node is a terminal of a branch. ~~the nodes~~

If the node can be incident.

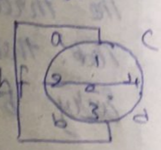
The no:- of branches incident at a node of a graph indicates degree of node.

when a graph is said to be connected

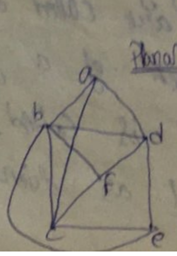
* " " " " " " if and only if there is a path b/w every Passive path if the node exits if these more than one path is ~~c~~ b/w two nodes.

<u>Planar graph</u>:- A graph is said to be " if it can be drawn on a plane surface such that know two branches draw together.

Planar graph



<u>non Planar graph</u>:-

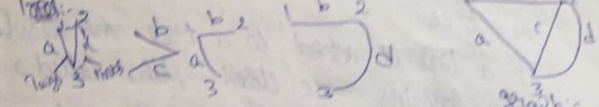


There will be branches which are not in same Plane as well as other it is called non-planar graph.

TREE & Co-tree:-

* A tree is connected sub graph of net work which consists of all ~~a~~ nodes, but not closed path.

Trees:-



Graph:-

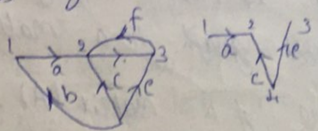
* The no of nodes in a graph = no of nodes in a tree
* The " " branches " " tree is < branch in a graph
* A graph is a tree if there is a unique path b/w any pair of nodes.

{a, c} = tree ; {b d} = co tree

<u>Links (or) link branches</u>:- in forming a tree for a given graph ~~and~~ certain branches (or) removed or opened the branches thus opened as called links (or) link branches.

* The set of all links of a given tree is called the co-tree of a graph. thus link branches and tree branches combine to for a graph of entire net work.

<u>Twigs</u>:- The branches of a tree are called its twigs



for a net work with 'b' branches and 'n' nodes the no of twigs for selected tree is $(n-1)$ and no of links is $b-(n-1)$.

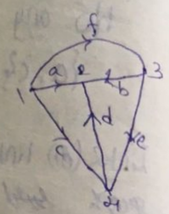
The no of twigs $(n-1)$ is known as tree value of a graph it is also called as rank of the tree.

If a link is added to a tree the resulting graph contains one closed path, called a loop.

Loops which contain ~~closed~~ one link closed is called closed loop.

Loops which are contain one link are independent are called basics loops.

Incident Matrix:-



Node / branches

$$\begin{array}{c|c} & \begin{array}{cccccc} a & b & c & d & e & f \end{array} \\ \begin{array}{c} 1 \\ 2 \\ 3 \\ 4 \end{array} & \begin{bmatrix} 1 & 0 & 1 & 0 & 0 & 1 \\ -1 & -1 & 0 & -1 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 & -1 \\ 0 & 0 & -1 & 1 & -1 & 0 \end{bmatrix} \end{array}$$

Def:- The incidence of elements to nodes in a connected graph is shown by element node incidence matrix (A)

* Arrow in a graph are the indication for current flow (or) voltage in net work.
* It is possible to have an anylitical discription of an oriented graph in a matrix form.
* The dimensions of a matrix (A) is 'n' ~~and~~ in to 'b' where 'n' is no of nodes and 'b' is no of branchs.
* An entry a_{ij} has the following values

$a_{ij} = 1$ if j^{th} branch is incident to and oriented away from i^{th} node

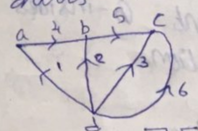
$a_{ij} = -1$ if j^{th} branch incident to and oriented towards the i^{th} node

$a_{ij} = 0$ if j^{th} branch is not incident to the i^{th} node.

* Reduce incidence matrix:-

If one row of 'a' is deleted the resulting $(n-1)\times b$ matrix is called the reduced incidence matrix A_1

given A_1 'a' is easly obtained in which each coloumn representing a branch contains two non-zero entries +1 and -1 and rest being zero.



At 'a' :- $-i_1 + i_4 = 0$

'b' :- $-i_4 + i_5 - i_2 = 0$

c :- $-i_5 - i_3 - i_6 = 0$

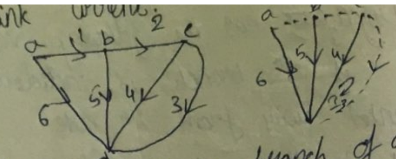
$$\begin{bmatrix} -1 & 0 & 0 & 1 & 0 & 0 \\ 0 & -1 & 0 & -1 & 1 & 0 \\ 0 & 0 & -1 & 0 & -1 & -1 \end{bmatrix} \cdot \begin{bmatrix} I_1 \\ I_2 \\ I_3 \\ I_4 \\ I_5 \\ I_6 \end{bmatrix} = 0$$

$$A_1 I_b = 0$$

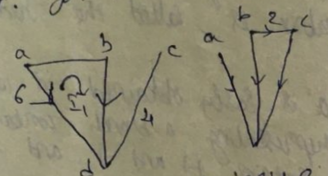
* Here I_b represent a call matrix or vector of a branch currents.

* Main currents and direct matrix:-

for given tree of a graph addition of tree b/w two notes form a tree called a fundamental loop. In a loop their exits a closed path and circulating current which is called link currents:

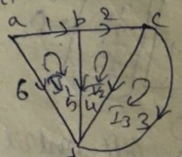


The current in any branch of a graph can be formed by ~~tee~~ link currents the fondemental loop formed by 'i' link as a ~~unik~~ Unique loop formed by ~~that~~ tree joining two nodes of loop Path of the fundemental loop are this node is called fondemental tie-set. for the same



The link current 6-insides with branch current direction.

ti-set matrix:-



Krichoff's voltage law can be applied to the fondemental loops to get set of linearly indipendent eq if $V_1, V_2, V_3, V_4, V_5, V_6$ are voltages the KVL eq. for the three fondemental loops can be written as.

$V_1 + V_5 - V_6 = 0$

$V_2 + V_4 - V_5 = 0$

$V_3 - V_4 = 0$

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 1 & -1 \\ 0 & 1 & 0 & 1 & -1 & 0 \\ 0 & 0 & 1 & -1 & 0 & 0 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \\ V_5 \\ V_6 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

Where 'V' is an $I \times b$ Matrix called ti-set matrix (or) fondamental loop matrix and V_B is a ~~cross~~ ~~Product~~ column matrix of branch matrix.

Ti-set matrix and branch currents:-

If I_B and I_L represents a branch current matrix and loop current matrix respectively and 'T' is the Ti-set matrix then

$$[I_B] = [B^T][I_L] \longrightarrow (1)$$

The eq (1) is known as link current transformation

Eq. consider a ti-set matrix for a graph.

$$B = \begin{bmatrix} 1 & 0 & 0 & 0 & 1 & -1 \\ 0 & 1 & 0 & 1 & -1 & 0 \\ 0 & 0 & 1 & -1 & 0 & 0 \end{bmatrix} ; \quad B^T = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & -1 \\ 1 & -1 & 0 \\ 1 & 0 & 0 \end{bmatrix}$$

$$I_B = \begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \\ i_5 \\ i_6 \end{bmatrix}$$

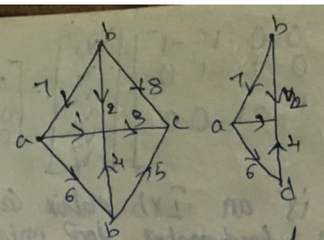
$$\therefore \begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \\ i_5 \\ i_6 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & -1 \\ 1 & -1 & 0 \\ 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} \rightarrow \text{from (1)}$$

$i_1 = I_1$; $i_2 = I_2$

$i_3 = I_3$; $i_4 = I_2 - I_3$; $i_5 = I_1 - I_2$; $i_6 = -I_1$

Cut-set and tree branch voltages:-

A cut-set is a minimal set of branches of a connected graph such that the removal of this branches causes the graph to be cut in to exactly two parts.

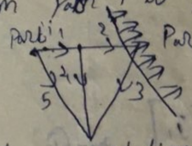


The important property of cut-set is that by restoring any one of the branches of the ~~head-se~~ cut-set the graph should be-come connected. A cut-set consists of one and only one branch of the net work tree, together with any links which must be cut to divide the net work in to '2'-Paths.

* The set formed by branches 3, 5, 8 is called the cut-set of the connected graph

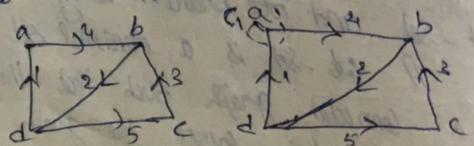
Cut-set orientation:-

we may take the oriantation either from Path 'i' to path '2' (or) from Part '2' to path 'i'

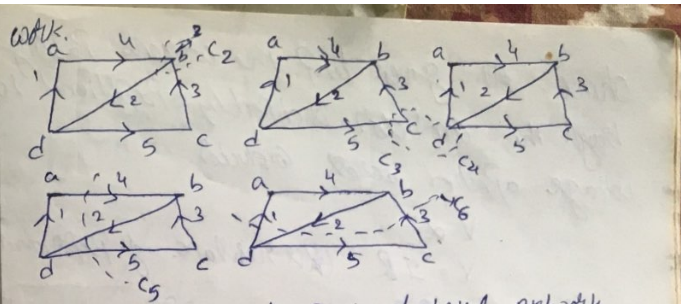


The oriantation of some branches of the cut-set may co-inside with the orintation of cut-set while some branch of cut-set may not co-inside.

Cut-set matrix and KCL for cut-set:-



KCL is also opticable to a cut-set of a net work.



Apply for any ~~Ao~~ lumpped electrical network the algebraic sum of all cut set branch currents is equal to zero.

apping KCL for each cut-set. we atain the following eq

Sol:- Let $i_1, i_2 \dots i_6$ be branche currents.

$C_1 = i_1 - i_4 = 0$; $C_2 = i_3 + i_4 - i_2 = 0$

$C_3 = -i_3 + i_5 = 0$; $C_4 = i_2 + i_5 - i_1 = 0$

$C_5 = -i_2 + i_4 + i_5 = 0$; $C_6 = i_1 - i_2 + i_3 = 0.$

$$Q \cdot I_6 = 0$$

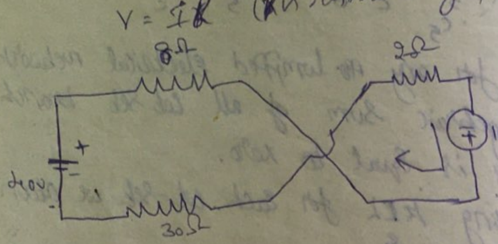
$$\begin{bmatrix} 1 & 0 & 0 & -1 & 0 & 0 \\ 0 & -1 & 1 & 1 & 0 & 0 \\ 0 & 0 & -1 & 0 & 1 & 0 \\ -1 & 1 & 0 & 0 & -1 & 0 \\ 0 & -1 & 0 & 1 & 1 & 0 \\ 1 & -1 & 1 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \\ i_5 \\ i_6 \end{bmatrix} = 0$$

where 'Q' is called the augmented cut-set matrix of the graph (or) all cut-set matrix of the graph the matrix I_B is the branch current

Ohms:- At given temp the current passing through the conductor is directly proportional to the voltage applied across conductor.

$V \propto$

$V = IR$ (R is resistance of proportionality).

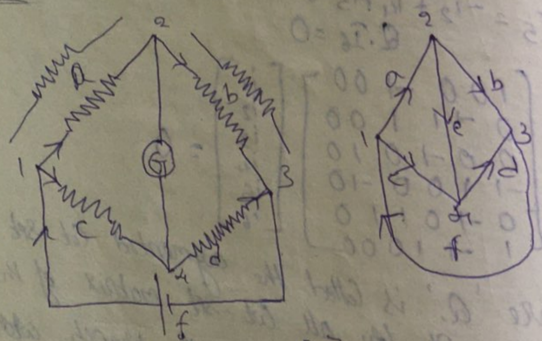


$V = IR$ $\qquad 100 = 8i + 40 + 3i + 2i$

$I = \frac{V}{R}$ $\qquad 60 = 40i$

$i = 3/2 = 1.5$ Amp

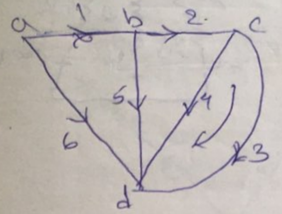
Incident matrix:-



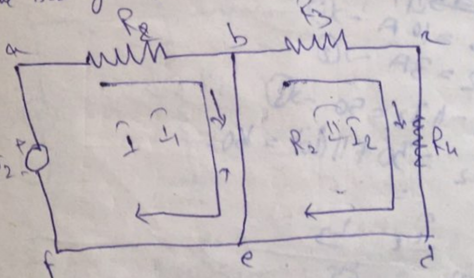
$$\begin{array}{c|cccccc} & a & b & c & d & e & f \\ \hline 1 & 1 & 0 & 1 & 0 & 0 & -1 \\ 2 & -1 & 1 & 0 & 0 & 1 & 0 \\ 3 & 0 & -1 & 0 & -1 & 0 & 1 \\ 4 & 0 & 0 & -1 & 1 & -1 & 0 \end{array}$$

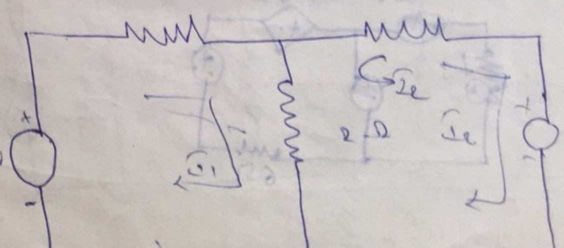
Reduce incident matrix

$$\begin{array}{c|cccc} & a & b & c & d \\ \hline 1 & 0 & 1 & 0 & 1 \\ 2 & 1 & -1 & 0 & 0 \\ 3 & -1 & 0 & 1 & 0 \end{array}$$



Fundamental cut set:- The cut set can be defined as independent linear variable in the set of variables then the tree is selected and a tabe tree is selected removing this tree in to the seprate that tree in to two parts all the twigs which go from 1 part disconnected to the other together with that twig of selected tree will constitute a cut set. this cut set is known fundamental cut set. Thus fundamental cut set of graph with respect to tree is a cut sets formed by 1 twig and lead to set of twigs unique set of links is.



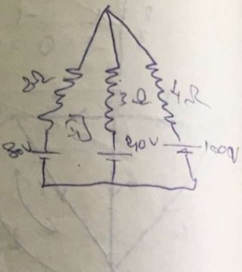


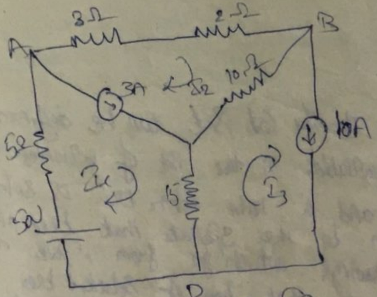
$5I_1 + 2(I_1 - I_2) = 10$

$2(I_2 - I_1) + 10I_2 = -50$

$2(I_1) + 3(I_1 - I_2) + 40 + 80 = 0$

$3(I_2 - I_1) + 4(I_2) + 100 - 40 = 0$





$I_1 - I_2 = 3A \rightarrow (1)$

$I_3 = 10A \rightarrow (2)$

$50 = 50 + 3I_1 + 3I_2 + 2I_2 + 10(I_2 - I_3) + 5(I_1 - I_3) \rightarrow (3)$

$\cancel{50 = 5I_1 +}$

$I_3 = 10A \rightarrow (1)$

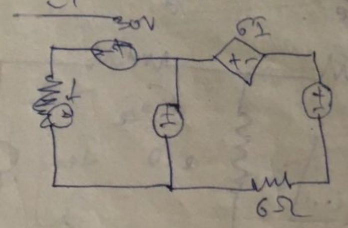
$I_1 - I_2 = 3A \rightarrow (2)$

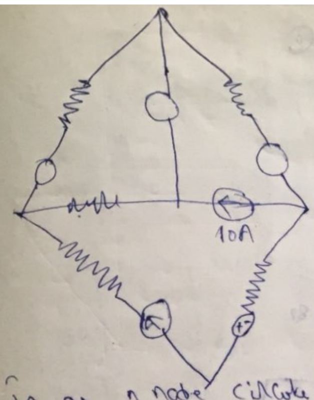
$6I_1 + 15I_2 - 11I_3 = 50 \rightarrow (3)$

$6I_1 + 15I_2 = 50 + 11(10) = 160.$

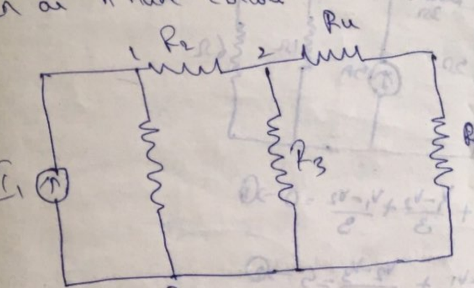
$=$

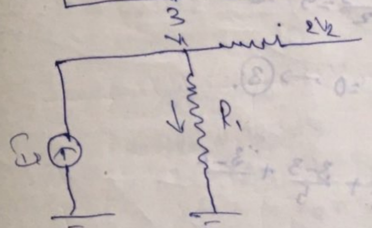
$I_1 \quad I_2 \quad I_3$

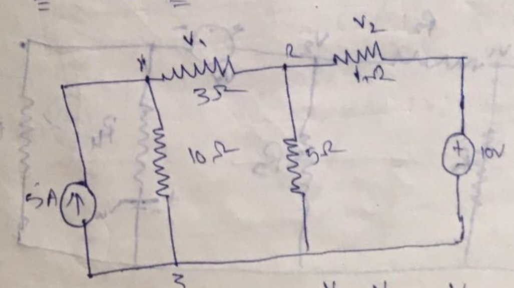




In an n node circuit 'i' one of the node is







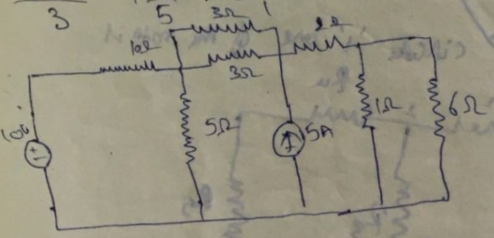
$5 = \frac{V_1 - V_2}{3} + \frac{V_1}{10} \rightarrow (1)$

$$\frac{V_2 - V_1}{3} + \frac{V_2}{5} + \frac{V_2 - 10}{1} = 0 \rightarrow (2).$$

$$5 = \frac{3-1}{3} + \frac{3}{10}$$

$$5 = \frac{2}{3} + \frac{3}{10}$$

$$\frac{\cancel{3}-2}{3} + \frac{1}{5} + \frac{1-10}{1} = 13.82$$

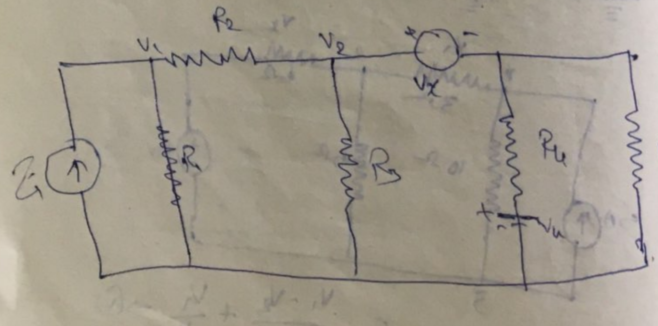


$$\frac{V_1 - 10}{10} + \frac{V_1}{5} + \frac{V_1 - V_2}{3} + \frac{V_1 - V_2}{3} = 0 \rightarrow (1)$$

$$\frac{V_2 - V_1}{3} + \frac{V_2 - V_1}{3} + \frac{V_2 - V_3}{2} = 5 \rightarrow (2)$$

$$\frac{V_3 - V_2}{2} + \frac{V_3}{1} + \frac{V_3}{6} = 0 \rightarrow (3).$$

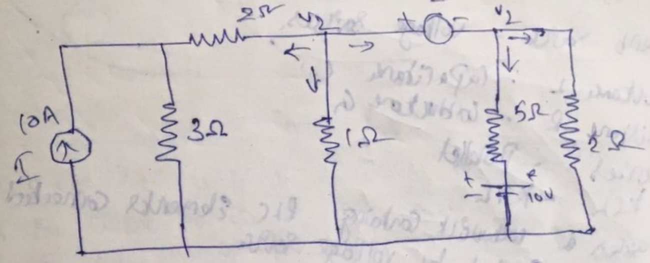
$$\frac{3-10}{10} + \frac{3}{5} + \frac{3-3}{5} + \frac{3-2}{}$$



$$I = \frac{V_1}{R_1} + \frac{V_1 - V_2}{R_2} \rightarrow (1)$$

$$V_2 - V_3 = V_x \rightarrow (2).$$

$$0 = \frac{V_2 - V_1}{R_2} + \frac{V_2}{R_3} + \frac{V_3 - V_4}{R_4} + \frac{V_3}{R_5} \rightarrow (3).$$



$$10 = \frac{V_1}{3} + \frac{V_1 - V_2}{2} \rightarrow (1)$$

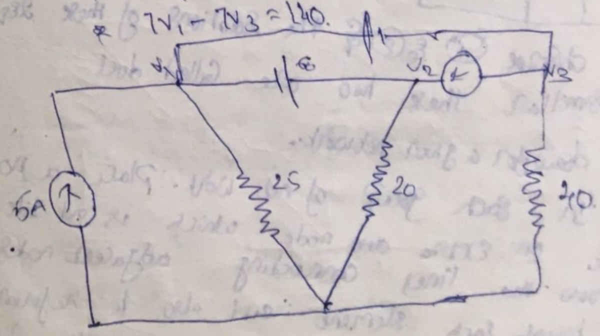
$$V_2 - V_3 = 20 \rightarrow (2)$$

$$\frac{5V_2 - 5V_1 + 10V_2 + 2V_3 - V_4 \cancel{V_2}}{10}$$

$$= 20V_2 - 20 - 5V + 2V_3 = (V_2 - V_3)^2$$

$$12V_1 + 7V_3 = 80$$

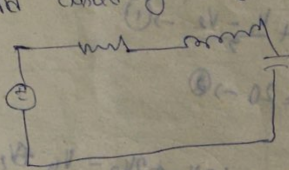
$$7V_1 - 7V_3 = 140.$$



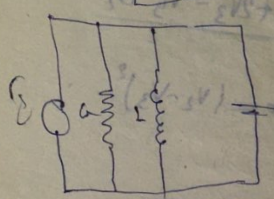
In an electrical circuits there are new circuits which can be interchanged to get new circuits. Such Pair of given term are given below.

Current Source = Voltage sources.
Inductance L – Capacitance C
Resistance R – Conductance G
Series – Parallel
KCL – KVL

Consider a network containing RLC elements connected in series and excited by voltage source



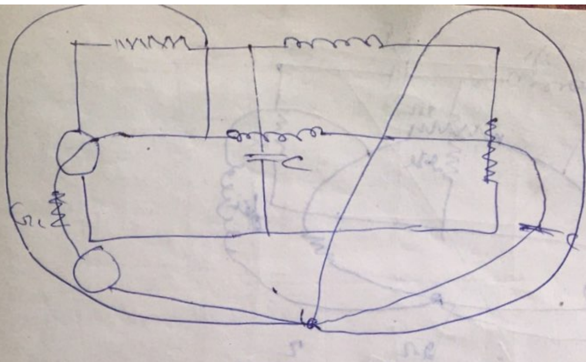
$V = Ri + L\frac{di}{dt} + \frac{1}{C}\int i\,dt$



If we observe ① & ② & the solutions of these 2eq will be simillar these two are called duel.

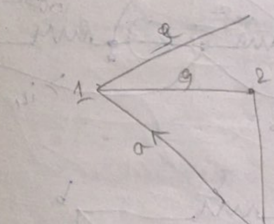
Procedure to draw for a given network:-

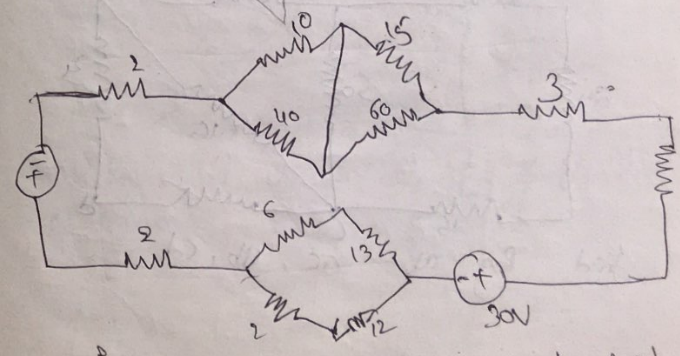
In each group of network place a node and place on extra ~~one~~ node which is out side then draw the lines connecting adjacent nodes passing through each element and also to reference node. by placing duel of each element in the line passing trough original elements.



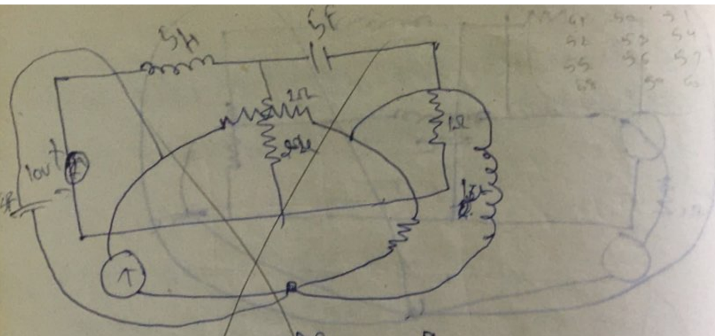
Show that the current produces the flux this flux leaves the circuit ~~the~~ to if the current flowing trough the circuit are changes with circuit time the flux will also changes

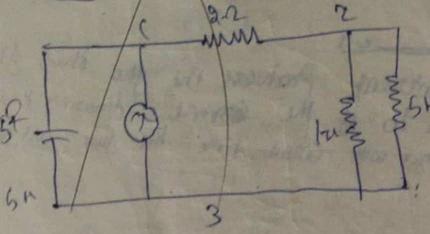
$M = \frac{N\phi}{2}$



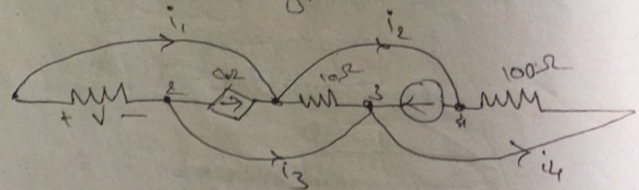


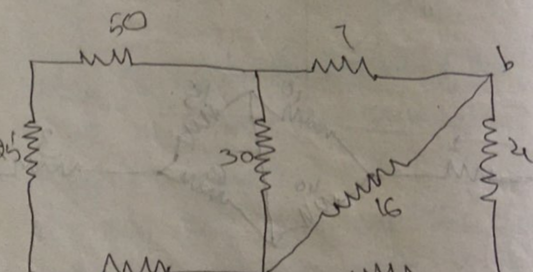
find power supply on source and also find current in circuit





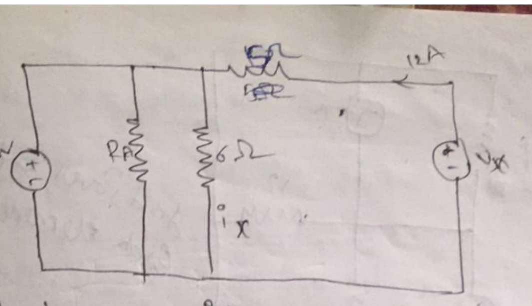
find i_1, i_2, i_3, i_4





find Req at ac, ab, cd.

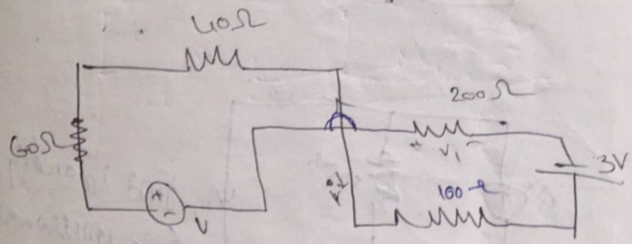
Q)



find V_x, i_x & RA

Ans:-

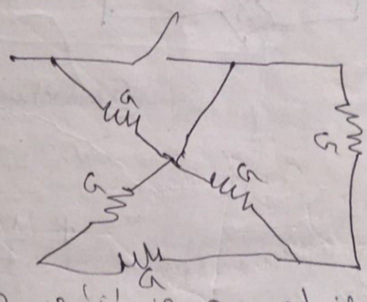
Q)



find Power supplied by 3V battery

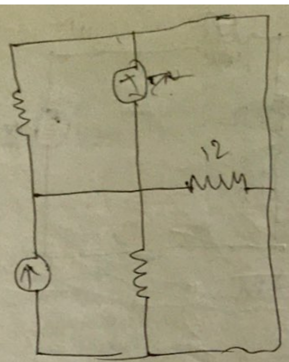
Ans = −37.5 watts

Q

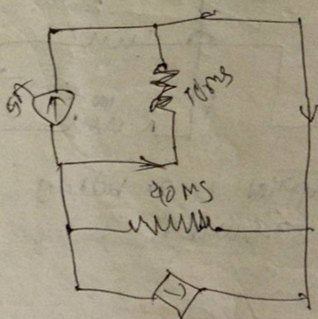


find Req is 's' is open and if 's' is closed

G = 10mA Ans = 160Ω, 60Ω



find Power by Each Element



find i_x and i_y (i_y = milliseconds)

Resistor

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

$V = i \cdot R$

$V = \frac{dv}{dt} \cdot R$

$dt = \frac{1}{V} \cdot dv \cdot R$

Inductance

$V = L \cdot \frac{di}{dt}$

$di = \frac{1}{L} v dt$

$\int_0^t di = \frac{1}{L} \int v \cdot dt$

$i(t) - i(0) = \frac{1}{L} \int_0^t v \cdot dt$

$P = Vi = \left(L \frac{di}{dt}\right) i$

$W = \frac{1}{2} L i^2$

Capacitor

$C = \frac{Q}{V}$, $Q = \frac{q}{C}$

$i = C \cdot \frac{dv}{dt}$

$dv = \frac{1}{C} \cdot i \, dt$

$\int_0^t dv = \int_0^t i \, dt$

$W = \frac{1}{2} C v^2$

$V = IR$

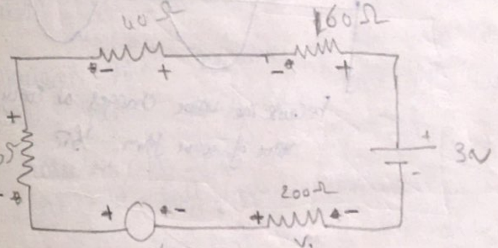
$I = \frac{V}{R_1 + R_2 + R_3}$

Current :- $V_{1m} = \cancel{m} \times I$ & $30I$

$\frac{1}{C} + \frac{1}{2} = \frac{1+3}{6} = \frac{4}{6}$

$0.166 + 0.5$

$I = 10\left(\frac{1}{6} + \frac{1}{2}\right) = 10\left(\frac{2}{3}\right) = \frac{20}{3}$



$V_{R_1} = \frac{V_s}{R_1 + R_2 + R_3}$

$V_{R_m} =$

$3V = 160 + 40 + 60 + V + 200$

$3V = 460 + V$

$2V = 460 \Rightarrow 230 V$

4- Chapter:-

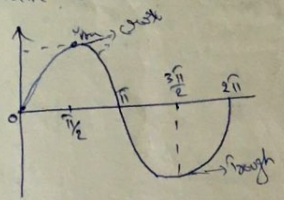
Periodic wave forms:-

A function f(x) is said to be Periodic when f(x)
$F(x) = f(x+nT)$ where T = Time Period of function f(x)

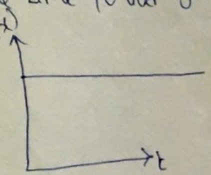
non Periodic:- if a function F(x) is said to be non Periodic when $F(x) \neq F(x+nT)$

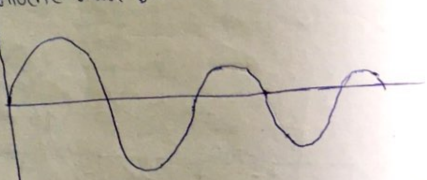
where 'n' is integer.

For Periodic wave form:-



The time Period for non periodic wave form is





because the value changes at every intervals value of wave form 1/2π.

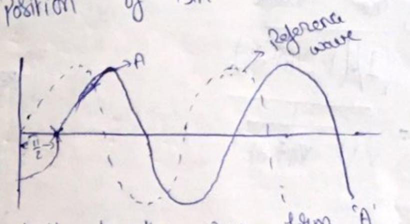
~~Amplitude~~:-
~~Angular~~

Frequency:- The frequency of a wave is defined as the no of cycles that wave completes in '1' sec.

Angular relation of Sin wave:-
A sin wave can be expressed in terms of angular measurement i.e either degrees are radian's.

Radian:- A radian is the angular distance measured along the circumference of circle which is equal to radius of circle
The sin wave completes a half circle in 180° of π radians when completes full circle with 360° are 2π ".

Phase of a sin wave:- It is an angular measurment that specifies Position of sin wave related to the reference.



The face shift of the wave form 'A' is π/2 with related to reference wave form indicated by dotted lines.

Laging wave form is 'A'

if $F(x) = \sin x$ then for the reference wave form and there is a phase shift with ~~R~~. ϕ for a wave form 'A' with function $f'(x) = \sin(x+\phi)$

Instantaneous value:- The value of sin wave is defined at different Points along the wave form.

Peack values:- The max value during +ve ~~sin value~~ half cycle (or) -ve half cycle

The difference b/w max value of +ve half cycle and max value of -ve half cycle.

Avg value:- The avg value of any function f(T) with period 'T' is given by $f(T)_{avg} = \frac{1}{t}\int_0^t f(t)\,dt$.

P. Rajesh.

If the function $V(t) = V_m \sin(\omega t)$

avg value :- $V(t) = \frac{2V_m}{\pi}$

avg value of sinwave: 0.637

~~Root mean square value~~ :-
" " " " of sin wave is a measure of heating effect of the wave

$V_{rms} = \sqrt{1/t \int_0^t v(t)^2 \, dt}$

$V_{rms} = \sqrt{\frac{1}{t} \int_0^t V(t)^2 \, dt}$

$V_{rms} = \frac{V_m}{\sqrt{2}}$

$\int_0^{2\pi} \frac{2V_m}{\pi}$

$\frac{2}{\pi}\left(\frac{V_m}{}\right)_0^{2\pi}$

$\frac{2V}{\pi}(2\pi - 0)$

If the function consists of no:- of sinosidal terms i.e

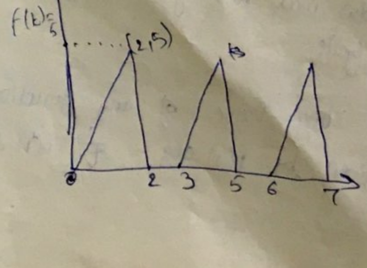
$V(t) = V_0 + V_{c_1}\cos(\omega t) + V_{c_2}\cos(\omega t) + \dots + V_{S_1}\sin(\omega t) + V_{S_2}\sin(\omega t)$

the effective value

$V_{rms} = \sqrt{V_0^2 + \frac{1}{2}(V_{c_1}^2 + V_{c_2}^2 + \dots) + \frac{1}{2}(V_{S_1}^2 + V_{S_2}^2 + \dots)}$

~~Peack factor~~ :- It is the ratio of Peack value to 'rms' value :- $\sqrt{2} \times V_{rms}$

~~Form factor~~ :- It is the ratio of rms value to avg value



$t = 3$

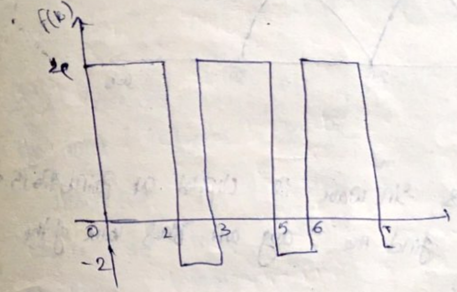
time fun :- $\frac{1}{3}\int_0^3 f(t)\, dt$

$= \frac{1}{3}\left[t\right]_0^3 = 10$

$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$

$V_{rms} = \sqrt{\frac{1}{t}\int_0^t (f(t))^2 \, dt}$

$= \sqrt{\frac{1}{3}\int_0^3 (25)} = 5/\sqrt{3}$



$\int_0^t f(t) =$ $f(t) = 4$:- $(2,3)$; $t = 2$

$\int_0^t f(t)dt = \int_2^3 f(t)\cdot dt = 1$

avg value :- $V(t) = \frac{2 \times V_m}{\pi} = \frac{2\times 4}{\pi} = 2$

avg $V_{rms} = \sqrt{\frac{1}{t}\int_0^t (f(t))^2 \cdot dt} = \sqrt{\frac{1}{2}\int_0^2 (2)^2 \cdot dt}$

$V_{rms} = \sqrt{\frac{1}{2} \times 4 \times 2} = 2\sqrt{3}$

$V_{rms} =$

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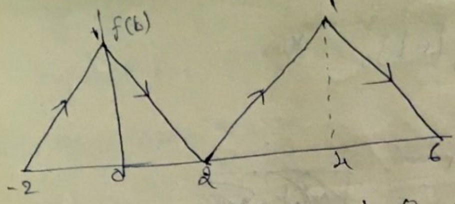
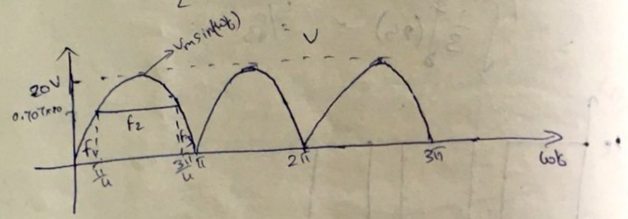
$V_{rn} = \frac{V_m}{\sqrt{2}} = 2\sqrt{3}$,,



$T = 4$; $\frac{y_2 - y_1}{x_2 - x_1} = \frac{1-0}{0-(-2)} = \frac{1}{2}$

$f(t) = \frac{1}{2}(t+2)$ = -2 to '0'

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



A full wave rectifies sin wave is clipped at point 0.75.5 as shown in figure find the avg and rms value of the function

$f_2 = 14.14V$; $f_3 = V_m \sin \omega t$

$\frac{1}{T}\int_0^t \frac{1}{t} f(v_m)\, dt = \int_{\frac{\pi}{4}}^{\frac{3\pi}{4}} \frac{1}{2}\, dt$.

$= \int_{\frac{\pi}{4}}^{\frac{3\pi}{4}} f(\omega t)\, dt =$

$\int \left[\cos(\omega t)\right]_{\frac{\pi}{4}}^{\frac{3\pi}{4}}$

$\cos\left(\frac{3\pi}{4}\right) - \cos\frac{\pi}{4} = 0.997 - 0.2496$
$= 0.75$,,

$\int_{\frac{3\pi}{4}}^{\pi} \sin(\omega t)\, dt = \cos\left(\frac{3\pi}{4}\right) - \cos\left(\frac{\pi}{4}\right)$
$= 0.99 - 0.99 = 0$,,

Determine the rms value of the voltage defined by
$v = 5 + 5\sin(314t) + \frac{\pi}{6}$

find rms value of function $v = 40 \times (1 - e^{-100t})$ where 't' lies b/w 0 to 0.1 and $v = 40\, e^{-50} \times (t - 0.1)$ where t lies b/w 0.1 to 0.2

Series Resonance :-

occurs when total reactants is zero

angular frequen :- $\omega = \frac{1}{\sqrt{LC}}$

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

Def:- Consider an RLC circuit, as shown in figure the total impedance for RLC " is given as $Z = R + J(X_L - X_C)$

resonance is a phenomenon in an Electrical circuit where the total reactants in the circuit become zero at some frequency

∴ $Z = R$ in the above circuit $X_L - X_C$ is total reactance occurred which should becomes zero at resonance

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

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

$Z = R + J(0)$

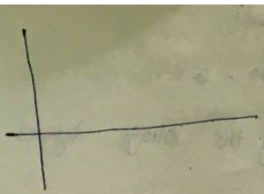
$Z = R$

$\boxed{\omega = \frac{1}{\sqrt{LC}}}$

$\omega = 2\pi f$

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

so the above eq represents the resonance frequency in an RLC circuit $f_r = \frac{1}{2\pi\sqrt{LC}}$



Resistor $R = 50\Omega$; $X_L = j25$; Capacitance reaction $= -jX_C$

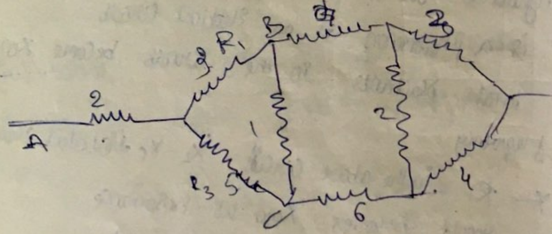
determine the value of capacitive reactance and impedence at resonance. find out resonance frequen

$X_C = R \Rightarrow X = 50.$ $X_L = \omega L$

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

find resonance frequency in RLC when $R = 10\Omega$; $L = 0.5mH$ and capacitance $C = 10\mu f$.

$$f_r = \frac{1}{2\pi\sqrt{10\times0.5}} = \frac{1}{2\pi\sqrt{5}} = \frac{1}{2x} = 2.25\,Hz \quad 10\times0.5$$



$2)\frac{3}{6}(1.6$

$$R_A = \frac{R_1R_3}{R_1+R_2+R_3} = \frac{3\times5}{3+2+5} = \frac{\cancel{15}^3}{\cancel{10}_2} = 1.6$$

$$R_B = \frac{R_1R_2}{R_1+R_2+R_3} = \frac{4\times1}{4+1+3} = \frac{\cancel{4}^1}{\cancel{8}_2} = 0.5$$

$$R_C = \frac{6\times1}{6+1+5} = \frac{\cancel{6}^1}{\cancel{12}_2} = 0.5.$$

$$R_D = \frac{3\times2}{3+2+4} = \frac{\cancel{6}^2}{\cancel{9}_3} = \frac{2}{3} = 0.66$$

$$R_E = \frac{4\times2}{4+2+6} = \frac{\cancel{8}^4}{\cancel{12}_3} = 0.133$$

$3)20(0.6$ $\frac{18}{2}$

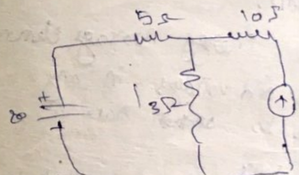
$3)40(0.13$

theorems:- Network:-

Super position theorem:-

In any linear network containing 2 or more sources the response in any element is equal to the algebraic sum of the responses caused by individual sources acting alone while other sources are non operative.

$\frac{20}{5+3} = \frac{20}{8} = \frac{5}{2}$



$\frac{5}{18}$

$13)50($ $\frac{39}{11}$

3.12 $\frac{25}{8}$ 2.5 $5Ω$

$20 = 8I - 3I_2$

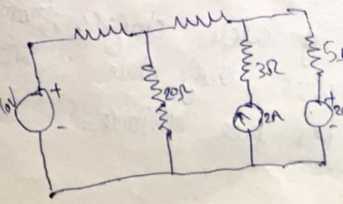
$20 = 8I_1 + \cancel{15}$

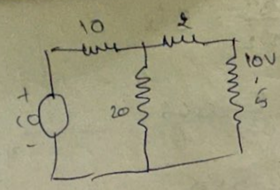
$8I_1 = 5$

$I_1 = \frac{5}{8} = 0.625.$

Find current flowing through 3Ω resistor using superposition theorem

find voltage across 2Ω resistor by using super position theorem.





$\frac{V-10}{10} + \frac{V}{20} + \frac{V}{7} = 0$

$V\left(\frac{1}{10} + \frac{1}{20} + \frac{1}{7}\right) = 1$

$V = \frac{140+70+20}{1400}$

$= \frac{230}{1400}$

$= \cancel{5.0332}$

$= 3.414$

V =

A Circuit having Constant Sources is said to be in Study State if the Currents and voltages donot change with time. Circuits with Currents and voltages having Constant amplitude and Constant frequency Sinosoidal functions are also considered to be in a Study State.

Transeses State :- Circuits with energy Storage elements change in Excitation, the currents and voltages in any elements may change from 1 State to another State. this is known as transes State.

The time taken for circuit to change from one Study State to another Study State is called transes time.

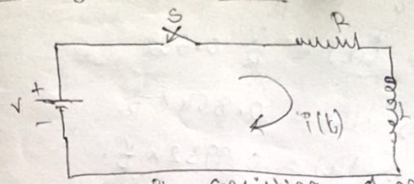
Natural response (or) forced response (or) Stud State Response :-

The response of the circuit depends up on the nature of the Elements in the circuit is known as natural response.

Transient response:-

The response of circle changes from once Steady State to another Study State is known as transcent response. (or) free responce.

DC responce of an RL circuit:-



Consider a circuit consisting of an resistance and an inductance as shown in figure apply KVL

$V = i(t) \cdot R + L \cdot \frac{di(t)}{dt}$

dividing B.S on L

$\frac{V}{L} = \frac{i(t) \cdot R}{L} + \frac{di(t)}{dt}$

$\frac{dy}{dx} + P \cdot y = Q$

$P = \frac{R}{L}$; $Q = \frac{di(t)}{dt}$

$y = \frac{V}{L}$

$I.f \cdot y = \int I.f \, Q + C.$

$I.f = e^{\int P \cdot dx}$

$I.f = e^{\int \frac{R}{L} \cdot dx}$

$I.f = e^{\frac{R}{L} \cdot i(t)}$

$e^{\frac{R}{L}(t)} \cdot \frac{i(t)}{R} = \int e^{\frac{R}{L}(t)} \cdot \frac{di(t)}{dt} + C$

$e^{\frac{Rt}{L}} \cdot i(t) = \frac{V}{R} e^{\frac{Rt}{L}} + C$

$\boxed{i(t) = \frac{V}{R} + C \cdot e^{-\frac{R(t)}{L}}} \rightarrow (1)$

At $t = 0$; $i(t) = 0$

$0 = \frac{V}{R} + C \cdot e^{-\frac{R(0)}{L}}$

$C = -\frac{V}{R}$

Substituting in (1)

$i(t) = \frac{V}{R}\left[1 - e^{-Rt/L}\right]$

Time constant = L/R

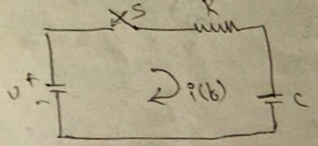
At $t = \tau \Rightarrow i(t) = \frac{V}{R} \times 0.632$

$t = 2\tau \Rightarrow i(t) = 0.864 \times \frac{V}{R}$

$t = 5\tau \Rightarrow i(t) = 0.9932 \times \frac{V}{R}$.

Transient time $= 5\tau = 5 \times \frac{L}{R}$.

Dc response of an RC network:-



$V = i(t)R + \frac{1}{C}\int i(t).dt \rightarrow (1)$

$0 = R\frac{di(t)}{dt} + \frac{i(t)}{C}$

$\Rightarrow 0 = \frac{di(t)}{dt} + \frac{i(t)}{RC} \rightarrow (2)$

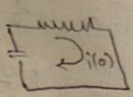
$0 = \left[D + \frac{1}{RC}\right]$

$D + \frac{1}{RC} = 0$

$D = -\frac{1}{RC}$

$\Rightarrow i(t) = C.e^{-t/RC}$

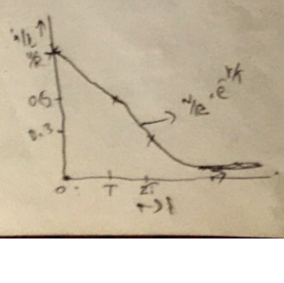
$i(0) = C.e^0 = C$



$\Rightarrow \frac{V}{R} = C$

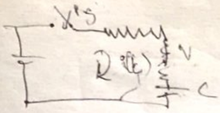
$i(0) = \frac{V}{R}$ when $t=0$

$i(t) = \frac{V}{R}.e^{-t/RC}$



Time constant $\tau = RC$

Dc



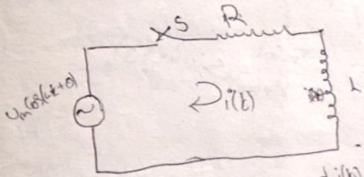
$V = i(t).R + L.\frac{di(t)}{dt} + \frac{1}{C}\int$

$0 = R.\frac{di(t)}{dt} + L.\frac{d^2i}{dt^2} + \frac{i(t)}{C}$

$D = \frac{d}{dt}$

$0 = \left[D^2 - \frac{1}{\cdot} - \frac{1}{LC}\right]i(t)$

Sinosoidal response of RL circuit:-



$V_m\cos(\omega t + \theta) = i(t)R + L.\frac{di(t)}{dt} \rightarrow (1)$

$\frac{V_m}{L}.\cos(\omega t + \theta) = i(t)\left(\frac{R}{L} + D\right)$

$D + R/L = 0$

$\Rightarrow D = -R/L$

$i_c(t) = C_1.e^{-R/L(t)}$

$i_p = k_1\cos(\omega t + \theta) + k_2\sin(\omega t + \theta)$

$i_p' = -k_1\omega\sin(\omega t + \theta) + k_2\omega\cos(\omega t + \theta)$.

Substituting in eq. (1)

$V_m\cos(\omega t + \theta) = \left[k_1\cos(\omega t + \theta) + k_2\sin(\omega t + \theta)\right]R + L\left[-k_1\omega\sin(\omega t + \theta) + k_2\omega\cos(\omega t + \theta)\right]$

$= \sin(\omega t + \theta)\left[k_2R - Lk_1\omega\right] + \cos(\omega t + \theta)\left[k_1R + k_2\omega L\right]$

$V_m = K_1 R + K_2 \omega L \rightarrow (1)$

$0 = K_2 R \mp K_1 \omega L \rightarrow (2)$

Solving above (1) and (2) eq ~~weqk~~

$V_m = \cancel{K} R K_1 R + K_2 \omega L$

$0 = K_2 R \mp K_1 \omega L$

$V_m = R(K_1 - K_2) \mp \omega L (K_2 - K_1)$

$V_m = \cancel{R - \omega L} K_1 - K_2$

$K_1 = \frac{V_m R}{R^2 + (\omega L)^2}$

$i_p = \frac{V_m R}{R^2+(\omega L)^2} \cdot \cos(\omega t + \theta) + \frac{V_m \omega L}{R^2+(\omega L)^2} \sin(\omega t + \theta)$

$i(t) = i_c + i_p$

$= C_1 \cdot e^{-R/L\, t} +$

At $t = 0$; $i(0) = 0$

$C_1 = -\left(\frac{V_m R}{R^2+(\omega L)^2} \cdot \cos\theta + \frac{V_m \omega L}{R^2+(\omega L)^2} \sin\theta \right)$

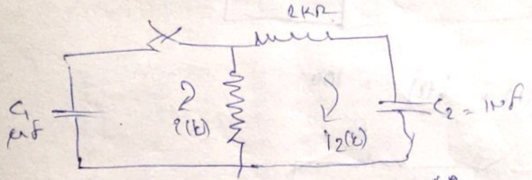
$i(t) = -\left(\frac{V_m R}{R^2+(\omega L)^2} \cdot \cos\theta + \frac{V_m \omega L}{R^2+(\omega L)^2} \sin\theta \right) e^{-R/L\, t} + \frac{V_m R}{R^2+(\omega L)^2} \cdot \cos(\omega t + \theta)$

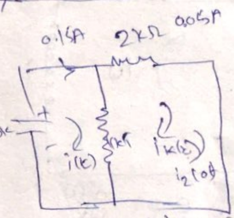
$+ \frac{V_m \omega L}{R^2+(\omega L)^2} \sin(\omega t + \theta).$

$V_m \cos(\omega t + \theta) = i(t) R + \frac{1}{C} \int i(t) \cdot dt.$

$\Rightarrow -V_m \sin(\omega t + \theta) = R \cdot \frac{di(t)}{dt} + \frac{i(t)}{C}\, i(t)$

$\Rightarrow V_m \sin(\omega t + \theta) = R \frac{di(t)}{dt} + \frac{i(t)}{C} \cdot i(t).$





$100 = i(t) - i_2(t) \rightarrow (1)$ 100k

$0 = 1k(i_2(t) - i_1(t)) + 2k\, i_2(t)$

$+ \frac{1}{1\mu} \int i_2(t)\, dt \rightarrow (2)$

$i_1(0) = 0.15A$

$i(0) = 0.05A$

$100 = i(t) - i_2(t) \rightarrow (1)$

$0 = 1k(i_2(t) - i_1(t)) + 2k\, i_2(t)) + \frac{1}{1\mu} \int i_2(t) \cdot dt \rightarrow (2)$

$0 = 1k(100) + 2k\, i_2(t) + \frac{1}{1\mu} \int i_2(t)\, dt.$

$0 = 100k + 2k\, i_2(t) + \frac{1}{1\mu} \int i_2(t)\, dt$

$0 = 3k \frac{d i_2(t)}{dt} + 10^6 \int i_2(t)$

$= 3k \frac{di_2(t)}{dt} - 1k \frac{di_2(t)}{dt} + 10^6$

$= 2k\, D + 10^6 = 0$

$= D = \frac{-10^6}{2k} = 0.5 \times 10^3$

$i_2(t) = C_1 e^{-0.5 \times 10^3 t}$

$i_2(t) = 0.05e$

$100 = i(t) - 0.05e$

$\Rightarrow 100 + 0.05 = i(t) = 100.05$

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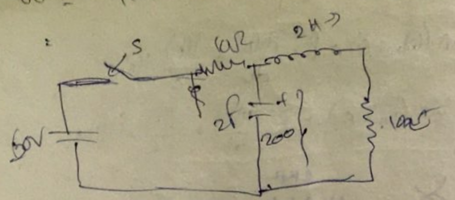
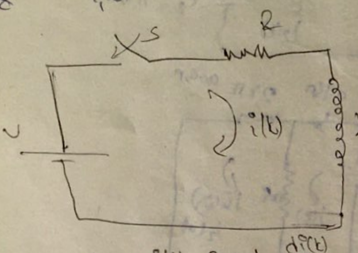
$100 = i_1(t) - 0.05 e^{k}$



$i_1(t) \times i_2(t) = 100$



$v = i(t) R + L \cdot \frac{di(t)}{dt}$

Apply laplace transform

$\Rightarrow \frac{V}{S} = I(s)R + L \cdot \left[S I(s) - i(0) \right]$

$I(s) = \left\{ R + LS \right\} = \frac{V}{S}$

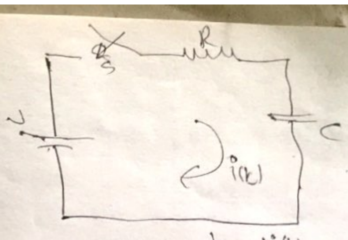
$\Rightarrow I(s) = \frac{V}{S(R+LS)}$

$\Rightarrow I(s) = \frac{V}{L} \cdot \frac{1}{(S+\frac{R}{L})S}$

Applying inverse laplace

$i(t) = \frac{V}{L}\left[\frac{L}{RS} - \frac{L}{R} \cdot \frac{1}{(S+\frac{R}{L})} \right]$

$i(t) = \frac{V}{R} \times \frac{V}{R} - \frac{V}{R} \times \frac{L}{R}$

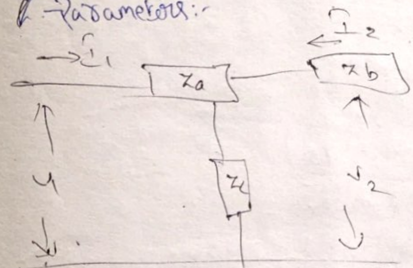


$v = i(t) R + \frac{1}{C} \cdot \frac{di(t)}{dt}$

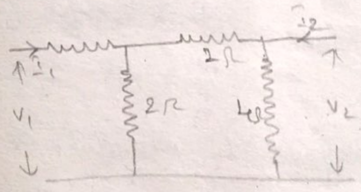
Apply laplace.

$\frac{V}{S} =$

Z-Parameters:-



Two Port Network:- Open Circuit of Z-Parameters



W.K.T Z-Parameter Eq are

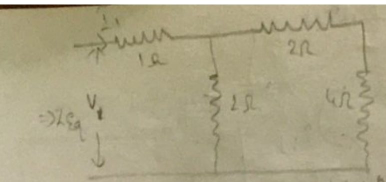
$V_1 = Z_{11} I_1 + Z_{12} I_2$

$V_2 = Z_{21} I_1 + Z_{22} I_2$

when $I_2 = 0$ then V_1 & I_1 is given by

$V_1 = Z_{11} I_1$

$\Rightarrow Z_{11} = \frac{V_1}{I_1} \Big|_{I_2 = 0}$



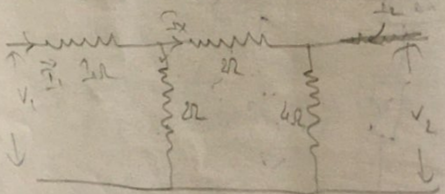
here 2Ω and 4Ω resistors are in series with 6Ω
Then another 2Ω and 6 is $\parallel$ with 6Ω

$\therefore Z_{eq} = 1 + \frac{6 \times 2}{6+2} = 1 + \frac{12}{8} = 2.5$

$\Rightarrow V_1 = I_1 \cdot Z_{eq} = I_1 \, 2.5$

$Z_{11} = \frac{V_1}{I_1}\Big|_{I_2=0} = 2.5\Omega$

now: $Z_{21} = \frac{V_2}{I_1}\Big|_{I_2=0}$



$V_2 = Z_{21} I_1$

$V_2 = 2 I_1$

$\therefore Z_{21} = 2\Omega$

current in 4Ω impedance be I_x

$I_x = I_1 \times \frac{2}{8} = \frac{I_1}{4}$

$V_2 = I_x 4 = \frac{I_1}{4} \times 4 = I_1$

$V_2 = I$

$Z_{21} = \frac{V_2}{I_1} = I_1$

when port of $I_1 = 0$

$Z_{22} = \frac{V_2}{I_2}\Big|_{I_1=0}$

$V_2 = Z_{22} I_2$

$V_2 = 2 I_1$

$Z_{22} = 2\Omega$

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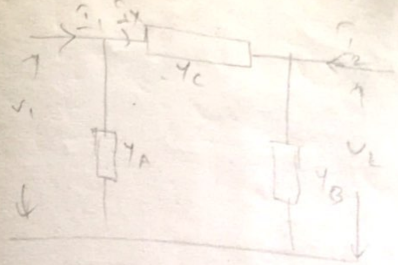
Z Parameter



$V_2 = Z_{22} I_2$

$V_1 = Z_{11} I_1 + Z_{12} I_2$

$V_2 = Z_{21} I_1 + Z_{22} I_2$

$I \rightarrow$
$Z_{11} \rightarrow$ total input circuit calculation
Z_{21} = impedance at Y_B through I_1
Z_{12} = impedance at Y_A through I_2
Z_{22} =

now: $I_2 = 0$

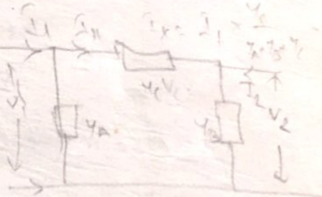
$V_1 = Z_{11} I_1 \Rightarrow Z_{11} = \frac{V_1}{I_1}\Big|_{I_2=0}$

$Z_{eq} \Rightarrow V_1 = I_1 \left(\frac{Y_A \times (Y_C + Y_B)}{Y_A + Y_C + Y_B} \right)$

$Z_{11} = \frac{Y_A \times (Y_B + Y_C)}{Y_A + (Y_B + Y_C)}$

$V_2 = Z_{21} I_1$

$Z_{21} = \frac{V_2}{I_1}$



$I_x = I_1 \frac{Y_C}{Y_A + Y_B + Y_C}$

$V_2 = I_1 \times Y_B$

$Z_{21} = \frac{Y_C}{Y_A + Y_B + Y_C} \times Y_B$

when port at $I_2 = 0$

$Z_{22} = \frac{V_2}{I_2}\Big|_{I_1=0}$

$V_2 = Z_{22} I_2$

$V_2 = Y_C Y_A I_2 \Rightarrow Z_{22} = Y_A + Y_C$

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Eq $V_1 = Z_{12} I_2$

$$Z_{12} = \frac{V_1}{I_2}\Big|_{I_1=0}$$

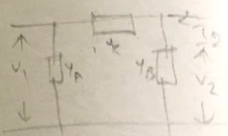
$$\cancel{Z_{12} = I_Y = \frac{I_2}{Y_A}}$$

$$V_1 = Y_A I_Y = I_2$$

$$= \cancel{Y_A} \times \frac{I_2}{\cancel{Y_A}} = I_2$$

$$V_1 = I_2$$

$$Z_{12} = \frac{V_1}{I_2} = I_2$$



$$V_1 = Z_{12} I_2$$

The voltage impedance at Y_A is

$$I_Y = I_2 \times \frac{Y_C}{Y_A+Y_B+Y_C}$$

$$\cancel{V_2 = I_Y \times \frac{Y_A+Y_B+Y_C}{Y_C} I_2}$$

$$V_2 = I_Y \times Y_A = I_2 \frac{Y_C}{Y_A+Y_B+Y_C} \times Y_A$$

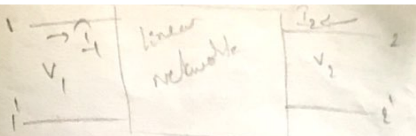
$$Z_{22} = \frac{V_2}{I_2}\Big|_{I_1=0} = \frac{Y_C}{Y_A+Y_B+Y_C} \times Y_A$$

Y - PARAMETERS:-

Eq Y_{eq} :

$$I_1 = Y_{11} V_1 + Y_{12} V_2$$

$$I_2 = Y_{21} V_1 + Y_{22} V_2$$



let V_2 be short circuit

$$I_1 = Y_{11} V_1 \Rightarrow Y_{11} = \frac{I_1}{V_1}\Big|_{V_2=0}$$

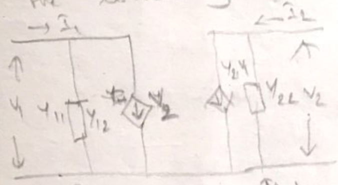
$$I_2 = Y_{21} V_1 \Rightarrow Y_{21} = \frac{I_2}{V_1}\Big|_{V_2=0}$$

when $V_1 = 0$ we get

$$I_1 = Y_{12} V_2 \Rightarrow Y_{12} = \frac{I_1}{V_2}\Big|_{V_1=0}$$

$$I_2 = Y_{22} V_2 \Rightarrow Y_{22} = \frac{I_2}{V_2}\Big|_{V_1=0}$$

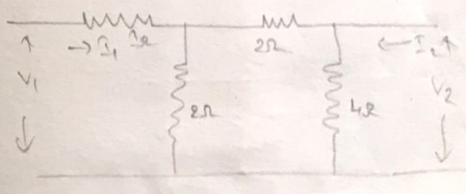
when the circuit of equivalent of two ports



$$\frac{I_1}{V_2}\Big|_{V_1=0} = \frac{I_2}{V_1}\Big|_{V_2=0}$$

$$Y_{12} = Y_{21}$$

P)



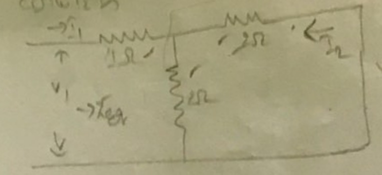
The Eq :- $I_1 = Y_{11} V_1 + Y_{12} V_2$

$$I_2 = Y_{21} V_1 + Y_{22} V_2$$

when $V_2 = 0$ we get

$$I_1 = Y_{11} V_1 \Rightarrow Y_{11} = \frac{I_1}{V_1}\Big|_{V_2=0}$$

So circuit is

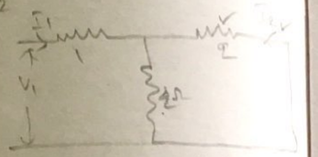


here wkt $V_1 = I_1 \times Z_{eq}$

$Z_{eq} = 1 + \frac{2 \times 2}{2+2} = 1+1 = 2\,\Omega$

$V_1 = I_1 \times 2 \Rightarrow I_1 = \frac{V_1}{2}$

$\therefore Y_{11} = \frac{I_1}{V_1} = \frac{I_1}{I_1 \times 2} = \frac{1}{2}\,℧$



now :- $Y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0}$

Impedance trough 2Ω I_2

~~$V_1 =$~~

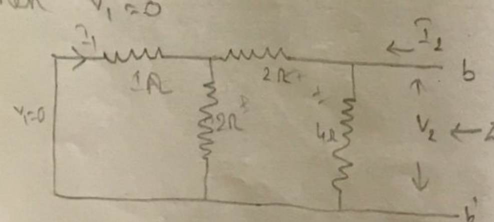
$-I_2 = I_1 \times \frac{2}{2+2} = I_1 \times \frac{2}{4} = \frac{I_1}{2}$ ($\because I_2$ is flowing ...)

$-I_2 = I_1 \times \frac{1}{2}$ $\left(\because I_1 = \frac{V_1}{2}\right)$

$-I_2 = \frac{V_1}{2} \times \frac{1}{2} = \frac{V_1}{4}$

$Y_{21} = -\frac{1}{4}\,℧$

when $V_1 = 0$



$Y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1=0}$

$V_2 = I_2 \cdot Z_{eq}$

~~$V_2 = -1 + \left(\frac{4 \times 4}{4+4}\right) = -1 + \frac{16}{8} = -1+2 = 1$~~

$Z_{eq} = \frac{(2+2+4)}{(1+2+2)} = \frac{8}{5}\,\Omega$

$V_2 = I_2 \times \frac{8}{5}$

$Y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1=0} = \frac{8}{5}\,℧$

when aa' short circuited $-I_1 = \frac{2}{5} I_2$

$I_2 = \frac{5}{8} \times V_2$

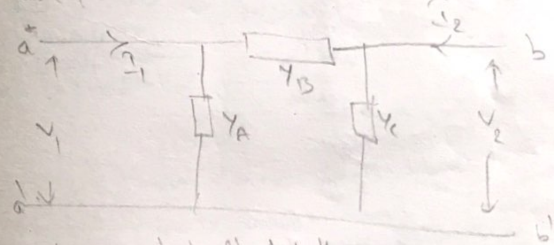
$-I_1 = \frac{2}{5} \times \frac{5}{8} \times V_2$

$Y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1=0} = -\frac{1}{4} V_2$

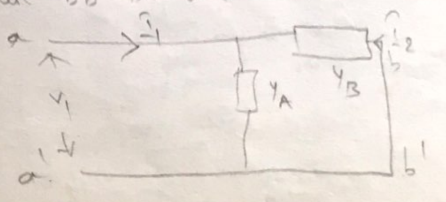
$\therefore$ The eq. $I_1 = 0.5\,V_1 - 0.25\,V_2$

$I_2 = -0.25\,V_1 + 0.625\,V_2$

1) Given Problem circuit



when bb' is shorted then



Eq of Y - Parameter

$I_1 = Y_{11} V_1 + Y_{12} V_2$

$I_2 = Y_{21} V_1 + Y_{22} V_2$

When $V_2 = 0$ then

$I_1 = Y_{11} V_1 \Rightarrow Y_{11} = \frac{V_1}{I_1}$

$Z_{eq} = \frac{1}{Y_{eq}}$

$\because V_1 = I_1 \cdot Z_{eq}$

$V_1 = I_1 \times \frac{}{Y_A + Y_B}$ $\quad I_1 = \frac{\cancel{Y_A(Y_A+Y_B)}}{\cancel{Y_A \times Y_B}}$

$Y_{11} = \frac{I_1}{V_1} = \frac{\frac{\cancel{V_1}(Y_A + Y_B)}{Y_A \times Y_B}}{\cancel{V_1}} = \left(\frac{Y_A + Y_B}{Y_A Y_B}\right)$

now:

$I_2 = Y_{21} V_1$

$Y_{21} = \frac{I_2}{V_1} =$

$V_1 = -I_2 = I_1 \times \frac{Y_B}{Y_A + Y_B}$

$-I_2 = \left(\frac{Y_A + \cancel{Y_B}}{Y_A Y_B}\right) \times \left(\frac{Y_B}{Y_A + \cancel{Y_B}}\right)$

$-I_2 = \frac{\cancel{Y_B}}{Y_A \cancel{Y_B}} = \frac{1}{Y_A}$

$I_2 = -\frac{1}{Y_A}$

$Y_{21} = \frac{I_2}{V_1} = \frac{-1/Y_A}{I_1}$

5/10/1

30/17 14/20

2/1

2

Circuit Elements:-

* Active Elements is a Source is called AE

Eg: Battery, generator

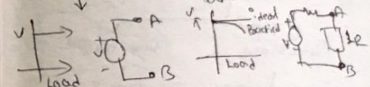
* Passive Elements energy is absorbed (or) dissipated is called P.E

Eg:- Resistance, Capacitor, Inductance, Semi conductor

1) Voltage Source

(a) Ideal VS

internal 'R' is '0'



across terminal is called terminal V across AB & independent of load current

(b) Practical VS

across terminal is called terminal V across AB

2) Current Source

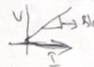
(a) ideal

(b) Practical

(1) * Linear Elements Passes through origin

which obeys ohms law

Eg:- R, C, L



Inductance $V_L \propto \frac{di}{dt}$

current capacitance $i_c \propto \frac{dv}{dt}$

(2) * non linear

doesn't obey ohms law

Eg:- Conductance, Semiconductor

(a) * Unilateral

Passive — Active

current passes through it in one direction

Eg:- Diode

(b) * Bilateral

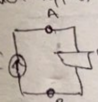
Passive — Active

current passes through either direction

Eg:- R, L, C

(a) * Ideal current Source

which supplies 'i' independent



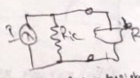
internal resistance ∞

=> open circuit (or) (—/—)

Short " (——)

(b) * Practical current Source

'i' is dependent



Ric internal resistance of current source

Practi Vs — Pract Cs

Independent — dependent — Independent — dependent

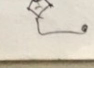
Eg:- Dc generator → dependent Vs

Battery → independent Vs

* Dependent Vs Practical

Voltage Controlled — current Controlled CCDVS

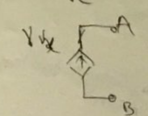
$V = \alpha V_x$

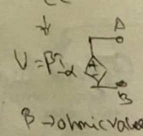


VCDVS α = Scalar

Dependent [source] ...

- VC
- CC



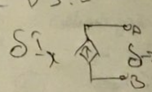


$\gamma \rightarrow$ Conductance of ohmic values which is value

$\beta \rightarrow$ ohmic values

Ex:- Resistance

CCDS:-

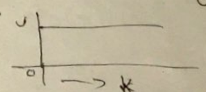


$\delta \rightarrow$ scalar.

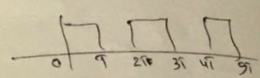
Active Elements
- Time varient
  - unilateral
  - bilateral
- Time invarient
  - unilat
  - bilateral
    - → Periodic
    - → non Periodic

Passive Elements.
- Time varient
  - unilat
  - bilat
- Time invarient
  - uni
  - bilat

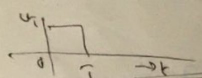
Ex:- Time varient:- battery



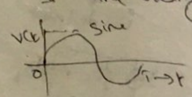
time varying unilateral periodic

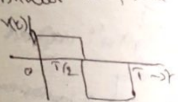


time varying unilater non periodic

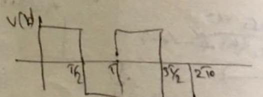


Ex Time varying bilater non Periodic





Alternating wave form



Kirchoffs law:-

- 1st law → Kirchoffs current law
- 2nd law → Kirchoffs voltage law

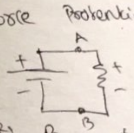
1) Kirchoffs current law:- Any Electrical N/w Consisting of linear, bilat, Passive, active Elements. the algebraic sum of the currents through the Elements meeting at Particular junction & node is zero

$i_1 + i_2 + i_5 - i_3 - i_4 = 0$

sum of currents Entering a node = sum of current leaving a node

Sign convention:- current Entering is +ve and
" leaving " -ve

2nd law:- (same ~~as~~ up to active elements from above KCL) The algebraic sum of source Potential drop across the elements in any closed loop is zero

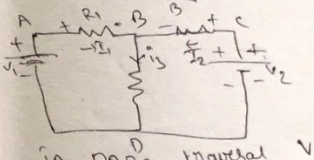


$V - IR = 0$

(Around traversal BVAB)

Sign Convention:- In any traversal where one Encounter -ve to +ve, is taken as voltage raise & sign is taken as +ve

+ve to -ve is taken as voltage fall & sign is taken as -ve



in DABC traversal $V_1 - I_1R_1 - I_3R_3 = 0$

In DCBD " $I_3R_3 + I_2R_2 - V_2 = 0$

DABCD:- $V_1 - I_1R_1 + I_2R_2 - V_2 = 0$

DC - Circuit Analysis

elements in

Net work Analaysis:-

Formulae:-

Chapter 1:-

Voltage:- $V = \frac{W}{Q}$ (or) $\frac{dw}{dq}$

Current:- $I = \frac{Q}{t}$ (or) $\frac{dq}{dt}$

Power:- $P = \frac{W}{t}$ (or) $\frac{\text{Energy (Joules)}}{\text{time}}$ (or) $\frac{dw}{dt}$

Energy:- $P = \frac{dw}{dt} = \frac{dw}{dq} \times \frac{dq}{dt} = v \times i = vi\ w$

Resistance:- $I = \frac{V}{R} \Rightarrow V = iR$ (or) $V = R.\frac{dq}{dt}$ (or) $i = \frac{V}{R}$

Power observed:- $P = vi = (iR)i = i^2R$

Energy lost :- $W = \int_0^t p.dt = i^2Rt = \frac{v^2}{R}t$

inductance:-

$V = L.\frac{di}{dt} \Rightarrow di = \frac{1}{L}v\,dt$

on integrating we get

$i(t) = \frac{1}{L}\int_0^t v.dt + i(0)$

Power observed:- $P = vi \Rightarrow Li\frac{di}{dt}$ (w)

Energy Stored:- $W = \int_0^t Li\frac{di}{dt}dt = \frac{Li^2}{2}$

CApacitance Parameter:-

$C = \frac{Q}{V}$; $C = \frac{q}{v}$

$i = C.\frac{dv}{dt}$; $dv = \frac{1}{C}.i\,dt$

on integrating:-

$v(t) = \frac{1}{C}\int_0^t i\,dt + v(0)$

Power observed:- $P = vi \Rightarrow vC.\frac{dv}{dt}$

Energy Stored:- $W = \frac{1}{2}Cv^2$.

Kirchhoff's voltage law:-

$V_s = V_1 + V_2 + V_3$

$i = \frac{V}{R_1 + R_2 + R_3}$

Kirchhoff's Current law:-

$I_1 + I_2 + I_3 = I_T$

Parallel resistance:-

$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots \frac{1}{R_m}$

Current divison:-

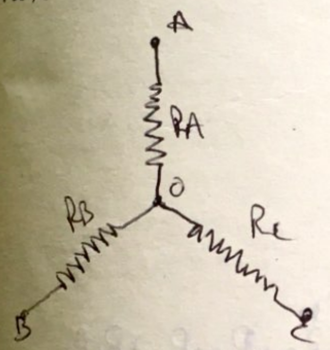
$I_i = \frac{R_T}{R_i + R_T} I_T$

Chapter: III:-

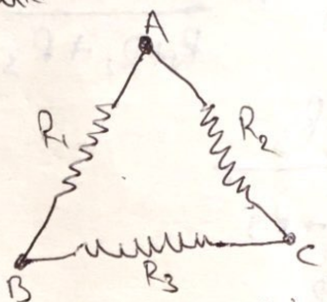
Star delta transformation:-

3.1) It is useful for solving complex networks. Basically, any three circuit elements i.e resistive, inductive (or) capacitive may be connected in two different ways. one way of connecting these elements is called the star connection & Y-connection the other way of connecting these elements these elements is called star connection & Y-connection. The other way of connecting these elements is called delta (Δ) connection

These connection is said to be star connection



Star circuit



Delta connected

in " " the resistance from terminals AB, BC and CA are respectively.

$R_{AB}(Y) = R_A + R_B$

$R_{BC}(Y) = R_B + R_C$

$R_{CA}(Y) = R_C + R_A$

Similarly in delta connected the resistance seen from terminals AB, BC, and CA respectively are ie: $\frac{ab}{a+b}$.

$$R(AB)\Delta = R_1 \parallel (R_2 + R_3) = \frac{R_1 \times (R_2 + R_3)}{R_1 + R_2 + R_3}$$

$$R(BC)\Delta = R_3 \parallel (R_1 + R_2) = \frac{R_3 \times (R_2 + R_1)}{R_1 + R_2 + R_3}$$

$$R(CA)\Delta = R_2 \parallel (R_1 + R_2) = \frac{R_2 (R_1 + R_3)}{R_1 + R_2 + R_3}.$$

~~R(CA~~

If we Equate of star and

$$R_A = \frac{R_1(R_2+R_3)}{R_1+R_2+R_3} \rightarrow$$

$$R_B = \frac{R_2(R_3+R_1)}{R_1+R_2+R_3} \rightarrow$$

$$R_C = \frac{R_3(R_1+R_2)}{R_1+R_2+R_3} \rightarrow$$

now:- R_1, R_2, R_3 replaced by a star connection of R_A, R_B, R_C

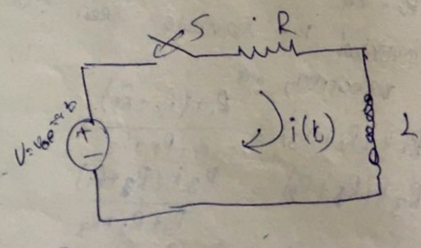
$$R_A = \frac{R_1 R_2}{R_1+R_2+R_3}$$

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

$$R_4 = \frac{R_2 R_3}{R_1+R_2+R_3}$$

$$R_1 = \frac{R_A R_B + R_B R_C + R_C R_A}{R_C} \quad ; \quad R_2 = \frac{R_A R_B + R_B R_C + R_C R_A}{R_B}$$

$$R_3 = \frac{R_A R_B + R_B R_C + R_C R_A}{R_A}.$$



$$I_S = \frac{\frac{V_0}{L}}{(S+a)\left(S+\frac{R}{L}\right)} \qquad A = \frac{V_0}{L\left(\frac{R}{L}-a\right)} \cdot \frac{V_0}{L\left(\frac{R}{L}-a\right)} = \frac{V_0}{R-aL}$$

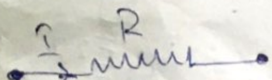
$$\frac{V_0}{L} = A\left(S+\frac{R}{L}\right) + B(S+a) \qquad \frac{V_0}{R-aL}$$

$S = -a.$

$$\frac{V_0}{L} = A\left(-\alpha+\frac{R}{L}\right)$$

$$B = \frac{-V_0}{R-aL}.$$

Net work anylaysis:-

1)
(a) Resistance:- 

interms of current $i = \frac{v}{R}$ $\quad i = \frac{v}{R}$

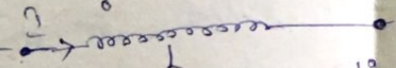
" " voltage $v = R\frac{dq}{dt}$ $\quad (\because i = \frac{dq}{dt})$

$\therefore i = \frac{v}{R}$

Power observed trough. resistor $P = vi = (iR)i = i^2R$

Energy lost in raistance in time 't' is

$W = \int_0^t P.dt = \int_0^t i^2R.dt = i^2Rt = \frac{v^2}{R}t$

(b) Inductance :- 

interms of voltage $v = L.\frac{di}{dt}$

$di = \frac{1}{L}.v.dt$

by integraiting on B.S

$\int_0^t di = \int_0^t \frac{1}{L}.v.dt$

$i(t) - i(0) = \frac{1}{L}\int_0^t v.dt$

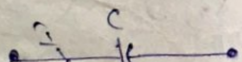
$i(t) = \frac{1}{L}\int_0^t v.dt + i(0)$

Power observed by inductor is

$P = vi = Li\frac{di}{dt}$ watts.

Energy stored by inductor is

$W = \int_0^t P.dt = \int_0^t Li.\frac{di}{dt} = \frac{Li^2}{2}$.

Capacitance :- 

$\therefore C = \frac{Q}{V}$; $C = \frac{q}{v}$ $\quad i = C\frac{dv}{dt}$

in terms of current

" " " voltage $dv = \frac{1}{C}.i\,dt$

integrating B.S we have

$\int_0^t dv = \frac{1}{C}\int_0^t i.dt$

$v(t) - v(0) = \frac{1}{C}\int_0^t i\,dt$

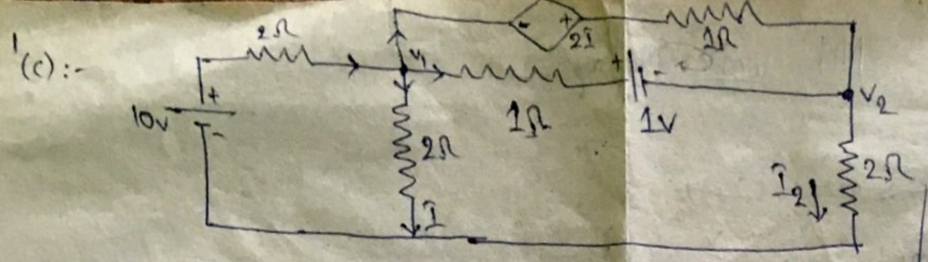
$v(t) = \frac{1}{C}\int_0^t i\,dt + v(0)$

The Power observed by capacitor is given by $P = vi = vC\frac{dv}{dt}$

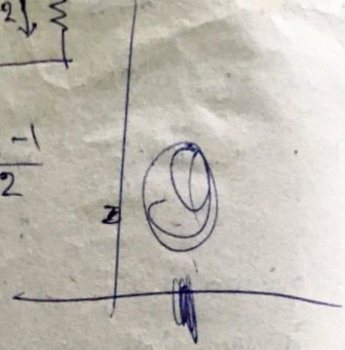
The Energy stored by capacitor is $W = \int_0^t p.\,dt = \int_0^t vC\frac{dv}{dt}.dt$

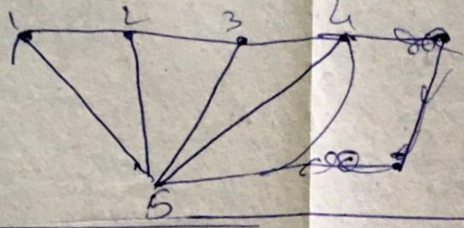
$W = \frac{1}{2}Cv^2$

1(c):-



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





KVL find out:-

first write the given ckt eq^n.
and then ~~taken~~ write in matrix form. as

$$A \quad i = B \quad \text{constants from eq}^n.$$

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$$

let $A = '\Delta'$.
now from Crammer's rule

$$\Delta_1 = \begin{bmatrix} 1 & 2 & 3 \\ 2 & 5 & 6 \\ 3 & 8 & 9 \end{bmatrix}; \quad \Delta_2 = \begin{bmatrix} 1 & 1 & 3 \\ 4 & 2 & 6 \\ 7 & 3 & 9 \end{bmatrix}; \quad \Delta_3 = \begin{bmatrix} 1 & 2 \\ 4 & 5 \\ 7 & 8 \end{bmatrix}$$

$$\therefore i_1 = \frac{\Delta_1}{\Delta}; \quad i_2 = \frac{\Delta_2}{\Delta}; \quad i_3 = \frac{\Delta_3}{\Delta}.$$

KCL find out:-

let write given ckt and currents 'i' flowing in it
'V' is given voltage
i given current.

$$\therefore i_1 = \frac{V}{R} = \frac{V}{2}; \quad i_2 = \frac{V}{3}$$

$$\therefore i = i_1 + i_2 + i_3$$

$$i = \frac{V}{2} + \frac{V}{3} + \dots$$

$$10 = \frac{V}{2} + \frac{V}{3} + \dots$$ solve we get 'V'

Scanned with CamScanner

Power:-

Write the $i =$; $V =$; R

$(\because V = iR)$

$P_1 = iV$,

$P = i^2 R$; $P = \frac{V^2}{R}$;

find out above relation from Given ckt and then and find total Power:- $P = P_1 + P_2 + P_3$

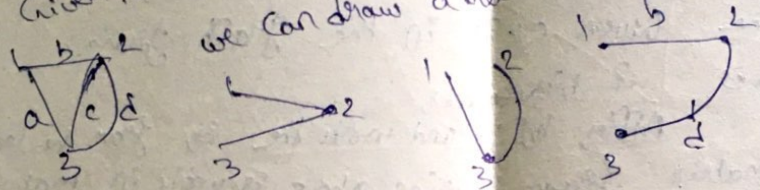
$P = (i_1 v_1) + (i_2 v_2) + \ldots$

2 chapter:-

Tree:-

A tree do not consist a closed loop is known as a tree.

Eg:- Given:- we can draw a tree in no. of ways



Tree contains 'n' nodes

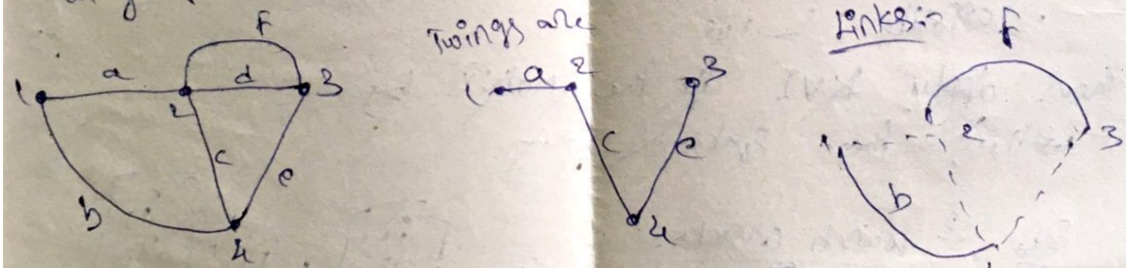
branches = $n-1$

in above ckt there are '3' nodes

$\therefore$ branches = $3-1 = 2$ branches.

Twigs & Links:-

Twigs:- Branches of trees are known as twigs



Index matrix:-

Branches →

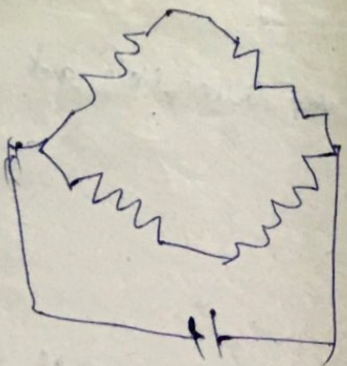
nodes ↓

Moving Both in Same direction means +ve

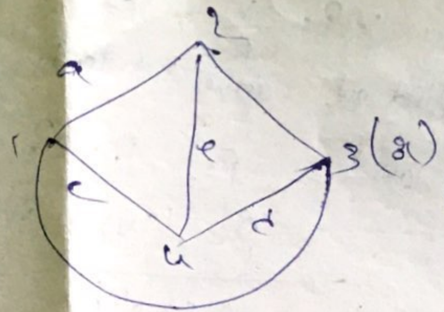
opposite means '-ve' in a loop

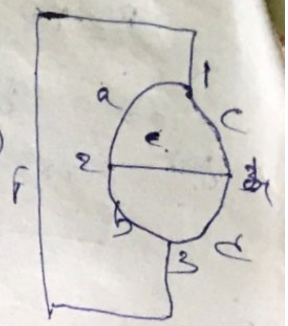
Graphical representation:-

Given ckt as



we can draw in





Tie - set matrix:-

first Draw the Given ckt in the graph form.
locate the nodes & branches
Apply KVL to and write the Eq from the loops
Take them in matrix form using above Eq write in matrix form
as

nodes ↓ Branches →

$$B V_b = 0$$

Then take one-one loop and indecate the directions by current flowing through it

if both i and direction are in same then '+ve'
" opposite '-ve'

Then apply KVL to the matrix by writing the Equation form

Tie - set & branch currents:-

find for ↓ $i_b = B^T I_L$

$$i_b = \begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \\ i_5 \end{bmatrix}, \quad I_L = \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix}$$

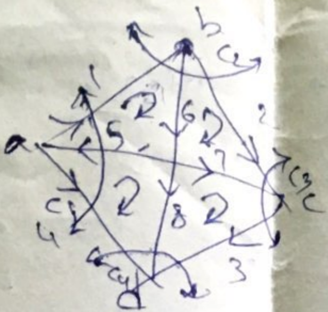
Current in Branches = Transpose matrix × current in Links

no of link branch $l = b-(n-1)$

l = branch − (nodes − 1)

Cut set:-

eg:-



current moving

if $c_1 = \{1,4,5\}$ are cutted

$c_2 = \{1,6,2\}$ " "

$c_3 = \{2,3,7\}$ " "

$c_4 = \{4,3,8\}$ " "

now apply KCL eq to above by moving the direction form

$c_1 = i_1 - i_5 - i_4 = 0$

$c_2 = i_2 - i_6 + i_1 = 0$

$c_3 =$ sameway

Then write in matrix for

$$\begin{array}{c|cccccccc} & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 \\ \hline c_1 & 1 & 0 & 0 & -1 & 1 & 0 & 0 & \\ c_2 & & \vdots & & & & & & \\ c_3 & & \vdots & & & & & & \\ c_4 & & \vdots & & & & & & \end{array}$$

$$Q \, \underline{i}_b = 0$$

$$\begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \\ \vdots \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

Mesh anylesis:-

Draw Given ckt:-

finding $i_1, i_2 \ldots$ current from loop equation

Super mesh:-

finding i_1, i_2, currents using loop eqⁿ.

nodal anylasis:

Draw the ckt:- at any point.

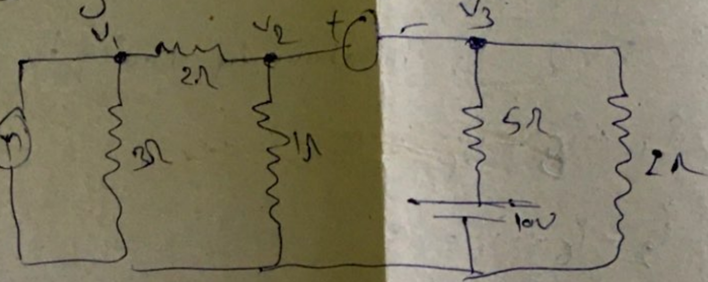
locate the node

write eqⁿ as

eg: $-6 + \frac{V_1 - 0}{12} + \frac{V_1 - 0}{6} + \frac{V_1 - 0}{3} = 0$

Super nodal Anylasis:-

Eg:-



first node:-

$\frac{V_1}{3} + \frac{V_1 - V_2}{2} = 10$

$V_1\left[\frac{1}{3}\right] + (V_1 - V_2)\left[\frac{1}{2}\right] = 10$

$0.83V_1 + 0.5V_1 - 0.5V_2 = 10$

$1.33V_1 - 0.5V_2 = 10$

2nd node:-

$\frac{V_2 - V_1}{2} + \frac{V_2}{1} + \frac{V_3 - 10}{5} + \frac{V_3}{2} = 0$

$V_3 - V_2 = 20V$

$0.5V_2 - 0.5V_1 + V_2 + 0.2V_3 - 2 + 0.5V_3 = 0$

$1.5V_2 + 0.7V_3 - 0.5V_1 - 2 = 0$

Dual & Duality:-

(R) Resistance - Conductance (G)

(I) inductance - Capacitor (C)

voltage source - current source

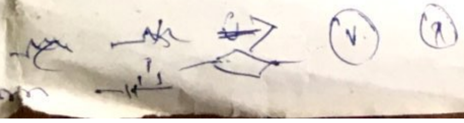
(V) voltage - current (I)

open - Short

series - Parallel

KVL - KCL

Thevinen - Norton



Unit - II

$MH = 10^{-3}$
$Cm^2 = 10^{-4}$

Magnetic Circuits:-

Flux density:- (B)

$$B = \frac{\phi}{A} \; wb/m^2 \; (or) \; Tesla$$

Dot Convention:- • → Entering '+'
when writing 'Eq' we should write opposite current in mutual inductance

Eg:- $V_1 = L_1 \frac{di}{dt} + M \frac{di_2}{dt}$

$V_2 = L_2 \frac{di}{dt} + M \frac{di_1}{dt}$

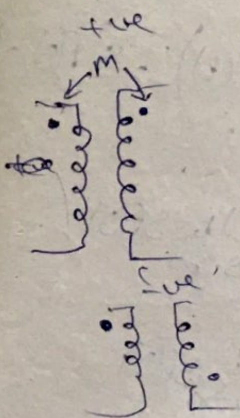
Co-efficient of coupling:- $k = \frac{M}{\sqrt{L_1 L_2}}$

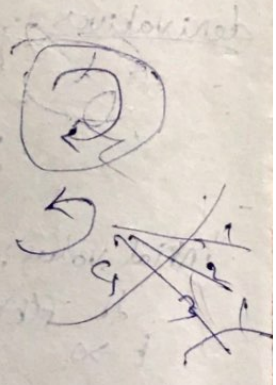
maximum mutual inductance $M = k\sqrt{L_1 L_2}$

Ideal Transformer.

Series Connection of coupled circuits

$L = L_1 + L_2 \pm 2M$ both entering '+'





$C_2 = \{1, 2, 3\}$
$C_2 \{ \quad \}$

Parallel:-

$$L_{eq} = \frac{L_1 L_2 - M^2}{L_1 + L_2 + 2M}$$

Flux:- (ϕ) wb

Flux density:- $B = \phi/A$ wb/m² (or) $B = \mu_0 H = 4\pi \times 10^{-7} \times H$

magneto motive force:- $MMF = NI$

magnetic field:- $H = \frac{MMF}{l} = \frac{NI}{l}$ AT/m

$\phi = B \times A$

The total energy stored in system t=0 is

$$W(t) = \frac{1}{2} L_1 [i_1(t)]^2 + \frac{1}{2} L_2 [i_2(t)]^2 - M[i_1(t) \cdot i_2(t)]$$

Unit - III

c) DC Response of RL circuit

$$i = \frac{V}{R}\left(1 - \exp\left(-\frac{R}{L}t\right)\right)$$

Laplace transform:-

$$\cos\omega t :- \frac{e^{+}+e^{-1}}{2} \; ; \; \sin\omega t = \frac{e^{1}-e^{-1}}{2i}$$

L.T Periodic function:-

$$L\{f(t)\} = \frac{1}{1-e^{-sT}}\int_0^T f(t).e^{-st}\,dt$$

derivatives:- $L(f'(t)) = sF(s)-f(0)$

$$L(f''(t)) = s^2F(s) - sf(0) - f'(0)$$

initial value:-

$$\lim_{t\to 0} f(t) = \lim_{s\to\infty} sF(s)$$

final value

$$\lim_{t\to\infty} f(t) = \lim_{s\to 0} sF(s)$$

Chapter:- 3

Theorems:-

Superposition

current - open ckt
voltage - short "

If current is opened then find out current of Load current to find where by
case (i) doing equivalent resistance

Case (ii):-

Thevinens:-

first make open ckt where the 'i' is to be find in resistor find shortest path and write loop Equation find 'i_L' as

find $V_{Th} = i_L \times R$

Then make the CKT shorts the voltages and find ark Equivalent resistance and find R_{Th}

R_{Th} =

Then replace the CKT from the voltage, current, and removed resistor using voltage division rule then find 'i' at removed resistor

nortons:-

find place shorts ckt
same above procedure

frequency $F = \frac{1}{T}$

time $T = \frac{1}{F}$

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

$\therefore v(t) = V_m \sin(\omega t + \phi)$ when left side of reference

$v(t) = V_m \sin(\omega t - \phi)$ Right side

Avg value :- $V_{av} = \frac{1}{T}\int_0^T v(t).dt$

Rms value $V_{rms} = \sqrt{\frac{1}{T}\int_0^T v(t)^2 . dt}$ (or) $V_{rms} = \frac{V_P}{\sqrt{2}}$

Peak factor :- $= \frac{V_P}{V_{rms}} = \frac{V_P}{V_P/\sqrt{2}}$

form factor $= \frac{V_{rms}}{V_{av}}$

Phase relation in pure resistor:-

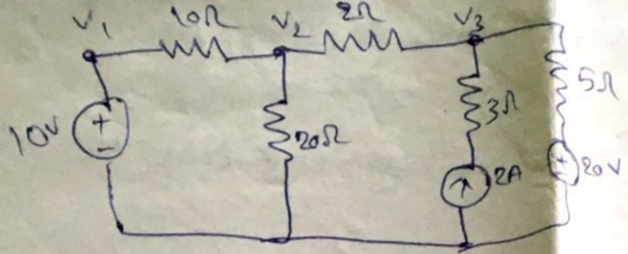
$v(t) = i(t)R$

$i(t) = i_m \sin \omega t$

$V_m = I_m R$

impedance :- $Z = \frac{V_m \angle 0^\circ}{I_m \angle 0^\circ} = R$

Superposition Th:-



node 'V₁':-

$$\frac{V_1}{10} + \frac{V_1 - V_2}{10} = 0$$

$$2V_1 - V_2 = 0$$

node 'V₂':-

$$2V_1 = V_2$$

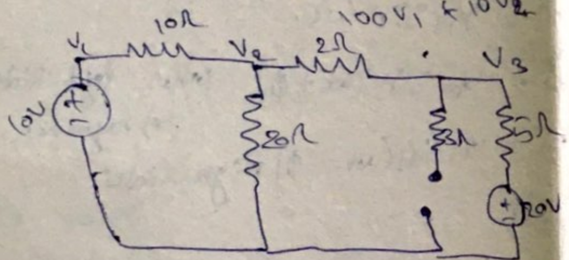
$$\frac{V_2 - V_1}{10} + \frac{V_2}{20} + \frac{V_2 - V_3}{2} = 0$$

$$10V_2 - 10V_1 + 5V_2 + 50V_2 - 50V_3 = 0$$

$$10V_2 - 10V_1 + 10V_1 + 100V_1 - 50V_3 = 0$$

$$100V_1 - 50V_3 + 10V_2 = 0$$

$$100V_1 + 10V_2 - 50V_3 = 0$$



$$\frac{V_1}{10} + \frac{V_1 - V_2}{10} = 0$$

$$2V_1 = V_2$$

$$\frac{V_2 - V_1}{10} + \frac{V_2}{20} + \frac{V_2 - 20}{5} = 0$$

$$\frac{4V_2 - 4V_1 + 2V_2 + 8V_2 - 160}{40} = 0$$

$$14V_2 - 4V_1 = 160$$

$$28V_1 - 4V_1 = 160$$

$$24V_1 = 160$$

$$V_1 = \frac{160}{24} = 6.66$$

2 | 10, 20, 2
  | 5, 10, 1

5 | 5, 10, 20
  | 1, 2, 4

Phase relation in pure inductor:- Chapter - 5

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

$V_m = \omega L I_m$

$= X_L \times I_m$

Capacitive resistance $X_C = \frac{1}{2\pi f C}$ $(\because \omega = 2\pi f)$

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

$X_L = \omega L$

Series RL circuit:- find $X_L = \omega L = 2\pi f L$

Total impedance formula $Z = R + J\omega L$

$\Rightarrow Z = \sqrt{R^2 + X_L^2}$ $X_L = \omega L$

Current $I = V_S/Z$.

Phase angle $\theta = \tan^{-1}\left(\frac{X_L}{R}\right)$

Polar form total impedance $Z = Z\angle^\circ$

Series RC ckt:-

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

Total impedance $Z = R + J\omega L$

$Z = \sqrt{R^2 + X_C^2}$

Current $I = \frac{V_c}{Z}$

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

Polar $\Rightarrow$.

Series RLC ckt:-

X_C ; X_L

Total impedance:- $Z = (R + JX_L - JX_C)$

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

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

V_T $I = \frac{V_S}{Z}$ = flowing voltage in Imped. Z

$V_R = IR$ =

IX_C =

IX_L =

Ilel ckt:-

RC ckt:-

$X_C = \frac{1}{2\pi fC}$

$I_R = \frac{V_S}{R}$; $I_C = \frac{V_S}{X_C}$

Total current. $(I_R + I_C)^*$ =

$Z = \frac{V_S}{I_T}$ =

RL ckt:-

$I_R = \frac{V_S}{R}$; $I_L = \frac{V_S}{X_L}$

$I_T = I_R + I_L$

$Z = \frac{V_S}{I_T}$.

Compound ckt:-

$Z_T = Z_1 + \frac{Z_2 Z_3}{Z_2 + Z_3}$