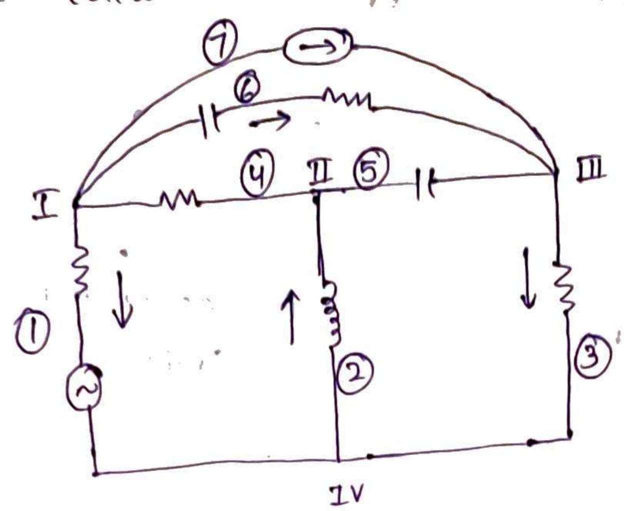
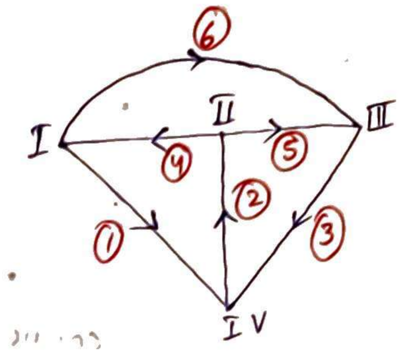
The Graph Theory.

14.11.10

while constructing a graph from a given n/w, all the passive elements, ideal voltage sources are replaced by short ckts and all the ideal current sources are replaced by open ckts



↔



* A linear oriented graph.

i.e. the graph branches $\leqslant$ the n/w branches

→ The no. of nodes or vertices $= n = 4$

→ The no. of branches or edges $= b = 6$

→ Complete Graph :- or the standard graph :-

Betn any pair of nodes, only one branch is connected for all the combinations.

Q1. Det. the no. of edges of a complete graph with 'n' nodes is

(a) n^2 (b) $n-1$ (c) $n(n-1)$ (d) $\frac{n(n-1)}{2}$

$$b = {}^nC_2 = \frac{n(n-1)}{2}$$

It is a way of selecting two nodes from a given set of n- nodes

→ For the present complete graph there are $\frac{4.(4-1)}{2} = 6$ branches

Connected Graph :-

In a connected graph all the nodes are connected by at least one branch, otherwise it is said to be un-connected.

connected graph

un-connected graph

Sub-graph :-

It is a graph with less no. of branches as compared with the original graph.

Tree of a Graph :-

→ Tree is a connected sub graph which connects all the nodes without any closed loop

→ Tree branches are called twigs

→ The no. of twigs of any graph $= n-1$

→ The no. of possible trees of a complete graph with 'n' nodes $= n^{(n-2)}$

→ For the present complete graph there are $4^{(4-2)} = 16$ possible trees.

Co-tree / The complemented tree :-

It is a tree formed with all the removed branches from the original graph in order to construct a tree.

→ Co-tree branches are called "links" or "chords".

→ The no. of links of any graph $= b-(n-1)$

$= b-n+1$

T (2,4,6) (tree) L (1,3,5) (Links) T(1,2,3) (tree) L (4,5,6) (Links)

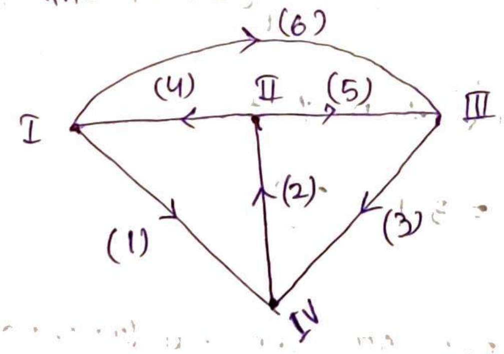
→ The Co-tree may consists a loop in its representation.

→ Tree + Co-Tree = original graph.

1. The incidence matrix :- (A_I)

Let the branch currents be $i_1, i_2 --- i_6$.

By writing the KCL equations at every node



$I \Rightarrow i_1 - i_4 + i_6 = 0$

$II \Rightarrow -i_2 + i_4 + i_5 = 0$

$III \Rightarrow i_3 - i_5 - i_6 = 0$

$IV \Rightarrow -i_1 + i_2 - i_3 = 0$

$$\begin{array}{c} \\ \mathrm{I} \\ \mathrm{II} \\ \mathrm{III} \\ \mathrm{IV} \end{array}\begin{array}{c} \begin{matrix} 1 & 2 & 3 & 4 & 5 & 6 \end{matrix} \\ \begin{bmatrix} 1 & 0 & 0 & -1 & 0 & 1 \\ 0 & -1 & 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 0 & -1 & -1 \\ -1 & 1 & -1 & 0 & 0 & 0 \end{bmatrix}_{4\times 6} \end{array} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \\ i_5 \\ i_6 \end{bmatrix}_{6\times 1} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}_{4\times 1}$$

$\Downarrow$ A_I $\quad\quad$ $\Downarrow$ $(n \times b)$

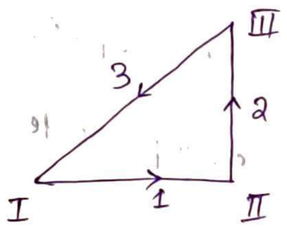
Properties :-

(i) For a given graph the incidence matrix is unique & its order is $(n \times b)$

(ii) The rank of the incidence matrix = rank of the graph $= n-1$.

(iii) The determinant of the incidence matrix of a closed loop is always equal to zero.

eg.



$$A = \begin{array}{c} \\ \mathrm{I} \\ \mathrm{II} \\ \mathrm{III} \end{array}\begin{array}{c} \begin{matrix} 1 & 2 & 3 \end{matrix} \\ \begin{bmatrix} 1 & 0 & -1 \\ -1 & 1 & 0 \\ 0 & -1 & 1 \end{bmatrix}_{3\times 3} \end{array}$$

$|A| = 0 \rightarrow$ rank $\neq n \neq 3$

So, rank $= n-1 = 3-1 = 2$.

2. The Fundamental Loop matrix or the fundamental ckt matrix / or The Tie set matrix :-

Let the branch voltages $v_1, v_2 - - v_6$.

f-loops or f-ckts or Tie-sets :-

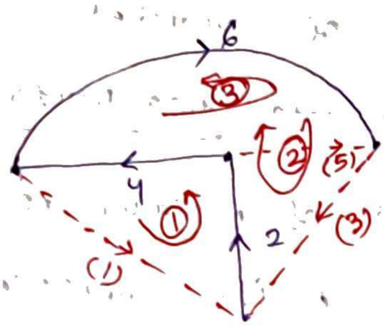
These are the minimum no. of loop or mesh eqns required to solve the corresponding n/w.

Steps :-

(i) Select a tree.

(ii) By adding one link at a time to the existing tree will result one f-loop at a time.

(iii) Select the f-loop current direction as on the link current direction.



$fl_1 \Rightarrow v_1 + v_2 + v_4 = 0$

$fl_2 \Rightarrow v_3 + v_2 + v_4 + v_6 = 0$

$fl_3 \Rightarrow v_5 - v_6 - v_4 = 0$

$$\begin{array}{c} \\ fl_1 \\ fl_2 \\ fl_3 \end{array} \begin{array}{c} \begin{matrix} 1 & 2 & 3 & 4 & 5 & 6 \end{matrix} \\ \begin{bmatrix} 1 & 1 & 0 & 1 & 0 & 0 \\ 0 & 1 & 1 & 1 & 0 & 1 \\ 0 & 0 & 0 & -1 & 1 & -1 \end{bmatrix}_{3\times 6} \end{array} \begin{bmatrix} v_1 \\ v_2 \\ v_3 \\ v_4 \\ v_5 \\ v_6 \end{bmatrix}_{6\times 1} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}_{3\times 1}$$

$\Downarrow$ (B_f) $\qquad \Downarrow$ $(b-n+1)\times b$

Properties :-

→ (i) The rank of the f-loop matrix equal to $b-n+1$

→ (ii) Since every link will result one f-loop at a time for any graph the no. of tie sets equal to links $= b-n+1$

→ (iii) Every f-loop consists of only one link in its representation.

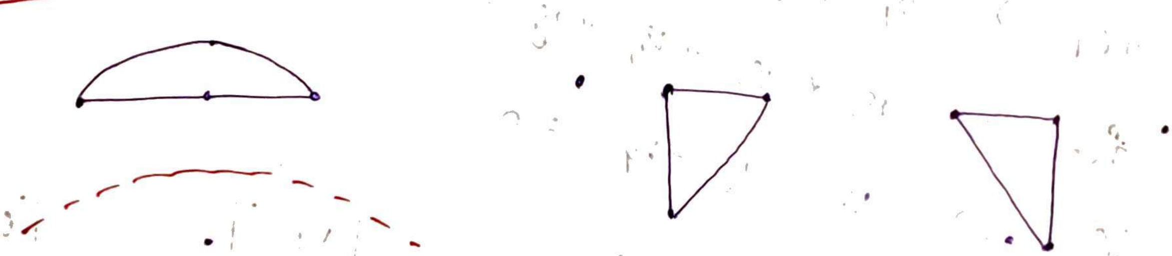
→(iv) Since every tree will result one f-loop matrix at a time, for any graph the no. of f-loop matrices are always equal to the no. of trees

→(v) For a complete graph there are n^{n-2} f-loop matrices.

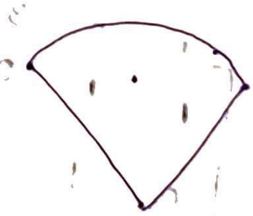
3. Cut-set

The cut set is a minimal set of branches of a graph, removal of each divides the graph into two parts i.e. the cut-set always consists of minimum no. of removed branches from the original graph in its representation

C (1,2,3)



The graph of the cut-set i.e the remaining branches



f- cut sets :-

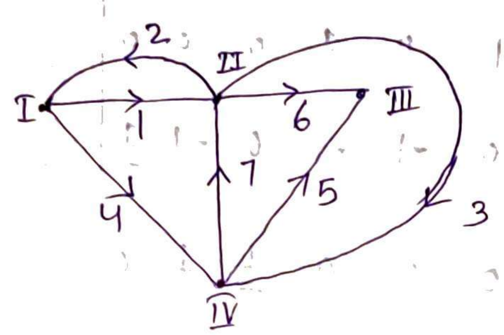
These are the minimum no. of ~~loop~~ nodal eqns required to solve the corresponding n/w.

steps -

(i) select a tree

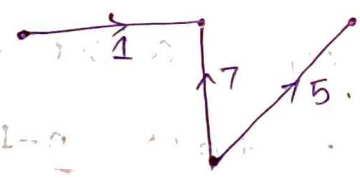
(ii) By removing one tree branch at a time will result one f-cut set at a time.

(iii) select the f-cut set direction as in the tree branch direction.



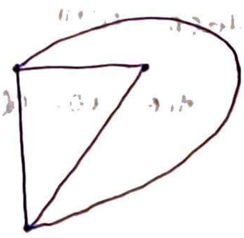
Obs :- It is not a complete graph.

step (2)



T (1, 7, 5)

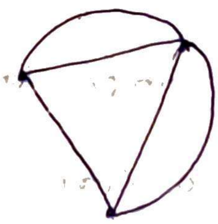
fc_1 : $C(\underline{1}, 2, 4)$ ✓



The graph after f-cut set i.e the remaining branches.

fc_2 : $C(\underline{7}\ 6, 4, 3)$

f_{c_3} : $c(\underline{5}, 6)$ ✓



The f-cut set matrix (Q_c) :-

$$Q_c = \begin{array}{c} \\ f_{c_1} \\ f_{c_2} \\ f_{c_3} \end{array} \begin{array}{c} \begin{array}{ccccccc} 1 & 2 & 3 & 4 & 5 & 6 & 7 \end{array} \\ \begin{bmatrix} \underline{1} & -1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & -1 & -1 & 0 & -1 & \underline{1} \\ 0 & 0 & 0 & 0 & \underline{1} & 1 & 0 \end{bmatrix} \end{array}$$

Properties :-

(i) The rank of the Q_c matrix = $n-1$

(ii) Since every tree branch will result one f-cut set at a time, for the graph no. of f-cut sets = twigs = $n-1$

(iii) Every f-cut set consists of only one tree branch in its representation.

(iv) Since every tree will result one f-cut set matrix at a time for any graph the no. of Q_c matrices are always equal to the no. of trees

→ For a complete graph, there are n^{n-2} Q_c matrices.

Q// A complete graph consists of 66 branches. Determine the no. of f-loops, f-cut sets and their respective matrices.

(A)

$$b = {}^nC_2 = \frac{n(n-1)}{2} = 66$$

$\Rightarrow n = 12$.

f-loops $= b - n + 1 = 66 - 12 + 1 = 55$.

f-cut sets $= n - 1 = 12 - 1 = 11$

f-loop matrices = f-cut-set matrices = no. of trees

$= n^{n-2} = 12^{10}$

Q// A n/w graph consists of 17 branches and 10 nodes. Det. the no. of equations required to solve the corresponding n/w.

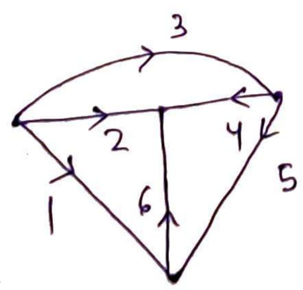
(A) nodal eqn = f-cutsets $= n-1 = 9$

mesh eqn = f-loops $= b-n+1 = 8$

so, the no. of eqns required = minimum of nodal, mesh eqns.

$= 8$

Q//



The valid cut set is

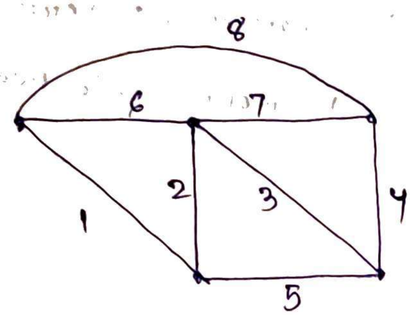
(a) 1, 2, 3, 4 ✗

(b) 3, 4, 5, 6 ✗

(c) 5, 6, 1, 2 ✗

(d) 1, 3, 4, 6

Q11



LIST I

A) 1, 2, 3, 4

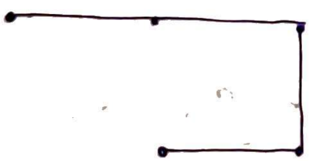
B) 1, 4, 5, 6, 7

C) 4, 5, 6, 7

D) 1, 2, 3, 8

LIST II

1. Twigs
2. Links
3. f-cutsets
4. f-loop.



A Tree.

(The graph after f-cutset)
i.e. the remaining branches

f-loop.

The Avg. and r.m.s values of the Periodic signals :-

Let $x(t)$ be the periodic signal of period 'T', then

$$X_{avg} = X_{d.c} = \frac{1}{T}\int_0^T x(t)\,dt = \frac{\text{Area over one period}}{\text{period}}.$$

$$x_{rms} = \sqrt{\frac{1}{T}\int_0^T x^2(t)\,dt}$$

Sinusoidal signals :-

→ The Avg. and r.m.s values of sine or co-sine function of any phase and frequency are.

→ 0 & $\frac{\text{max value}}{\sqrt{2}}$.

Q// $i(t) = 3 + 4\sqrt{2}\cos(100t + 10^\circ) + 5\sqrt{2}\cos(200t + 10^\circ)$ A.

$$I_{d.c} = I_{avg.} = \frac{1}{T}\int_0^T i(t).dt = 3 + 0 + 0 = 3A.$$

$$I_{rms} = \sqrt{\frac{1}{T}\int_0^T i^2(t)\,dt} = \sqrt{3^2 + \left(\frac{4\sqrt{2}}{\sqrt{2}}\right)^2 + \left(\frac{5\sqrt{2}}{\sqrt{2}}\right)^2 + 0 + 0 + 0}$$

$$=$$

Q// $V(t) = 2 - 3\sqrt{2}\cos(10t + 45^\circ) + 3\cos 10t$ V

$$V_{avg} = V_{dc} = \frac{1}{T}\int_0^T v(t).dt = 2 + 0 + 0 = 2V.$$

$$V_{rms} = \frac{1}{T}\int_0^T v^2(t)\,dt = \sqrt{2^2 + \left(-\frac{3\sqrt{2}}{\sqrt{2}}\right)^2 + \left(\frac{3}{\sqrt{2}}\right)^2 + 0 + \underbrace{(\text{non-zero term})}_{2bc} + 0}$$

$$= \sqrt{8.5}\ V.$$

Another method.

when same frequencies are present then do the simplification first

$$v(t) = 2 - 3\sqrt{2}\cos(10t + 45°) + 3\cos 10t \text{ V.}$$

$$\Rightarrow v(t) = 2 - 3\sqrt{2}\left(\cos 10t \cdot \frac{1}{\sqrt{2}} - \sin 10t \cdot \frac{1}{\sqrt{2}}\right) + 3\cos 10t$$

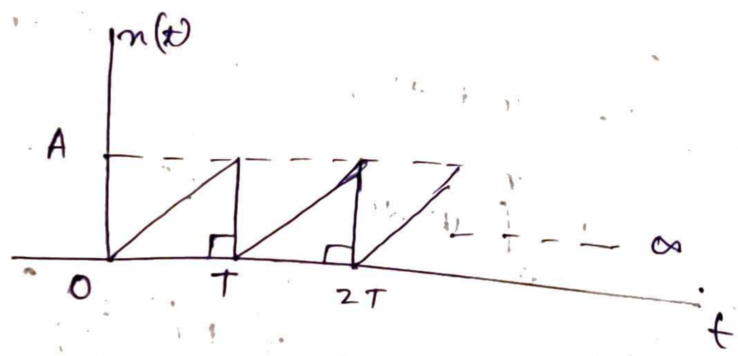
$$= \underline{2 - 3\sin 10t \text{ V.}}$$

$$V_{rms} = \sqrt{2^2 + \left(-\frac{3}{\sqrt{2}}\right)^2 + 0}$$

$$= \underline{\sqrt{8.5} \text{ V.}}$$

Non-sinusoidal signals of periodic nature :-

Q//

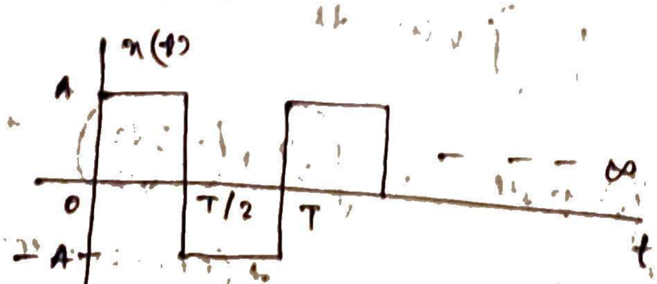


$$x(t) = \frac{A}{T} t \quad \text{for } 0 \leq t \leq T$$

$$x_{avg.} = \frac{\frac{1}{2} \cdot T \cdot A}{T} = \underline{\frac{A}{2}}.$$

$$x_{rms} = \sqrt{\frac{1}{T}\int_0^T \left(\frac{A}{T} t\right)^2 . dt} = \underline{\frac{A}{\sqrt{3}}}.$$

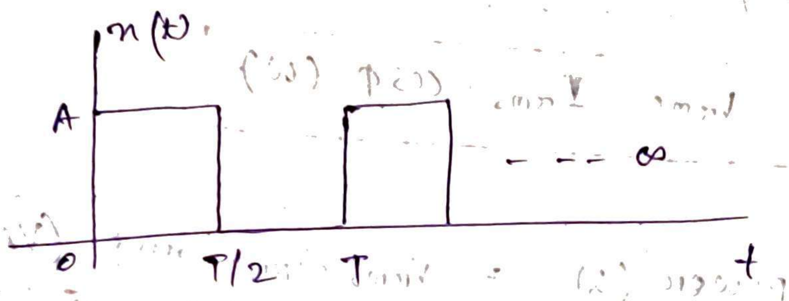
Q//



$$x_{avg} = x_{d.c} = \frac{\frac{AT}{2} - \frac{AT}{2}}{T} = 0$$

$$x_{rms} = \sqrt{\frac{1}{T}\left(\int_0^{T/2} A^2 \, dt + \int_{T/2}^{T} (-A)^2 \, dt\right)} = A$$

Q// Hal



(Half rectified sq. wave)

$$x_{avg} = x_{d.c} = \frac{\frac{AT}{2} + 0}{T} = A/2$$

$$x_{rms} = \sqrt{\frac{1}{T}\left[\int_0^{T/2} A^2 \, dt + \int_{T/2}^{T} (0)^2 \, dt\right]} = \frac{A}{\sqrt{2}}.$$

→ Full rectified square wave ⇒ D.C

For d.c = Avg. value = r.m.s value = max^m. value.

The power Calculation :-

case (i) Let $v(t) = V_m \cos(\omega t + \alpha)$ V.

$i(t) = I_m \cos(\omega t + \beta)$ A.

(i) The true power / The Active power (P)

$$\Rightarrow \boxed{P = V_{rms} \cdot I_{rms} \cdot \cos\phi \ (W)}$$

(ii) The reactive power $\boxed{(Q) = V_{rms} \cdot I_{rms} \cdot \sin\phi \ (VAR)}$

(iii) The complex power or The Apparent Power (S)

$$\boxed{S = V_{rms} \cdot I_{rms} \ (VA)}$$

$$\Rightarrow \boxed{S = \sqrt{P^2 + Q^2}} \ (VA)$$

(Q) Let $v(t) = 160 \sin(\omega t + 10^\circ)$ V

$i(t) = 5 \sin(\omega t - 20^\circ)$ A calculate all the powers

(A) $V_{rms} = \frac{160}{\sqrt{2}}$ V

$I_{rms} = \frac{5}{\sqrt{2}}$ A

$Z = \frac{V}{I} = \frac{160 \angle 10^\circ - 90^\circ}{5 \angle -20^\circ - 90^\circ}$

$= 32 \angle 30^\circ$

$\phi = 30^\circ \Rightarrow$ inductive.

Q// Let $V = 4 \angle 10^\circ$ V.

$I = 2 \angle 20^\circ$ A. Then calculate all the powers.

(A) $V_{rms} = 4V$, $I_{rms} = 2A$

$$Z = \frac{V}{I} = 2\angle 30^\circ$$

Note: when directly phasors are given then the magnitudes are taken as r.m.s values, since they are measured by using the r.m.s. meters.

case (ii)

let $Z = R \pm jX$

$$i(t) = I_m \cos(\omega t + \beta) \text{ A}$$

$$I_{rms}^2 \cdot Z = I_{rms}^2 \cdot R \pm j I_{rms}^2 \cdot X$$

$$\boxed{\begin{aligned} S &= P \pm jQ \\ |S| &= \sqrt{P^2 + Q^2} \\ \angle S &= \pm \tan^{-1}\left(\frac{Q}{P}\right) \end{aligned}}$$

$$\boxed{\begin{aligned} P &= I_{rms}^2 \cdot R\ (W) = P_{avg}. \\ Q &= I_{rms}^2 \cdot X \quad (VAR) \end{aligned}}$$

Q.

$$i = 5\sqrt{2} \cos 2t \text{ A}$$

$$Z = \left(3 + \frac{j}{3}\right) \Omega$$

$$I_{rms} = \frac{5\sqrt{2}}{\sqrt{2}} = 5 \text{ A}.$$

$$P = 5^2 \times 3 = 75 W.$$

$$Q = 5^2 \times \frac{1}{3} = \frac{25}{3} \text{ VAR}$$

$$S = \sqrt{P^2 + Q^2} \text{ VA}.$$

case (iii)

$$Z = R \pm jX$$

$$Y = \frac{1}{Z} = G \mp jB.$$

$$v(t) = V_m \cos(\omega t + \alpha)\ V$$

$$V_{rms}^2 \cdot Y = V_{rms}^2 \cdot G \mp j V_{rms}^2 \cdot B$$

$$\boxed{\begin{aligned} S &= P \mp Q \\ |S| &= \sqrt{P^2 + Q^2} \\ \angle S &= \mp \tan^{-1}(Q/P) \end{aligned}}$$

$$\boxed{\begin{aligned} P &= V_{rms}^2 \cdot G\ (W) = P_{avg}. \\ Q &= V_{rms}^2 \cdot B\ \ VAR. \end{aligned}}$$

The n/w synthesis :

Theory : Refer L.T

Realizations :

Refer material.

- FF – I → Partial fraction expansion of $z(s)$.
- FF – II → " " " " $Y(s)$.
- C – I → polynomial division by decending order.
- C – II → " " by ascending order.

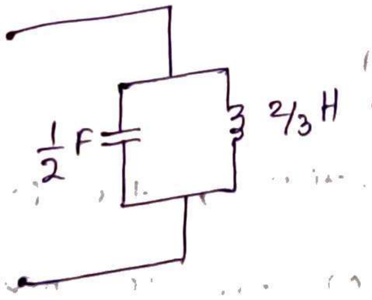
Q// The Driving point impedance function of a one port n/w is $Z(s) = \frac{2s}{s^2+3}$ Ω. Its realization is.

(A) $Z(s) = \frac{2s}{s^2+3} = \frac{1}{s/2 + 3/2s} = \frac{1}{Y(s)}$

$Y(s) = s \cdot \frac{1}{2} + \frac{1}{s \cdot 2/3}$.

$Y(s) = sC + \frac{1}{sL}$.

(℧) (℧) (℧)

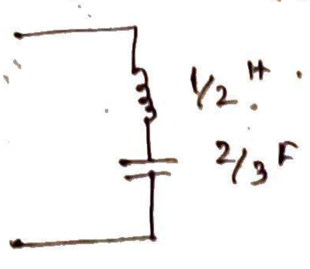


Q// $Y(s) = \frac{2s}{s^2+3} = \frac{1}{\frac{s}{2} + \frac{3}{2s}} = \frac{1}{Z(s)}$

$Z(s) = s \cdot \frac{1}{2} + \frac{1}{s \cdot \frac{2}{3}}$.

$Z(s) = s \cdot L + \frac{1}{s \cdot C}$

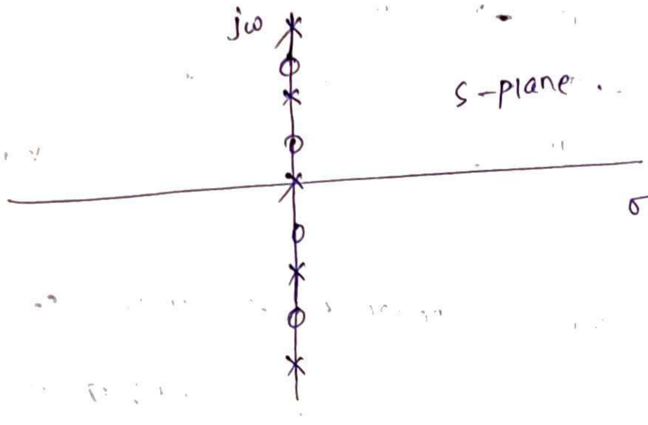
(Ω) Ω Ω)



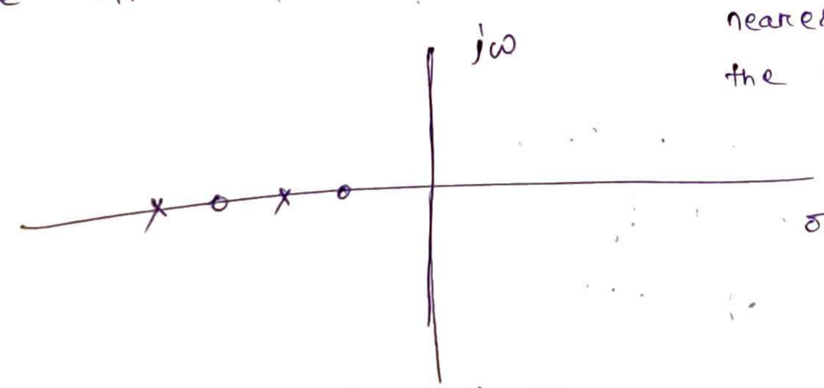
(i) For the LC impedance funcn the poles and zeroes are alternate and lies only on the imaginary ~~real~~ axis

eg.

$$Z(s) = \frac{(s^2+1)(s^2+3)}{s(s^2+2)(s^2+4)}$$



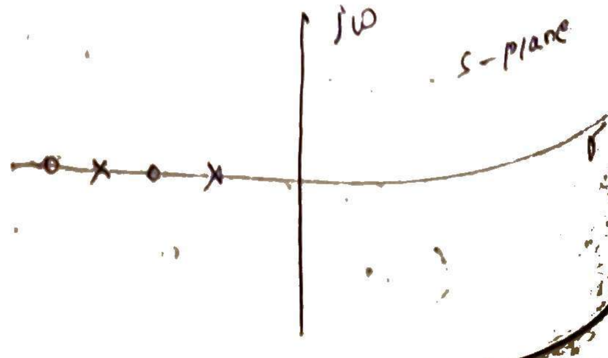
(ii) For the RL impedance funcn, the poles and zeroes are alternate, lies only on the -ve real axis and nearest to the origin is the zero the (zero can be at the origin)



$$z(s) = \frac{(s+1)(s+3)}{(s+2)(s+4)}$$

(iii) For the RC impedance function, the poles and zeroes are alternate, lies only on the -ve real axis and nearest to the origin is the pole (the pole can be at the origin)

$$Z(s) = \frac{(s+2)(s+4)}{(s+1)(s+3)}$$



(iv) For the RLC impedance funcn, the poles and zeroes are complex conjugate phase and they are symmetric w.r.t the -ve real axis.

Note: In the above case instead of impedance function if admittance functions are given then they are converted into the impedances function first and later the above tests are performed.

→ RL - imp. funcn ≡ RC - Admittance funcn and vice versa.

→ Immittance = Impedance or Admittance.

Q) The driving point immittance funcn of a one port n/w is.

$$f(s) = \frac{(s+2)(s+4)}{(s+1)(s+3)}$$

then the choice is.

(i) R-L impedance funcn.

(ii) R-C admittance funcn.

(iii) L-C imp. funcn

(iv) R-L admittance funcn.

Soln → If $f(s) = Z(s)$, then it is an R-C funcn.

→ If $f(s) = Y(s)$, then it is an R-L funcn

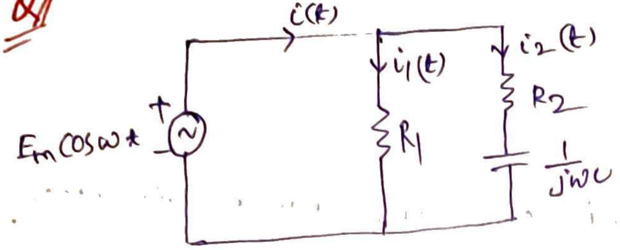
Concn :- i.e. In imp. domain it is an RC funcn and in admittance domain, it is an R-L funcn.

The LOCUS DIAGRAMS .. -1

16.11.10

G-2001 | EC-2m.

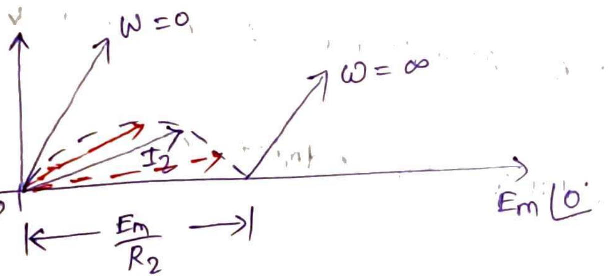
Q1



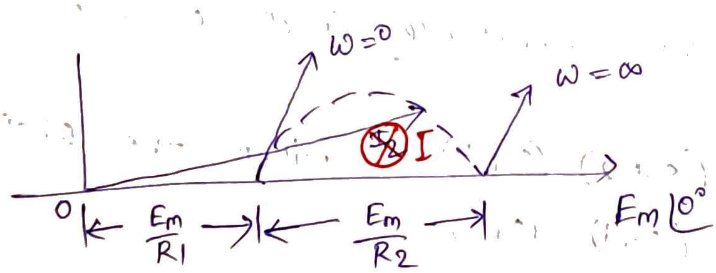
N/W is in S.S.

In the ckt shown, the freq. of the source ω is varied from 0 to ∞. then the locus of the current phasor 'I_2' is

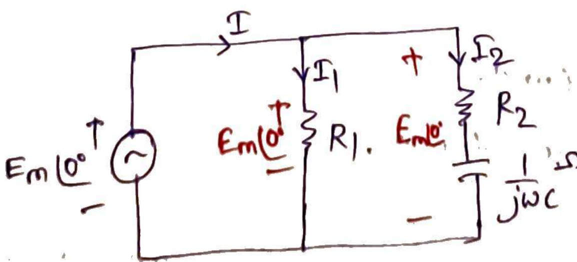
(a)



(b)



Transform the above n/w into the phasor domain.



N/W is in P-D

By KCL in P-D ⇒ $I = I_1 + I_2$

$$\Rightarrow I_1 = \frac{E_m \angle 0°}{R_1}$$

$$I_2 = \frac{E_m \angle 0°}{R_2 + \frac{1}{j\omega C}}$$

$$I_2 = \frac{E_m \angle 0^\circ}{R_2 + \frac{1}{j\omega C}} = \frac{E_m \angle 0^\circ}{R_2 - \frac{j}{\omega C}} = \frac{E_m \angle \tan^{-1}\frac{1}{\omega C R_2}}{\sqrt{R_2^2 + \left(\frac{1}{\omega C}\right)^2}}$$

$\omega = 0 \Rightarrow I_2 = 0$

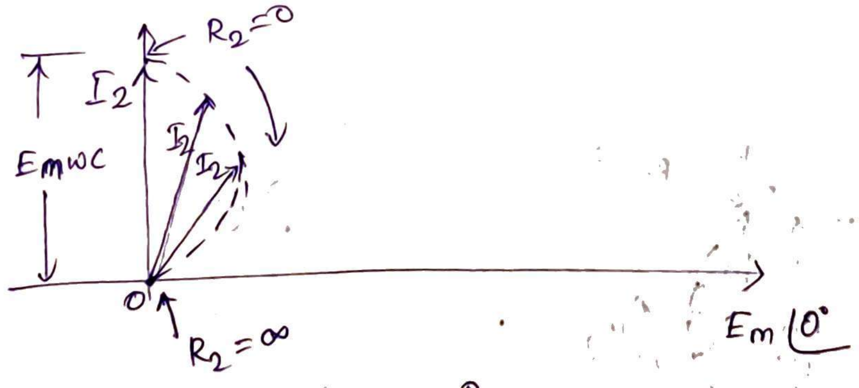
$\omega = \infty \Rightarrow I_2 = \frac{E_m \angle 0^\circ}{R_2}$

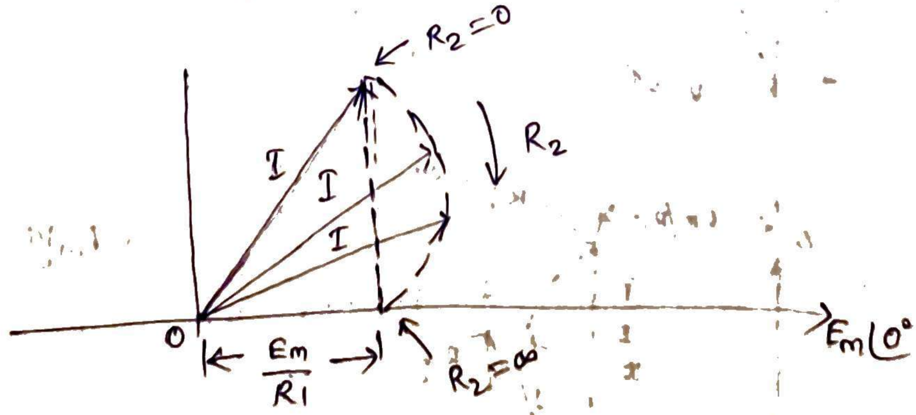
→ $0 < \omega < \infty$, the current phasor I_2 always lead the voltage $E_m \angle 0^\circ$

Q// In the above case instead of 'ω' if R_2 is varied from 0 to ∞ then the locus of the current phasor I_2.

(A) $R_2 = 0 \Rightarrow I_2 = \frac{E_m \angle 0^\circ}{0 + \frac{1}{j\omega C}} = E_m \omega C \angle 90^\circ$.

$R_2 = \infty \Rightarrow I_2 = 0\,A$.





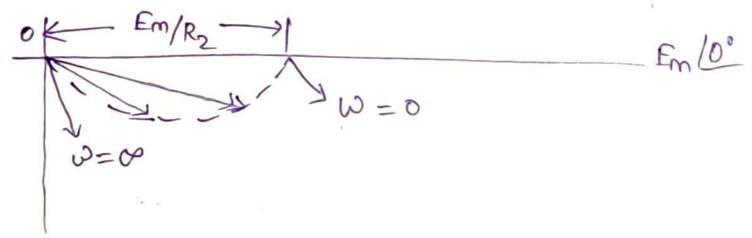
Q// In the above case instead of capacitor is inductor is present then

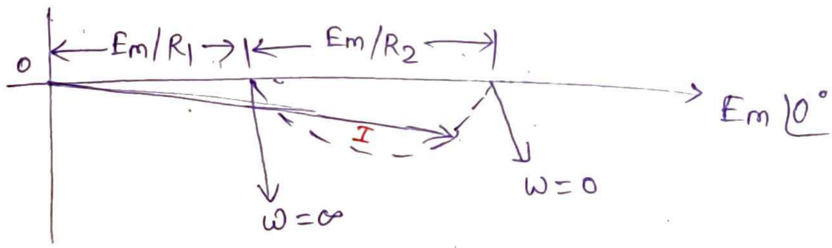
$$I = I_1 + I_2$$

$$I_1 = \frac{E_m \angle 0^\circ}{R_1}$$

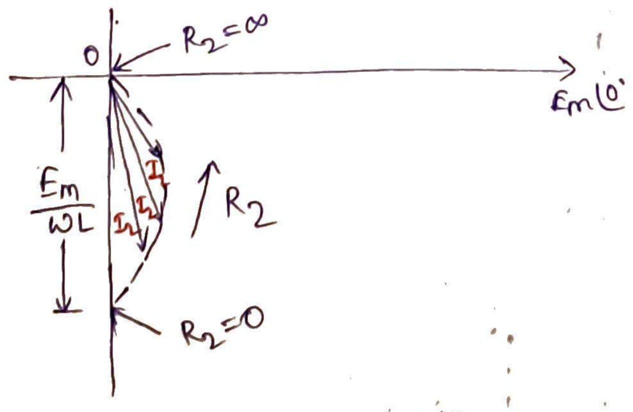
$$I_2 = \frac{E_m \angle 0^\circ}{R + j\omega L} = \frac{E_m \angle -\tan^{-1}\frac{\omega L}{R_2}}{\sqrt{R_2^2 + (\omega L)^2}}$$

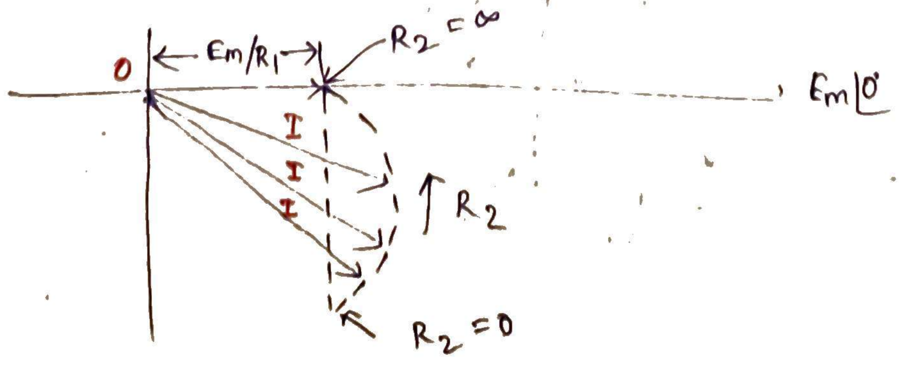
'ω' varied





R2 varied





FILTERS :-

$Z_R = R\,\Omega$

$Z_L = j\omega L\,\Omega$

$Z_C = \frac{1}{j\omega C}\,\Omega$

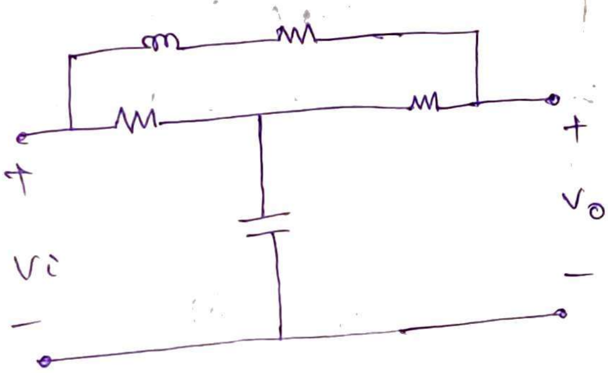
$\omega = 0 \Rightarrow Z_L = 0 \Rightarrow L \rightarrow S.C$

$Z_C = \infty \Rightarrow C \Rightarrow O.C$

$\omega = \infty \Rightarrow Z_L = \infty \Rightarrow L \rightarrow O.C$

$Z_C = 0 \rightarrow C \rightarrow S.C$

Q) The ckt shown in fig. represents



~~(a)~~ LPF ✓

(b) HPF

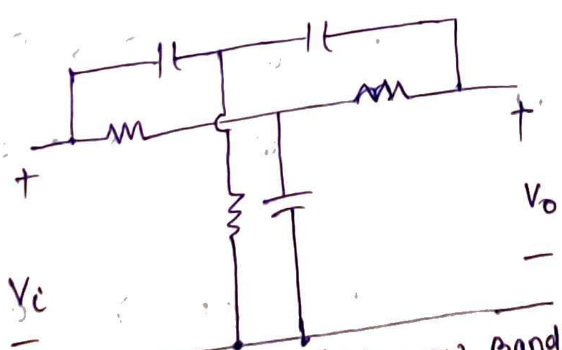
(c) BPF

(d) BSF.

$\omega = 0 \Rightarrow V_o = V_i$

$\omega = \infty \Rightarrow V_o = 0$.

Q)



(Narrow Band reject Notch filter)

(a) LPF

(b) HPF

(c) BPF

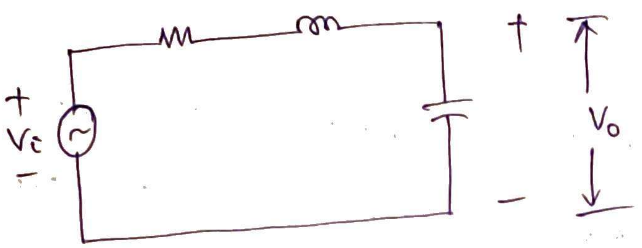
~~(d)~~ BSF

$\omega = 0 \Rightarrow V_o = V_i$

$\omega = \infty \Rightarrow V_o = V_i$

Q) The series and parallel RLC ckt at resonance are called as BPF

Q//

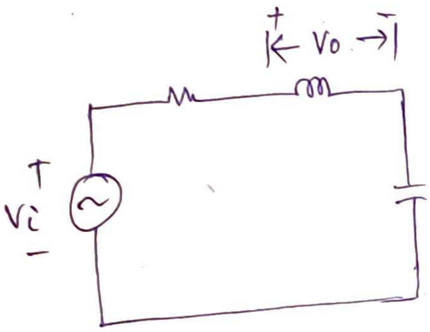


$\omega = 0 \Rightarrow V_o = V_i$

$\omega = \infty \Rightarrow V_o = 0$

$\Rightarrow$ LPF

Q//

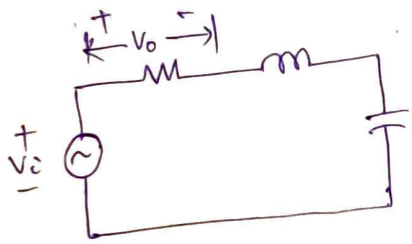


$\omega = 0 \Rightarrow V_o = 0$

$\omega = \infty \Rightarrow V_o = V_i$

HPF

Q//



$V_o = R \cdot i(t)$

$\omega = 0 \Rightarrow V_o = 0$

$\omega = \infty \Rightarrow V_o = 0$

BPF

2nd order Filters :-

LPF : $H(S) = \dfrac{1}{S^2+S+1}$: $\omega = 0 \Rightarrow S = 0 \Rightarrow H(S) = 1$ ✓

$\omega = \infty \Rightarrow S = \infty \Rightarrow H(S) = 0$ ✗

HPF : $H(S) = \dfrac{S^2}{S^2+S+1}$: $\omega = 0 \Rightarrow S = 0 \Rightarrow H(S) = 0$ ✓

$\omega = \infty \Rightarrow S = \infty \Rightarrow H(S) = 1$ ✓

BPF : $H(S) = \dfrac{S}{S^2+S+1}$: $\omega = 0 \Rightarrow S = 0 \Rightarrow H(S) = 0$ ✗

$\omega = \infty \Rightarrow S = \infty \Rightarrow H(S) = 0$ ✗

BSF : $H(S) = \dfrac{S^2+1}{S^2+S+1}$: $\omega = 0 \Rightarrow S = 0 \Rightarrow H(S) = 1$ ✓

$\omega = \infty \Rightarrow S = \infty \Rightarrow H(S) = 1$ ✓

& $|H(j\omega)|$ is a funcⁿ of 'ω'

APF : $H(s) = \frac{1-s}{1+s}$: $\omega = 0 \Rightarrow s = 0 \Rightarrow H(s) = 1$

$\omega = \infty \Rightarrow s = \infty \Rightarrow H(s) = -1$

$= 1 \angle 180^\circ$

& $|H(j\omega)|$ is independent of 'ω'

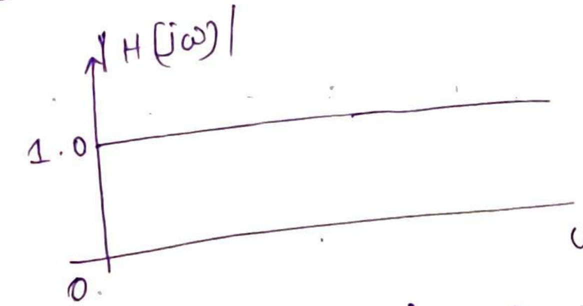
Q) The max. Phase Shift added the ALL pass filter to the i/p signal is

A) $H(s) = \frac{1-s}{1+s}$

$H(j\omega) = \frac{1-j\omega}{1+j\omega}$

$|H(j\omega)| = 1$

$\angle H(j\omega) = \phi = -\tan^{-1}\omega - \tan^{-1}\omega = -2\tan^{-1}\omega.$



$\omega = 0 \Rightarrow \phi = 0^\circ = \phi_{min}.$

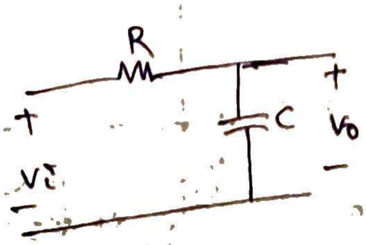
$\omega = \infty \Rightarrow \phi = -2\tan^{-1}\infty = -2 \times 90^\circ = -180^\circ$

$= +180^\circ$

$= \pm 180^\circ = \phi_{max}$

Q) The max. Phase Shift added by the first order LPF to the i/p signal is

A)



$\omega = 0 \Rightarrow V_o = V_i$

$\omega = \infty \Rightarrow V_o = 0$

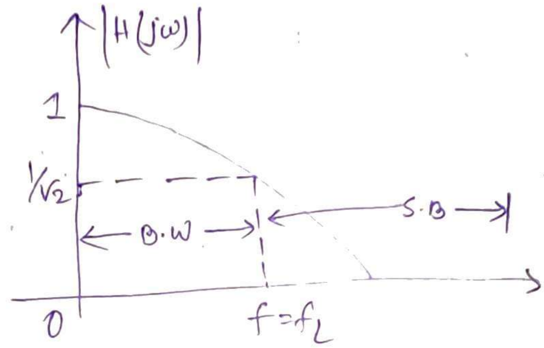
$$\rightarrow V_o(s) = \left(\frac{V_i(s)}{R+\frac{1}{sC}}\right)\cdot\frac{1}{sC}$$

$$\Rightarrow \frac{V_o(s)}{V_i(s)} = H(s) = \frac{1}{1+sCR}$$

$$H(j\omega) = \frac{1}{1+j\omega CR} = \frac{1}{1+j\,f/f_L} \quad \Big| \text{ where } f_L = \frac{1}{2\pi RC}.$$

$$|H(j\omega)| = \frac{1}{\sqrt{1+\left(\frac{f}{f_L}\right)^2}}$$

$$\angle H(j\omega) = \phi = -\tan^{-1}(f/f_L)$$

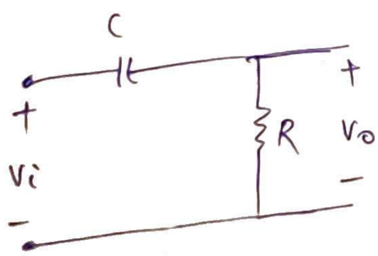


$f=0 \Rightarrow \phi = 0° = \phi_{min}$.

$f=\infty \Rightarrow \phi = -45° = \phi_{max}$

→ It can delay the signal max. $\underline{\underline{-45°}}$.

Q11 HPF:



$$\rightarrow V_o(s) = \left(\frac{V_i(s)}{R+\frac{1}{sC}}\right) R$$

$$\Rightarrow \frac{V_o(s)}{V_i(s)} = H(s) = \frac{sCR}{1+sCR}.$$

$\omega_0 = 0 \Rightarrow V_o = 0$

$\omega = \infty \rightarrow V_o = V_i$

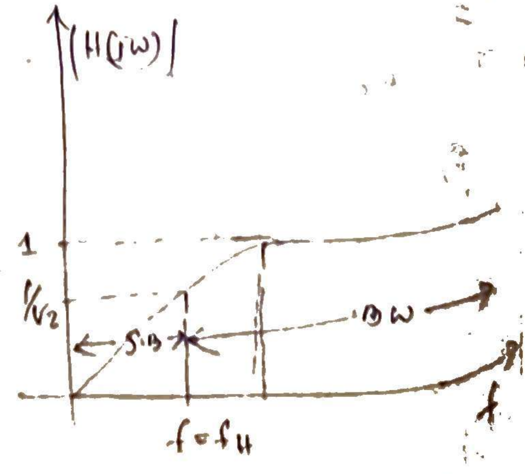
$$\Rightarrow H(j\omega) = \frac{1}{1-\frac{j}{\omega CR}} = \frac{1}{1-j\frac{f_H}{f}} \quad \Big| \text{ where } f_H = \frac{1}{2\pi RC}$$

$$|H(j\omega)| = \frac{1}{\sqrt{1+\left(\frac{f_H}{f}\right)^2}}$$

$$\angle H(j\omega) = \phi = \tan^{-1}\left(\frac{f_H}{f}\right)$$

$f = \infty \Rightarrow \phi = 0 = \phi_{min}$

$f = f_H \rightarrow \phi = 45° = \phi_{max}$



Coupled ckts → (M)

→ These are the ckts in the presence of mutual inductance (M). This is due to the mutual flux betn the coils. The mutual flux ~~need~~ aid or ~~need~~ ~~are~~ may oppose the self fluxes based on the dot convention, if the current enters the dots or leaves the dots simultaneously then the mutual flux will aid to the self fluxes other-wise it will oppose.

→ The mutual ~~flux~~ terms are because of the currents flowing through the other coils.

- Types of couplings
  - Electrical coupling → physical connection exist
    - Series (aiding / oppose)
    - Parallel (aid / opp)
  - Magnetical coupling → No physical connection. (T/F coupling)
    - mag. aiding
    - mag. opposing.

Magnetic aiding :-

$$v_1 = L_1 \frac{di_1}{dt} + M\frac{di_2}{dt} \quad \text{——} \ (1)$$

$$v_2 = L_2 \frac{di_2}{dt} + M\frac{di_1}{dt} \quad \text{——} \ (2)$$

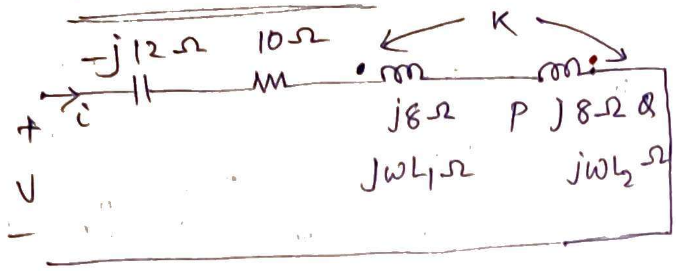
$$v_1 = (L_1 - M)\frac{di_1}{dt} + M\frac{d}{dt}(i_1 + i_2) \longrightarrow (3)$$

$$v_2 = (L_2 - M)\frac{di_2}{dt} + M\frac{d}{dt}(i_1 + i_2) \longrightarrow (4)$$

(1) = (3)

(2) = (4)

Q// For the series resonance det. the value of 'K'.



N/W is in S.S.

$X_C = X_L$

(A) $X_C = 12$ (given.)

$X_{Leq} = 12$ must be series resonance.

So, the dot in the 2nd coil is at 'Q'.

$\Rightarrow \quad L_{eq} = L_1 + L_2 - 2M.$

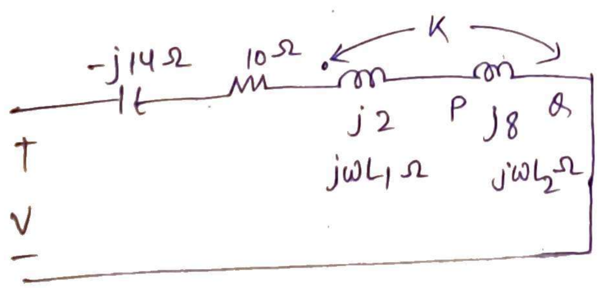
$\Rightarrow \quad L_{eq} = L_1 + L_2 - 2K\sqrt{L_1 L_2}$

$\Rightarrow \quad \omega L_{eq} = \omega L_1 + \omega L_2 - 2K\sqrt{\omega L_1 \, \omega L_2}$

$\Rightarrow \quad 12 = 8 + 8 - 2K\sqrt{8 \cdot 8}$

$\Rightarrow \quad 12 = 16 - 2K \cdot 8 \quad \Rightarrow K = \frac{1}{4} = 0.25.$

Q//



$X_C = 14$ (given)

$\Rightarrow \quad X_{Leq} = 14$ must for series resonance.

So, the dot in the 2nd coil is at 'P'.

$\Rightarrow \quad L_{eq} = L_1 + L_2 + 2M$

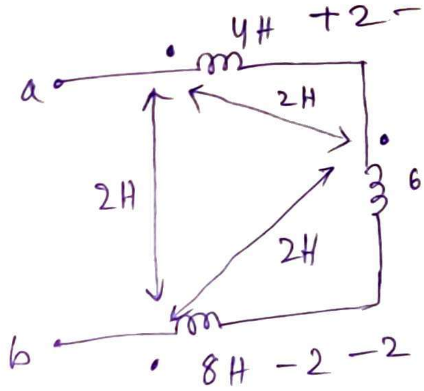
$\Rightarrow \quad L_{eq} = L_1 + L_2 + 2K\sqrt{L_1 L_2}$

$\Rightarrow \omega L_{eq} = \omega L_1 + \omega L_2 + 2K\sqrt{\omega L_1 \cdot \omega L_2}$

$\Rightarrow 14 = 2 + 8 + 2K\sqrt{2 \cdot 8}$

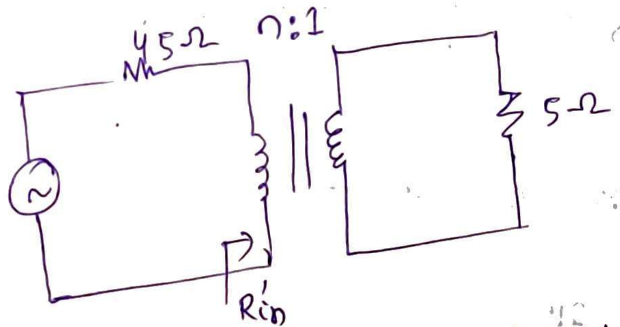
$\Rightarrow k = \frac{1}{2} = 0.5$

Q11 Det. Lab.



$L_{ab} = 4 + 6 + 8 + \cancel{2} - \cancel{2} - 2 - 2 = 14\,H$

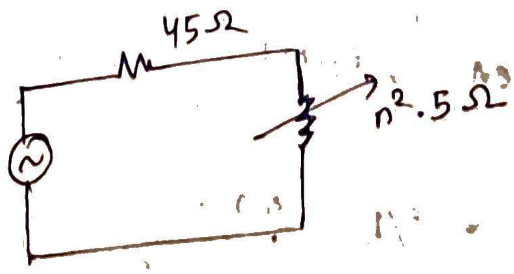
Q4



For the max. power transfer to the 5Ω resistor, the value of 'n' is

$Z_{in} = \left(\frac{N_1}{N_2}\right)^2 \cdot Z_L$

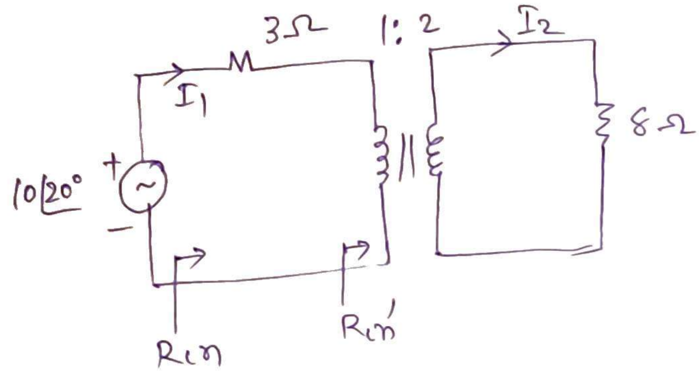
$\Rightarrow R'_{in} = n^2 \cdot 5\ \Omega$



For MPT, $R_L = R_S$

$\Rightarrow n^2 . 5 = 45 . \Rightarrow n = 3.$

Q// Det. I_1 & I_2



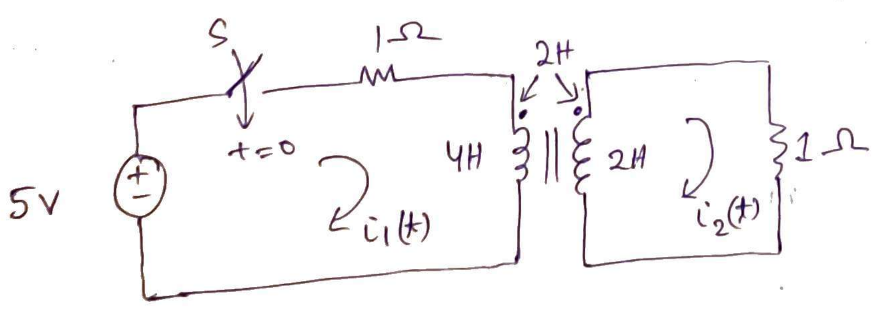
$$R_{in}' = \frac{8}{2^2} = 2\,\Omega$$

$$R_{in} = 3 + R_{in}' = 5\,\Omega.$$

$$I_1 = \frac{10\angle 20°}{5} = 2\angle 20°\ A.$$

$$\frac{I_1}{I_2} = n = 2 \Rightarrow I_2 = \frac{I_1}{2} = 1\angle 20°\ A.$$

Q// Det. $i_1(t)$ and $i_2(t)$ for $t \geq 0$.



(A) Initial condn.

$i_1(0^-) = 0A = i_1(0^+)$

$i_2(0^-) = 0A = i_2(0^+)$

Final condn. $i_1(\infty) = 5/1 = 5A.$

$i_2(\infty) = 0A.$

$$5 = 1\cdot i_1 + 4\frac{di_1}{dt} - 2\frac{di_2}{dt}$$

$$\Rightarrow \frac{5}{s} = 1\cdot I_1(s) + 4\left[s\,I_1(s) - i_1(0^+)\right] - 2\left[s\cdot I_2(s) - i_2(0^+)\right]$$

$$0 = 1\cdot i_2 + 2\frac{di_2}{dt} - 2\frac{di_1}{dt}$$

$$\Rightarrow 0 = 1\cdot I_2(s) + 2\left[s\,I_2(s) - i_2(0^+)\right] - 2\left[s\,I_1(s) - i_1(0^+)\right]$$

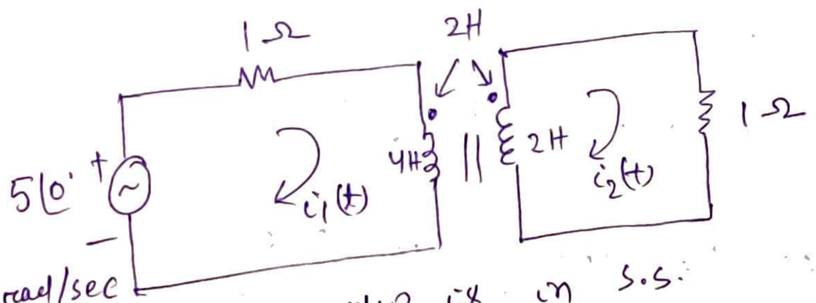
$I_1(s) =$ ✓

$I_2(s) =$ ✓

$\Rightarrow i_1(t) =$ ✓

$\Rightarrow i_2(t) =$ ✓

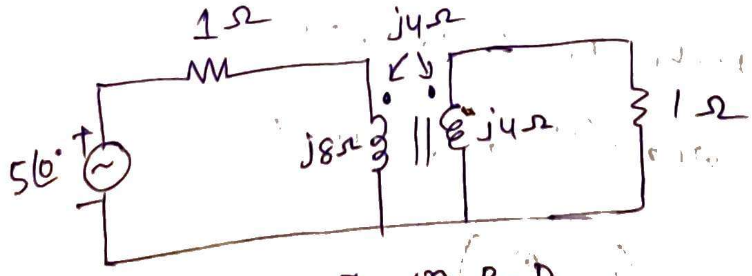
Q// Det. the S.S. current $i_1(t)$ & $i_2(t)$



$\omega = 2$ rad/sec

N/W is in S.S.

(A) Transform the above N/W into the phasor Domain.



N/W is in P-D

$V = Z\cdot I$

BY KVL in P-D $\Rightarrow$

$$5\angle 0^\circ = 1\cdot I_1 + j8\cdot I_1 - j4\cdot I_2$$

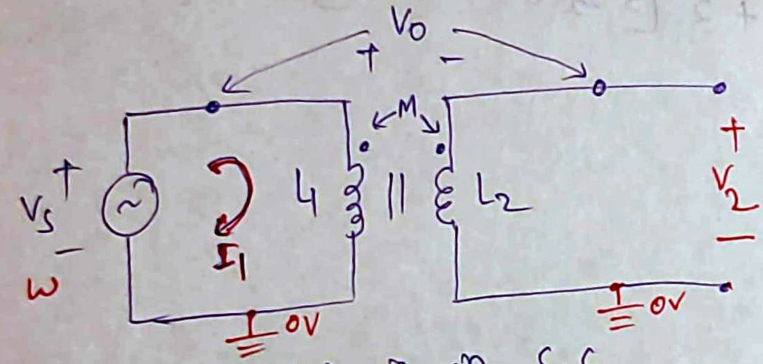
$0 = 1 \cdot I_2 + j4 \cdot I_2 - j4 \cdot I_1$

$I_1 = \frac{\Delta_1}{\Delta}$, $I_2 = \frac{\Delta_2}{\Delta}$

$\Rightarrow i(t) = R.P\left[I_1 \cdot e^{j2t}\right] A$

$i_2(t) = R.P\left[I_2 \cdot e^{j2t}\right] A$

Q11



NW is in S.S

Express Vo in terms of Vs.

A

BY KVL in P-D $\Rightarrow$

$V_s - V_0 - V_2 = 0$

$\Rightarrow V_0 = V_s - V_2 = V_s\left(1 - \frac{V_2}{V_s}\right)$

$I_2 = 0A$, As the 2ndary is open.

$V = Z \cdot I$.

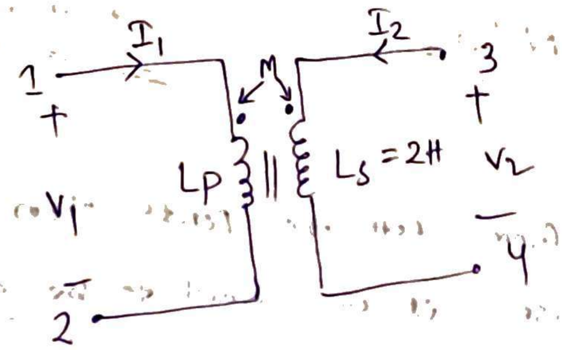
BY KVL in P-D $\Rightarrow$

$V_s = j\omega L_1 \cdot I_1 + j\omega M \cdot (0)$

$V_2 = j\omega L_2 \cdot (0) + j\omega m \cdot (I_1)$

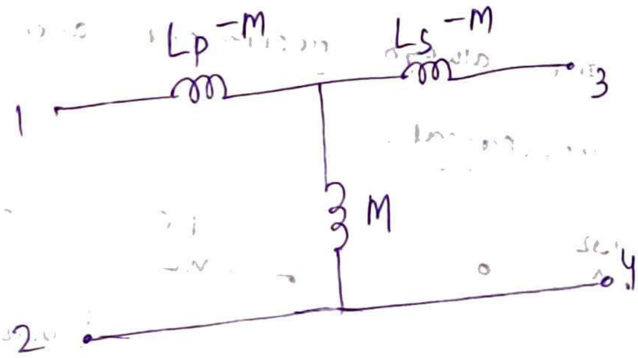
$\Rightarrow V_0 = V_s\left(1 - \frac{M}{L_1}\right)$

Q11



$L_{12} = 4H$ with 3 & 4 open.

$L_{12} = 3H$ with 3 & 4 short. Det. K



$$L_{12} = 4 = L_p - M + M$$

$$\Rightarrow L_p = 4H.$$

$$L_{12} = 3 = L_p - M + M \parallel (L_s - M)$$

$$= L_p - M + \frac{M \cdot (L_s - M)}{L_s} = L_p - M + M - \frac{M^2}{L_s}.$$

$$\Rightarrow 3 = 4 - \frac{M^2}{2} \Rightarrow M = \sqrt{2}$$

$$K = \frac{M}{\sqrt{L_p L_s}} = \frac{\sqrt{2}}{\sqrt{4 \cdot 2}} = \frac{1}{2} = 0.5.$$

Two Port N/Ws.

18.11.10

Symmetrical N/W :-

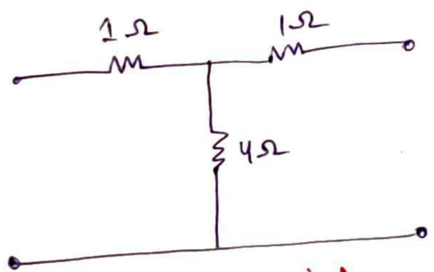
When the N/W looks from both the ports then it is said to be symmetrical, otherwise it is said to be assymetrical.

Reciprocal N/W :-

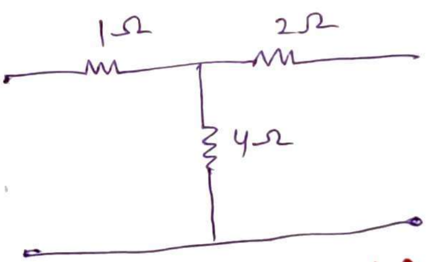
When the N/W obeys the reciprocity thm then it is said to be reciprocal, otherwise it is said to be non-reciprocal.

→ All the passive N/Ws are always reciprocal and all the active N/Ws are always non reciprocal.

eg.



(symi & Reci)



(Assymi & Reci)

→ V_1 . V_2

I_1 I_2

→ From the four variables, we can select two variables as indipendent variable in ${}^4C_2 = 6$ different ways and hence 6 sides of parameters for a given two port N/W.

→ $$\begin{pmatrix} V_1 \\ I_1 \end{pmatrix} = \begin{pmatrix} A & B \\ C & D \end{pmatrix} \begin{pmatrix} V_2 \\ -I_2 \end{pmatrix}$$

Here '$-I_2$' is the leaving current from port '2' i.e the current delivered to the load.

$\rightarrow$ $\begin{pmatrix} V_{be} \\ i_c \end{pmatrix} = h \begin{pmatrix} i_b \\ V_{ce} \end{pmatrix} \longrightarrow$ controlled variables

$$\begin{pmatrix} V_1 \\ I_2 \end{pmatrix} = \begin{pmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{pmatrix} \begin{pmatrix} I_1 \\ V_2 \end{pmatrix}$$

Q// The Y-parameters of a two port n/w is

$Y = \begin{pmatrix} 0 & -\frac{1}{2} \\ \frac{1}{2} & \frac{1}{2} \end{pmatrix} \mho$, Then the n/w is,

(A) $Y_{11} \neq Y_{22}$ $\Rightarrow$ Asymi.

$Y_{12} \neq Y_{21}$ $\Rightarrow$ Non reciprocal & Active, that too dependent sources with resistances.

Q// $T = \begin{pmatrix} 2 & 3 \\ 1 & 2 \end{pmatrix}$

(A) $A = D$ $\Rightarrow$ symi

$AD - BC = 1$ $\Rightarrow$ reciprocal and passive, that too only resistances.

Q// In a two port reciprocal n/w, the O/P open ckted voltage divided by the input current is equal to:

(A) (a) h_{12} (b) Z_{12} (c) $\frac{1}{Y_{21}}$ (d) B.

$Z_{21} = \frac{V_2}{I_1}\Big|_{I_2=0} \Omega$ $(Z_{12} = Z_{21})$

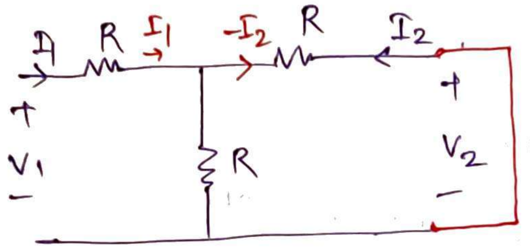
$\rightarrow$ reciprocal.

or $\Rightarrow$ $Y = Z^{-1}$

$$\begin{pmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{pmatrix} = \begin{pmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{pmatrix}^{-1}$$

$\rightarrow$ $Y_{21} = \dfrac{-Z_{21}}{Z_{11} Z_{22} - Z_{21} Z_{12}}$ etc.

Q11 Det. h_{12}



(A) Since passive $\Rightarrow$ Reciprocal. $\Rightarrow$ $h_{12} = -h_{21}$

$h_{21} = \left.\dfrac{I_2}{I_1}\right|_{V_2=0} = h_{fe}$

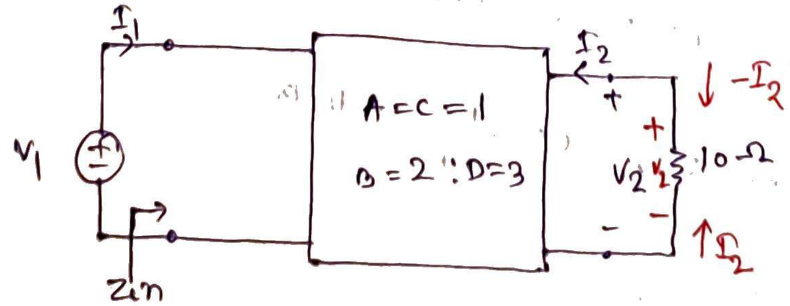
$-I_2 = \left.\dfrac{I_1 . R}{R+R}\right|_{V_2=0}$

$\Rightarrow$ $h_{21} = -1/2.$

$h_{12} = \frac{1}{2}$

JTO Q11

Det. Z_{in}



$\rightarrow$ $AD - BC = 1$ $\Rightarrow$ Reci $\Rightarrow$ only resistances.

$$Z_{in} = R_{in} = \frac{V_1}{I_1} = \frac{AV_2 - BI_2}{CV_2 - DI_2}$$

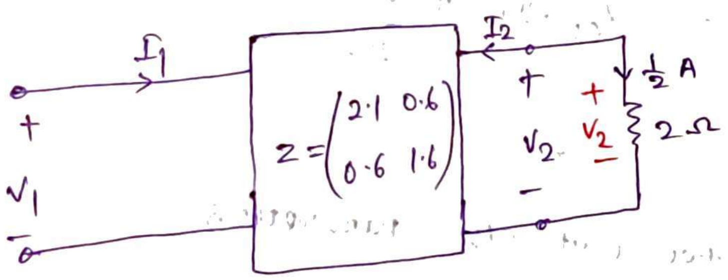
$$= \frac{V_2 - 2I_2}{V_2 - 3I_2}$$

$V = R \cdot I$ | By ohm's Law.

$\Rightarrow V_2 = 10(-I_2)$

$$Z_{in} = \frac{-10I_2 - 2I_2}{-10I_2 - 3I_2} = \frac{-12I_2}{-13I_2} = \frac{12}{13}.$$

Q) Det. V_1



$V_1 = 2.1\,I_1 + 0.6\,I_2$

$V_2 = 0.6\,I_1 + 1.6\,I_2$

$V_2 = 2 \cdot \frac{1}{2} = 1\,V$

BY KCL $\Rightarrow I_2 + \frac{1}{2} = 0 \quad \Rightarrow I_2 = -0.5\,A.$

$\Rightarrow V_1 = 6V.$

$1 = 0.6 \times I_1 + 1.6 \times -0.5.$

$\frac{1.8}{0.6} = I_1 = \underline{3}$

$V_1 = 2.1 \times 3 + 0.6(-0.5) = \underline{6}.$

fig ③ P-87

$$I = Y \cdot V$$

Nodal $\Rightarrow$ $-I_1 + Y_A \cdot V_1 + Y_C (V_1 - V_2) = 0.$

$$-I_2 + Y_B \cdot V_2 + Y_C \cdot (V_2 - V_1) = 0.$$

fig ⑤

By KVL $\Rightarrow$ $V_1 = Z_A \cdot I_1 + Z_C (I_1 + I_2)$

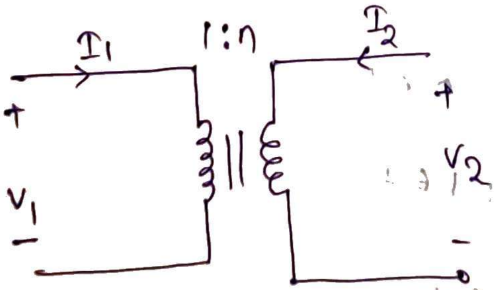
$$V_2 = Z_B \cdot I_2 + Z_C \cdot (I_1 + I_2)$$

fig ⑦

By KVL $\Rightarrow$ $V_1 = (r_b + r_e) I_1 + \mu_{bc} \cdot V_2$

By KCL $\Rightarrow$ $I_2 = \alpha_{cb} \cdot I_1 + \dfrac{V_2}{r_c + r_d}$.

Q11 Det. all the two port n/w parameters



$K = 1 \Rightarrow M = \sqrt{L_1 L_2}$

(A)

$\dfrac{V_2}{V_1} = \dfrac{N_2}{N_1} = n = \dfrac{I_1}{-I_2}$ | (From coupled ckts)

$\Rightarrow \dfrac{V_2}{V_1} = n \quad ; \quad \dfrac{I_1}{-I_2} = n.$

→ **T:**

$$V_1 = \frac{1}{n} V_2 - (0) I_2 .$$

$$I_1 = (0) V_2 - n I_2 .$$

$$T = \begin{pmatrix} 1/n & 0 \\ 0 & n \end{pmatrix} \qquad AD - BC = 1$$

$$T' = T^{-1} = \begin{pmatrix} n & 0 \\ 0 & 1/n \end{pmatrix}$$

→ **h:**

$$V_1 = (0) I_1 + \frac{1}{n} V_2$$

$$I_2 = \frac{-I_1}{n} + (0) V_2 .$$

$$\Rightarrow h = \begin{pmatrix} 0 & \frac{1}{n} \\ -\frac{1}{n} & 0 \end{pmatrix} \qquad h_{12} = -h_{21} \Rightarrow \text{reciprocal.}$$

$$g = h^{-1} = \begin{pmatrix} 0 & -n \\ n & 0 \end{pmatrix} \qquad g_{12} = -g_{21} .$$

→ **Y & Z** ✗

$$V_2 = n V_1$$

$$I_1 = -n I_2 .$$

Note: In an ideal transformer it is impossible to express V_1, V_2 in terms of I_1 and I_2 simultaneously, Hence the z-parameter does not exist, similarly the Y-parameter.

Q4/2 In the above case if the ~~polarities of the sources~~ $\frac{}{2}$ turns ratio is $n:1$ then.

(a) $$\frac{V_2}{V_1} = \frac{N_2}{N_1} = \frac{1}{n} = \frac{I_1}{-I_2}.$$

$$\Rightarrow T = \begin{pmatrix} n & 0 \\ 0 & \frac{1}{n} \end{pmatrix} \quad \& \quad h = \begin{pmatrix} 0 & n \\ -n & 0 \end{pmatrix}$$

etc.

fig-17

BY KVL - in L-D $\Rightarrow$ $V_1(s) = 4\, I_2(s) + \frac{100}{s}\left[I_1(s) + I_2(s)\right]$

$$V_2(s) = 3\, I_2(s) + \frac{10}{s}\left[I_1(s) + I_2(s)\right]$$

fig-19

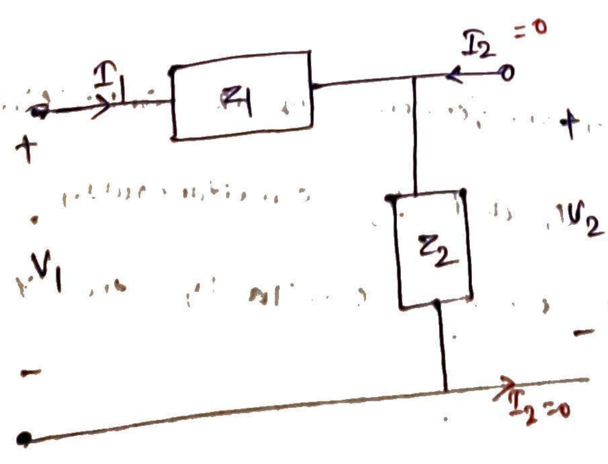
T_a : $Z_1 = 0.5\,s = \frac{s}{2}\,\Omega.$

$Z_2 = 2\,\Omega.$

$$T_a = \begin{pmatrix} 1+\frac{Z_1}{Z_2} & Z_1 \\ \frac{1}{Z_2} & 1 \end{pmatrix} = \begin{pmatrix} 1+\frac{s}{4} & \frac{s}{2} \\ \frac{1}{2} & 1 \end{pmatrix}$$

$$T = (T_a)(T_{N_1})$$

fig (18 a)



(A)

$V_1 = AV_2 - BI_2$

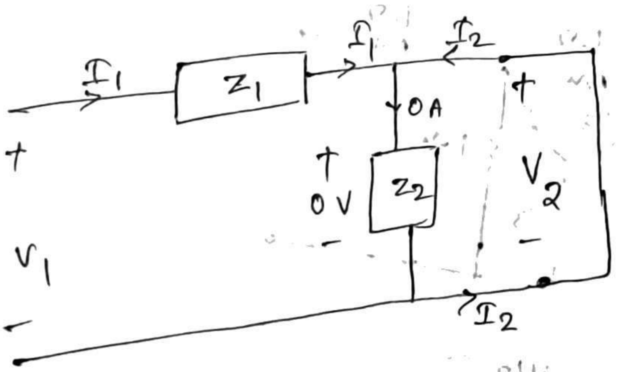
$I_1 = CV_2 - DI_2$

$A = \left.\dfrac{V_1}{V_2}\right|_{I_2=0}$ $\quad C = \left.\dfrac{I_1}{V_2}\right|_{I_2=0}$

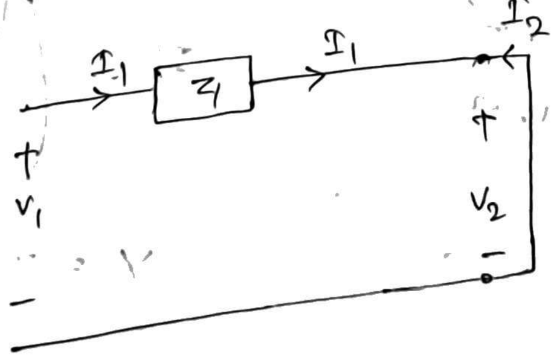
$$\left.\begin{aligned} V_1 &= (Z_1+Z_2)\cdot I_1 \\ V_2 &= Z_2 \cdot I_1 \end{aligned}\right|_{I_2=0}$$

$\Rightarrow \quad A = 1 + \dfrac{Z_1}{Z_2}$ $\quad C = \dfrac{1}{Z_2}$

$B = \left.\dfrac{V_1}{-I_2}\right|_{V_2=0}$ $\quad D = \left.\dfrac{I_1}{-I_2}\right|_{V_2=0}$



$V_2 = 0$



$V_2 = 0$

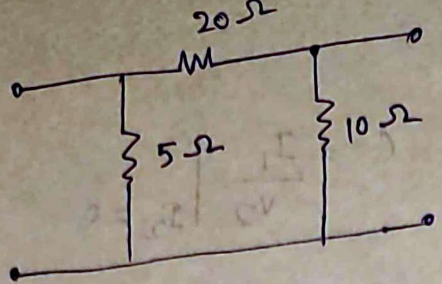
BY KCL $\Rightarrow$ $-I_1 - I_2 = 0$

$\Rightarrow$ $I_1 = -I_2$ $\Rightarrow D = 1$

BY KVL $\Rightarrow$ $V_1 = Z_1 I_1 = Z_1(-I_2) \Rightarrow B = Z_1$

$$T_a = \begin{pmatrix} 1 + \dfrac{Z_1}{Z_2} & Z_1 \\ \dfrac{1}{Z_2} & 1 \end{pmatrix} \quad ; \quad \underline{\underline{AD - BC = 1}}$$

Q// Det. Y_{12}



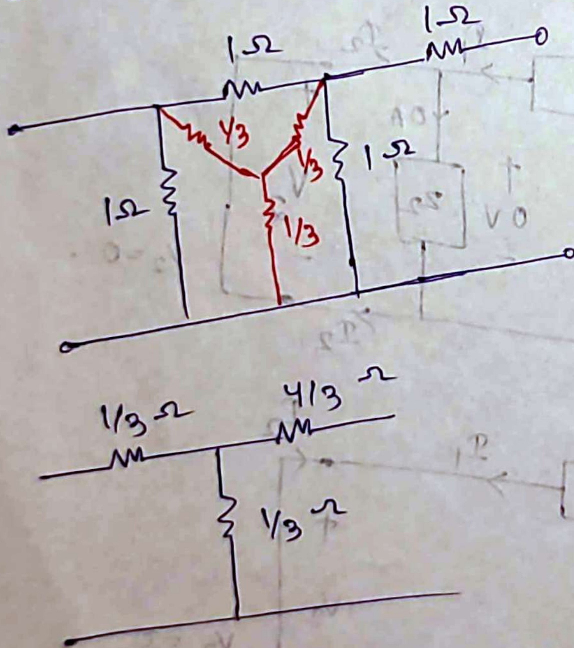
(A) $Y_{12} = Y_{21} = -Y_C$

$= -\frac{1}{Z_C} = -\frac{1}{20} = -0.05\ \mho$

$Y_{11} = Y_A + Y_C = \left(\frac{1}{5} + \frac{1}{20}\right) \mho$

$Y_{22} = Y_B + Y_C = \left(\frac{1}{10} + \frac{1}{20}\right) \mho$

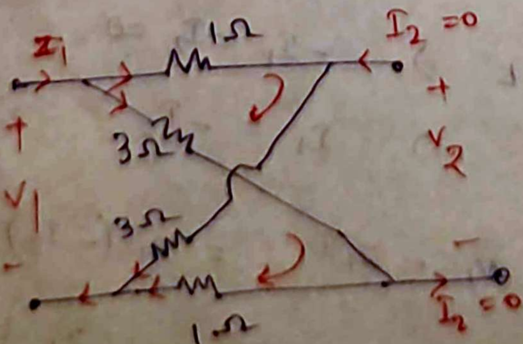
Q// Det. Z



$Z = \begin{pmatrix} \frac{1}{3}+\frac{1}{3} & \frac{1}{3} \\ \frac{1}{3} & \frac{4}{3}+\frac{1}{3} \end{pmatrix}$

$Y = Z^{-1}$

Q// Det Z.



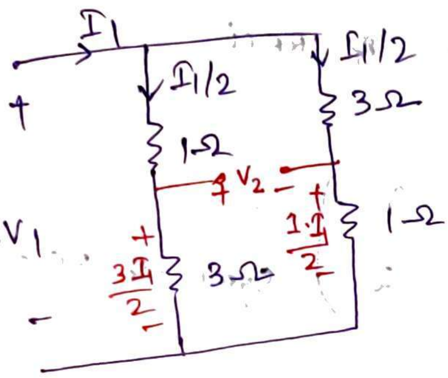
$$z_{11} = \frac{V_1}{I_1}\bigg|_{I_2=0}$$

$$V_1 = (4 \parallel 4) \cdot I_1 \bigg|_{I_2=0}$$

$$z_{11} = 2\ \Omega$$

similarly $V_2 = (4 \parallel 4) \cdot I_2 \Big|_{I_1=0}$ $\Rightarrow$ $z_{22} = 2\ \Omega$.

Passive & Reci.



$I_2 = 0$.

Obs! Here V_2 is the open ckted voltage

By KVL $\Rightarrow$ $\frac{3 \cdot I_1}{2} - V_2 - \frac{1 \cdot I_1}{2} = 0$

$\Rightarrow V_2 = I_1$

$\Rightarrow z_{21} = 1\ \Omega = z_{12}$.

$$z = \begin{pmatrix} 2 & 1 \\ 1 & 2 \end{pmatrix} \Omega$$

Symi & Reci

$$y = z^{-1} = \begin{pmatrix} \frac{2}{3} & -\frac{1}{3} \\ -\frac{1}{3} & \frac{2}{3} \end{pmatrix} \mho$$

Symi & Reci

T :

$$V_1 = 2I_1 + I_2 \quad — (1)$$

$$V_2 = I_1 + 2I_2 \quad — (2)$$

(2) $\Rightarrow \quad I_1 = V_2 - 2I_2 \quad \rightarrow (3)$

(3) in (1) $\Rightarrow \quad V_1 = 2(V_2 - 2I_2) + I_2$

$$= 2V_2 - 3I_2 \quad \rightarrow (4)$$

$$\Rightarrow T = \begin{pmatrix} 2 & 3 \\ 1 & 2 \end{pmatrix}$$ symi & Reci

$$T' = T^{-1} = \begin{pmatrix} 2 & -3 \\ -1 & 2 \end{pmatrix}$$ symi & Reci.

h :

(2) $\Rightarrow \quad 2I_2 = -I_1 + V_2$.

$$\Rightarrow I_2 = -\frac{I_1}{2} + \frac{V_2}{2} \quad \longrightarrow (5)$$

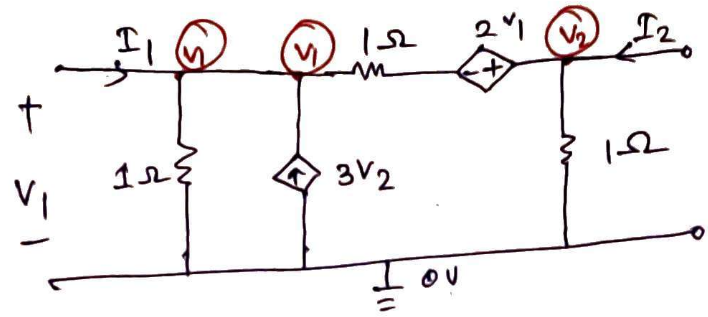
(5) in (1) $\Rightarrow \quad V_1 = 2I_1 - \frac{I_1}{2} + \frac{V_2}{2}$

$$= \frac{3}{2} I_1 + \frac{V_2}{2} \quad \longrightarrow (6)$$

$$\Rightarrow h = \begin{pmatrix} \frac{3}{2} & \frac{1}{2} \\ -\frac{1}{2} & \frac{1}{2} \end{pmatrix}$$ symi & Reci.

$$g = h^{-1} = \begin{pmatrix} \frac{1}{2} & -\frac{1}{2} \\ \frac{1}{2} & \frac{3}{2} \end{pmatrix}$$ symi & Reci

Q1 Det. all the two port n/w parameters



(A)

NODAL ⇒

$$-I_1 + \frac{V_1}{1} - 3V_2 + \frac{V_1 + 2V_1 - V_2}{1} = 0$$

$$\Rightarrow \quad I_1 = 4V_1 - 4V_2 \quad \text{—(1)}$$

Nodal ⇒

$$-I_2 + \frac{V_2}{1} + \frac{V_2 - 2V_1 - V_1}{1} = 0$$

$$\Rightarrow \quad I_2 = -3V_1 + 2V_2 \quad \text{—(2)}$$

$$\Rightarrow \quad Y = \begin{pmatrix} 4 & -4 \\ -3 & 2 \end{pmatrix}$$

Asymi & Non-reci and active that too dependent sources with only Resi

$Z = Y^{-1}, g, h, T, T'$ by re-writing the eqn.

Q1

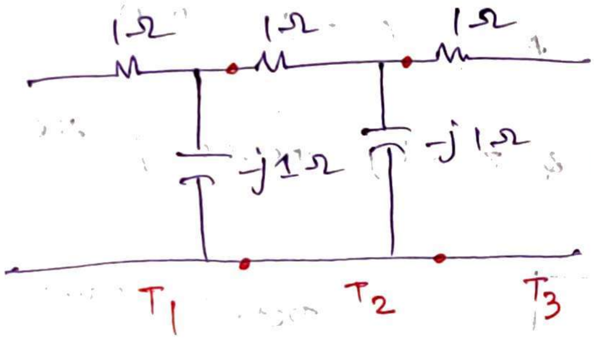
Q// The z-Parameter of two two port n/w's are

$\begin{pmatrix} 1 & 0 \\ 1 & 1 \end{pmatrix}$ & $\begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix}$, If these two n/w's are connected in series, then the z-Parameter of the overall two port Network.

(A) $|Z| = (Z_A) + (Z_B) = \begin{pmatrix} 2 & 2 \\ 4 & 5 \end{pmatrix} \Omega$.

$Y = Z^{-1}$, g, h, T, T' by re-writing the eq^{n}s.

Q// Det. T



cascade

$T_1 = T_2$: $Z_1 = 1\Omega$

$Z_2 = -j1\Omega$

$$T_1 = T_2 = \begin{pmatrix} 1 + \frac{1}{-j1} & 1 \\ \frac{1}{-j1} & 1 \end{pmatrix}$$

$$= \begin{pmatrix} 1+j & 1 \\ j & 1 \end{pmatrix}$$

AD − BC = 1

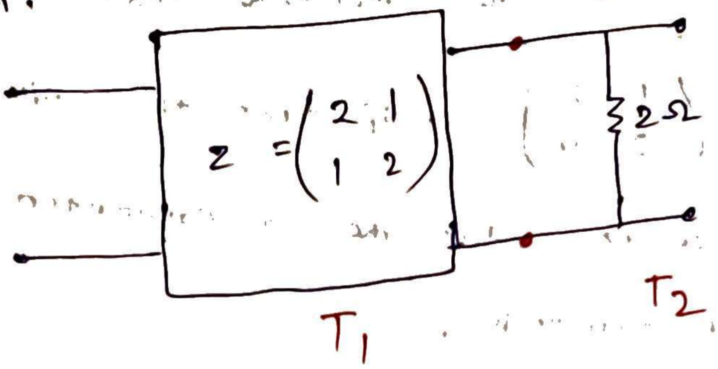
T_3 :- $Z_1 = 1\Omega$

$Z_2 = \infty$ $\Rightarrow T_3 = \begin{pmatrix} 1 & 1 \\ 0 & 1 \end{pmatrix}$

$\boxed{T = (T_1)(T_2)(T_3)}$ AD − BC = 1 must

$T' = T^{-1}$, g, h, Y & Z by re writing the eq^{n}s.

Q1 Det h:



T_1 : $z = \begin{pmatrix} 2 & 1 \\ 1 & 2 \end{pmatrix} \Rightarrow T_1 = \begin{pmatrix} 2 & 3 \\ 1 & 2 \end{pmatrix}$

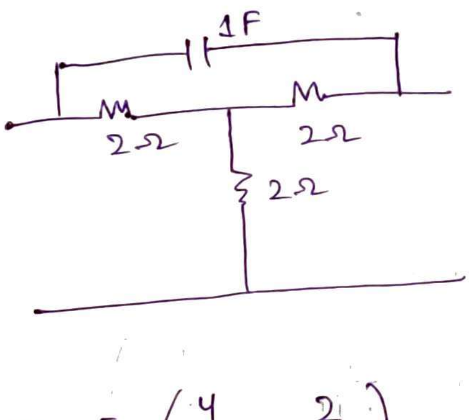
T_2 : $z_1 = 0$ $\Rightarrow T_2 = \begin{pmatrix} 1 & 0 \\ \frac{1}{2} & 1 \end{pmatrix}$

$z_2 = 2\Omega$

$T = (T_1)(T_2)$ $AD - BC = 1$ must.

$T = T^{-1}$, g, h, Y & z by rewriting the eq^{n}s.

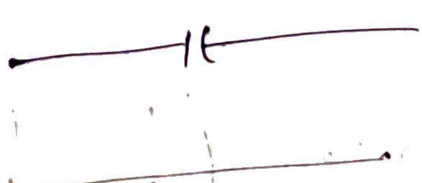
Q4



Det. Y - parameter.

(A) $Z_A = \begin{pmatrix} 4 & 2 \\ 2 & 4 \end{pmatrix}$

$Y_A = \begin{pmatrix} \frac{1}{3} & -1/6 \\ -1/6 & \frac{1}{3} \end{pmatrix} \mho$.



(B)

$z = \frac{1}{s}\,\Omega \Rightarrow Y = s\,\mho$

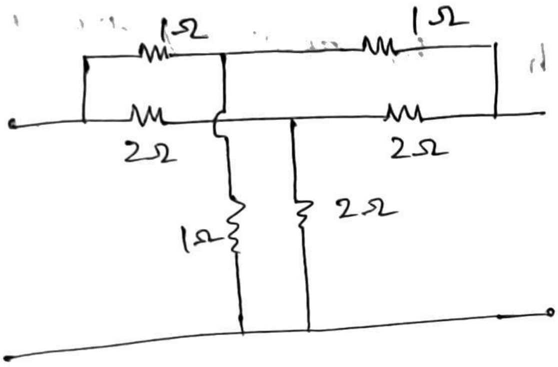
$$Y_B = \cancel{Y/2Y} \begin{pmatrix} Y & -Y \\ -Y & Y \end{pmatrix} = \begin{pmatrix} s & -s \\ -s & s \end{pmatrix} \mho$$

$$|Y| = |Y_A| + |Y_B|$$

symi & Reci.

$Z = Y^{-1}, T, T', g, h$ by rewriting the eqn.

Q/



Det. Y.

$$Z_A = \begin{pmatrix} 4 & 2 \\ 2 & 4 \end{pmatrix} \Omega \qquad Z_B = \begin{pmatrix} 2 & 1 \\ 1 & 2 \end{pmatrix} \Omega$$

$$Y_A = \begin{pmatrix} \frac{1}{3} & -1/6 \\ -1/6 & 1/3 \end{pmatrix} \mho \quad \Rightarrow Y_B = \begin{pmatrix} \frac{2}{3} & \frac{-1}{3} \\ \frac{-1}{3} & \frac{2}{3} \end{pmatrix} \mho$$

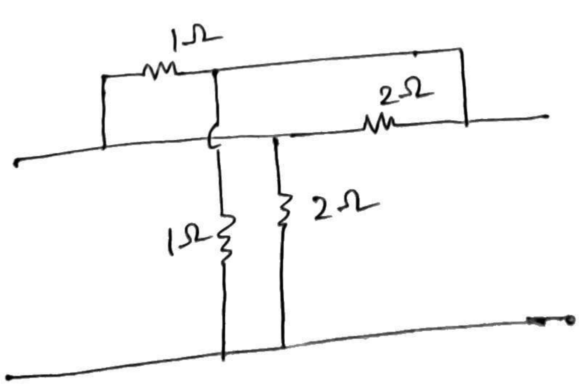
$$Y = (Y) + (Y_B) = \begin{pmatrix} 1 & -\frac{1}{2} \\ -\frac{1}{2} & 1 \end{pmatrix} \mho$$

Symi & Reci

$Z = Y^{-1}, T, T', g, h$ by rewriting the eqn.

Q

Det. Y.



$$Z_A = \begin{pmatrix} 2 & 2 \\ 2 & 4 \end{pmatrix} \Omega$$

$$Y_A = \begin{pmatrix} 1 & -1/2 \\ -\frac{1}{2} & \frac{1}{2} \end{pmatrix} \mho$$

$$Z_B = \begin{pmatrix} 2 & 1 \\ 1 & 1 \end{pmatrix} \Omega.$$

$$\Rightarrow Y_B = \begin{pmatrix} 1 & -1 \\ -1 & 2 \end{pmatrix} \mho$$

$$(Y) = (Y_A) + (Y_B)$$

Asymmi & Reci

$Z = Y^{-1}, T, T', g, h.$ by rewriting the eqⁿs.