DATE

* Power factor is the cosine of $\angle$le of impedance
* Power factor is also the cosine of the angle between V & I

Ex: If $V = V_m \sin\omega t$
$i = I_m \sin(\omega t + \theta)$ leads v //

If i leads v, power factor is leading

Pf

18th Oct' 19

$Z = |Z|\angle\theta$

$I = \frac{V\angle 0}{Z\angle\theta}$

i) If 'θ' is −ve
$I = \frac{V\angle 0}{|Z|\angle -\theta} = \frac{V\angle\theta}{Z} \Rightarrow$ I leads V $\rightarrow$ reactance is Capacitive

ii) If θ is +ve, I lags V $\rightarrow$ reactance is Inductive

• Let $V = V_m \sin\omega t$. If pf is leading $I = I_m \sin(\omega t + \theta)$
and if the pf is lagging $I = I_m \sin(\omega t - \theta)$

~~Avg~~ Complex Power

$V = V_m \angle\theta_v = V_m \sin(\omega t + \theta_v)$
$I = I_m \angle\theta_v = I_m \sin(\omega t + \theta_i)$

$$Z = \frac{V}{I} = \frac{V_m\angle\theta_v}{I_m\angle\theta_i} = \frac{V_m}{I_m}\underbrace{\angle\theta_v - \theta_i}_{\theta}$$

$$= \frac{V_m/\sqrt{2}}{I_m/\sqrt{2}}\angle\theta_v - \theta_i$$

$$= \frac{V_{rms}}{I_{rms}}\angle\theta_v - \theta_i = |Z|\angle\theta$$

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$$P_{av} = \frac{V_m I_m}{2} \cos(t)$$

$$S = \frac{1}{2} V_m \angle \theta_v \times I_m \angle -\theta_i$$

$$= V_{rms} I_{rms} \angle \theta_v - \theta_i \quad = V_{rms} I^{*}_{rms}$$

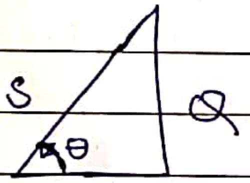
$$S = \underbrace{V_{rms} I_{rms} \cos \angle \theta_v - \theta_i}_{\text{real power } (P_{av}) \text{ true power}} + \underbrace{j V_{rms} I_{rms} \sin \angle \theta_v - \theta_i}_{\text{reactive power (VAR volt ampere reactive.)}}$$

Idle power : It absorbs & gives

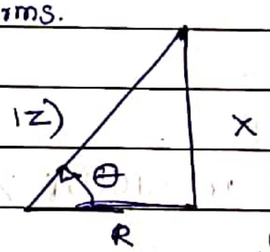
$$S = P_{av} + jQ$$

* If the reactance power is -ve, power factor angle is negative, powerfactor is leading & the reactance is capacitive in nature
* If the reactance power is positive, power factor angle is +ve, pf is lagging & the reactance is inductive in nature.

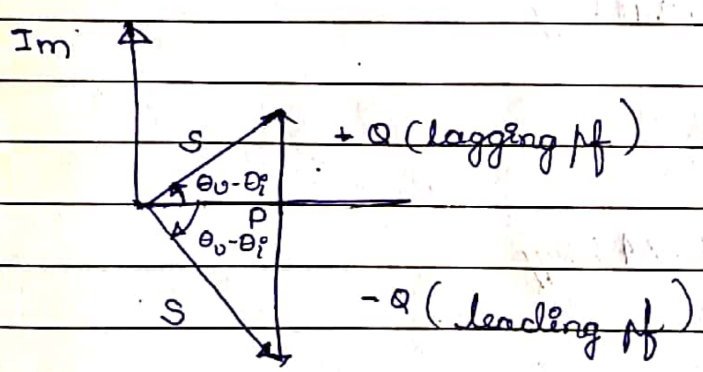
APPARENT POWER : $|S| = V_{rms} I_{rms}$.



power triangle



Impedance triangle



1) A series connected load draws a current $i(t) = 4\cos(100\pi t + 10°)$ A when the applied voltage is $v(t) = 120\cos(100\pi t - 20°)$ V. Find the apparent power & the power factor of the load. Determine the element values that form the series connected load

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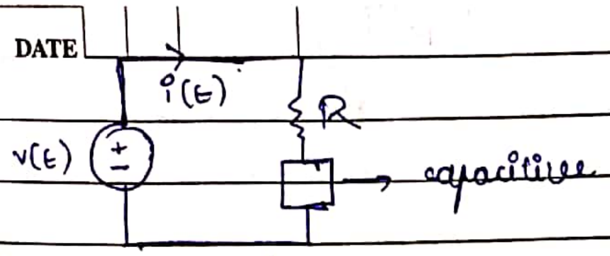


(a) $V = 120 \angle -20^\circ$

$I = 4 \angle 10^\circ$ → leads v = Capacitive

$Z = \frac{V}{I} = \frac{120 \angle -20^\circ}{4 \angle 10^\circ} = 30 \angle -30^\circ = 25.98 - j15$

$\theta = -30^\circ$

Power factor $= \cos(-30^\circ) = \frac{\sqrt{3}}{2}$ (leading)

(b) $S = V_{rms} I_{rms} \angle \theta_v - \theta_i$

$= \frac{120}{\sqrt{2}} \cdot \frac{4}{\sqrt{2}} \angle -30^\circ$

$= 240 \angle -30^\circ$ VAR //

$= 207.846 - j\,120$ //

$R = 25.98$

$X_C = 15$

$\frac{1}{\omega C} = 15$ $\qquad \omega = 100\pi$ //

$C = 2.122 \times 10^{-4} = 212.2\,\mu F$ //

Power dissipated in R

$I_{rms}^2 R$

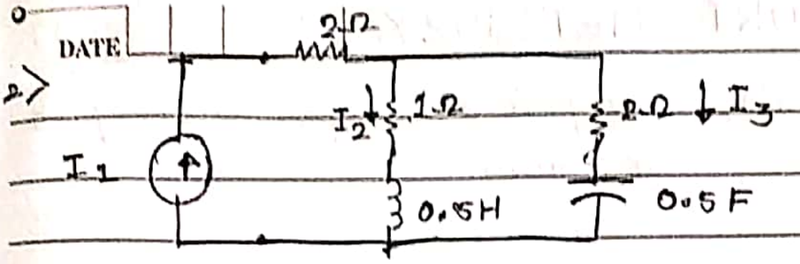
$= \left(\frac{4}{\sqrt{2}}\right)^2 (25.98) = 207.84\,W$ //

• $(I_{rms})^2 \times 15 \angle -90$

$= 120 \angle -90$

$= 0 - j\,120$

2)



$I_1 = 5\sqrt{2}\sin 2t$

$\omega = 2$

Impedance of Inductor $= j\omega L = j(2)(0.5) = j\Omega$

Capacitive $= \frac{1}{j\omega C} = \frac{1}{j(2)(0.5)} = -j\Omega$

$$Z = \left[1+j \,\|\, 2-j \right] + 2$$

$$\frac{(1+j)(2-j)}{3}$$

$$= \frac{2-j+2j-j^2}{3} = \frac{3+j}{3} = \frac{1+j}{3} = 1+0.33j$$

$$= 3.018 \angle 6.34$$

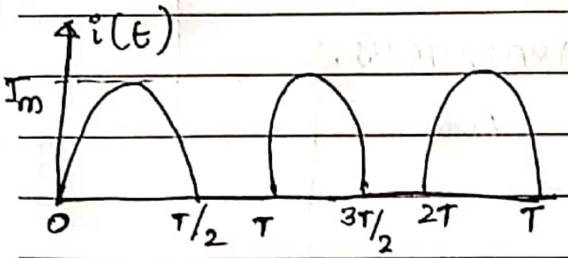
$$P_{av} = I_{rms}^2 |Z| \cos(6.34°)$$

$$= \left(\frac{5\sqrt{2}}{\sqrt{2}}\right)^2 \times 3.018 \times \cos(6.34°)$$

$$= 74.99$$

$$\approx 75W$$

$$Q = 5^2 \times 3.018 \times \sin(6.34) = 8.35 \text{ VAR}$$



Find I_{rms}?

$$I_{rms} = \left[\frac{1}{T} \int_0^{T/2} I_m^2 \sin^2\omega t \, dt \right]^{1/2}$$

$2 \times \frac{2\pi}{T} \times \frac{T}{2}$

$$= \frac{I_m^2}{T}\left[\frac{1-\cos 2\omega t}{2} dt \right]^{1/2} = \frac{I_m^2}{2T}\left[(t)_0^{T/2} - \frac{\sin 2\omega t}{2} \right]$$

$$= \frac{I_m^2}{2\cancel{T}} \times \frac{\cancel{T}}{2} = \left(\frac{I_m^2}{4}\right)^{1/2} = \frac{I_m}{2}$$

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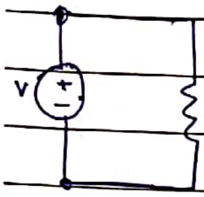
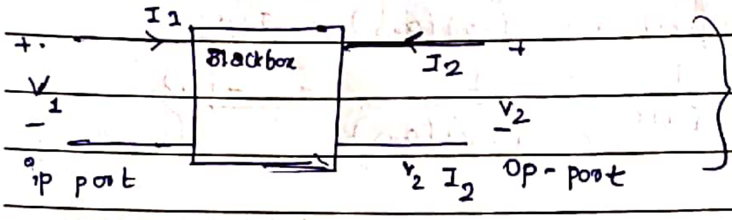
DATE | TWO - PORT NETWORKS: 21st Oct'19

1 port → two terminals, one port it enters another port it leaves.



driving point of the net

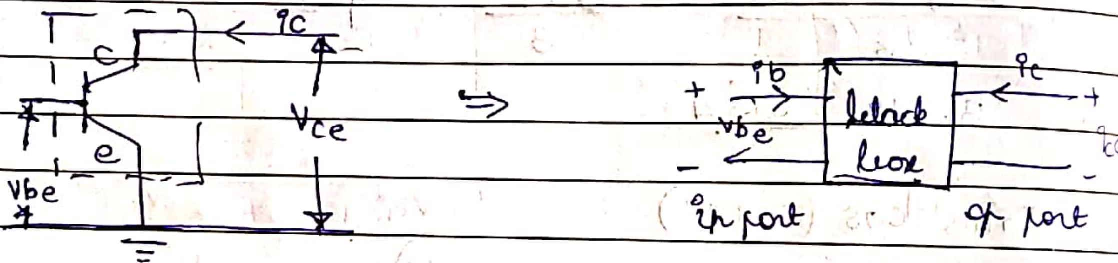


$V_1 I_1$

4 variables
↳ group of 2

★ Convention (Two port network) current goes in

Ex:-



4 Variables V_1, I_1, V_2, I_2

★ If we make two of each group, two sets will be formed where one set is dependent variable & other set is independent variables.

★ Out of all combinations, 6 combinations we will consider.

① Z-PARAMETER:- OPEN CIRCUIT IMP PARAMETERS.

We make dependent variables as V_1, V_2 then independent " are I_1, I_2

$\therefore (V_1, V_2) = f(I_1, I_2)$

$$V_1 = Z_{11} I_1 + Z_{12} I_2 \rightarrow ①$$
$$V_2 = Z_{21} I_1 + Z_{22} I_2 \rightarrow ②$$

$$= \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} \rightarrow ①$$

$$Z_{11} = \left. \frac{V_1}{I_1} \right|_{I_2 = 0}$$

Driving point input impedance with op open ckt

DATE

$$Z_{21} = \frac{V_2}{I_1}\Big|_{I_2=0} (\Omega) \longrightarrow \text{Forward transfer impedance with o/p OC}$$

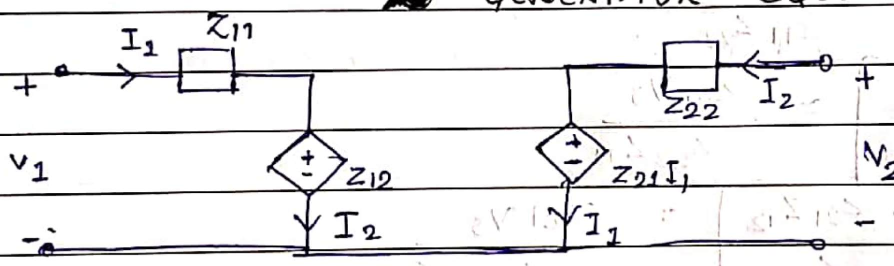
* If denominator is input port variable → Forward
* If it is output port set by the i/p → Transfer
(one input & one output) variable of Impedance.

$$Z_{12} = \frac{V_1}{I_2}\Big|_{I_1=0} (\Omega) \longrightarrow \text{Reverse transfer impedance with i/p OC}$$

$$Z_{22} = \frac{V_2}{I_2}\Big|_{I_1=0} (\Omega) \longrightarrow \text{Driving point output impedance with i/p OC.}$$

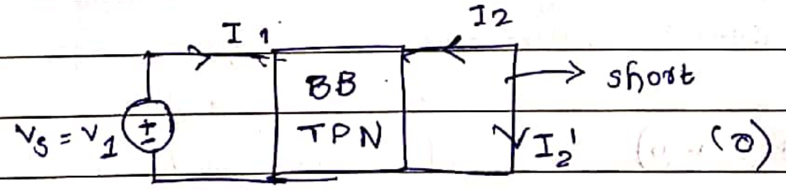
* represent with dependent source which contain both input port and output port also there, orelse represent it as box.

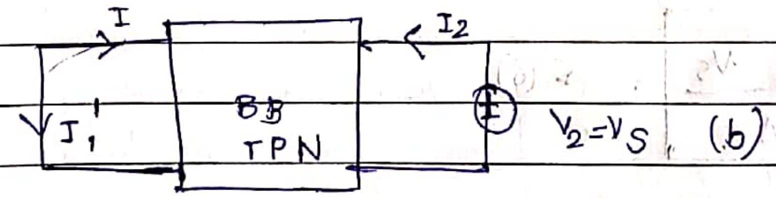
2 - GENERATOR EQUIVALENT CKT



RECIPROCAL & SYMMETRICAL NETWORKS:

1.1> RECIPROCAL NETWORKS:





$$I_1' = I_2'$$

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Consider (a) network

$V_1 = V_S \qquad V_2 = 0$

$I_1 = I_1 \qquad I_2 = -I_2'$

$V_1 = Z_{11} I_1 + Z_{12} I_2 \rightarrow ① \qquad V_S = Z_{11} I_1 + Z_{12}(-I_2)' \rightarrow ④$

$V_2 = Z_{21} I_1 + Z_{22} I_2 \rightarrow ② \qquad 0 = Z_{22} I_1 - Z_{22}(I_2)'$

$Z_{22} I_2' = Z_{22} I_1$

$\boxed{I_2' = \frac{Z_{21} I_1}{Z_{22}}} \rightarrow ③$

from ④

$I_1 = \frac{V_S + Z_{12} I_2'}{Z_{11}} \rightarrow ⑤$

Sub, 5 in 3

$I_2' = \frac{Z_{21}\left[\frac{V_S + Z_{12} I_2'}{Z_{11}}\right]}{Z_{22}} = \frac{Z_{21}}{Z_{22}}\left[\frac{V_S + Z_{12} I_2'}{Z_{11}}\right]$

$\Rightarrow \frac{Z_{21} V_S}{Z_{22} Z_{11}} + \frac{Z_{21} Z_{12} I_2'}{Z_{11} Z_{22}}$

$I_2'\left[1 - \frac{Z_{21} Z_{12}}{Z_{11} Z_{22}}\right] = \frac{Z_{21} V_S}{Z_{22} Z_{11}}$

$I_2'\left[\frac{Z_{11} Z_{22} - Z_{21} Z_{12}}{Z_{11} \cancel{Z_{22}}}\right] = \frac{Z_{21} V_S}{Z_{22} \cancel{Z_{11}}}$

wkt $\begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} = \Delta Z = Z_{11} Z_{22} - Z_{12} Z_{21}$

$I_2'(\Delta Z) = Z_{21} V_S \rightarrow ⑥$

$\boxed{I_2' = \frac{Z_{21} V_S}{\Delta Z}} \rightarrow ⑥$

Consider (b) network

$V_2 = V_S \ ; \ V_1 = 0 \qquad 0 = -Z_{11} I_1' + Z_{12} I_2$

$I_1 = -I_1' \ ; \ I_2 = I_2 \qquad V_S = -Z_{21} I_1' + Z_{22} I_2 \rightarrow 8$

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$$z_{12} I_2 = z_{11} I_1'$$

$$I_1' = \frac{z_{12} I_2}{z_{11}} \rightarrow (7)$$

from (8)

$$I_2 = \frac{V_S + z_{21} I_1'}{z_{22}}$$

$$I_1' = \frac{z_{12}}{z_{11}} \left[\frac{V_S + z_{21} I_1'}{z_{22}} \right] = \frac{z_{12} V_S}{z_{11} z_{22}} + \frac{z_{12} z_{21} I_1'}{z_{11} z_{22}}$$

$$\Rightarrow I_1' \left[1 - \frac{z_{12} z_{21}}{z_{11} z_{22}} \right] = \frac{z_{12} V_S}{z_{11} z_{22}}$$

$$\Rightarrow I_1' \left[\frac{z_{11} z_{22} - z_{12} z_{21}}{\cancel{z_{11}} \cancel{z_{22}}} \right] = \frac{z_{12} V_S}{\cancel{z_{11}} \cancel{z_{22}}}$$

$$\Rightarrow I_1' [\Delta z] = V_S z_{12}$$

$$\Rightarrow \boxed{I_1' = \frac{V_S z_{12}}{\Delta z}} \rightarrow (9)$$

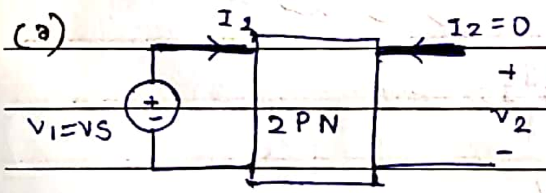
$$\boxed{z_{12} = z_{21}}$$

$$\Rightarrow I_1' = \frac{V_S z_{21}}{\Delta z}$$

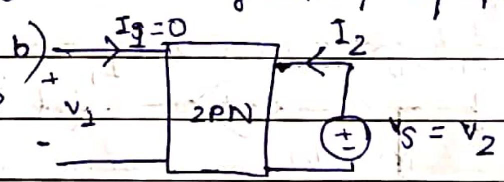
$$\Rightarrow I_1' = I_2'$$

1.2) SYMMETRICAL NWS : We can interchange i/p & o/p ports

(a)



$\Rightarrow$ b)



If $\frac{V_S}{I_1} = \frac{V_S}{I_2}$

a) $V_1 = V_S$ $V_2 = V_2$

$I_1 = I_1$ $I_2 = 0$

$V_1 = z_{11} I_1 + z_{12} I_2 \Rightarrow V_S = z_{11} I_1 \Rightarrow \boxed{\frac{V_S}{I_1} = z_{11}} \rightarrow (1)$

$V_2 = z_{21} I_1 + z_{22} I_2 \Rightarrow V_2 = z_{21} I_1$

DATE

b) $V_2 = V_S$; $V_1 = V_1$

$I_2 = I_2$; $I_1 = 0$

$\Rightarrow V_1 = Z_{12} I_2$

$V_S = Z_{22} I_2$

$$\boxed{\frac{V_S}{I_2} = Z_{22}} \rightarrow (2)$$

Comparing eqns (1) & (2) $\Rightarrow \boxed{Z_{11} = Z_{22}}$

Single Generator Equivalent Circuit:

$V_1 = Z_{11} I_1 + Z_{12} I_2 \rightarrow (1)$

$V_2 = Z_{21} I_1 + Z_{22} I_2 \rightarrow (2)$

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

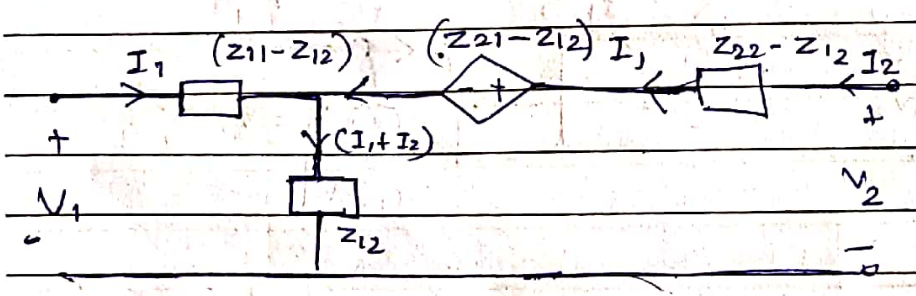
$V_1 = Z_{12}(I_1 + I_2) + I_1(Z_{11} - Z_{12}) = 0 \rightarrow (3)$

$V_1 - Z_{12}(I_1 + I_2) - I_1(Z_{11} - Z_{12}) = 0$

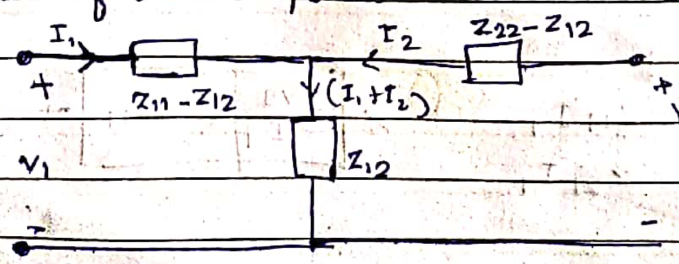
$V_2 = Z_{21} I_1 + \underline{Z_{22} I_2} + \underline{Z_{12} I_1} - Z_{12} I_1 + \underline{Z_{12} I_2} - \underline{Z_{12} I_2}$

$= Z_{12}(I_1 + I_2) + (Z_{22} - Z_{12}) I_2 + (Z_{21} - Z_{12}) I_1 \rightarrow (4)$

$V_2 - Z_{12}(I_1 + I_2) - (Z_{22} - Z_{12}) I_2 - I_1(Z_{21} - Z_{12}) = 0$



Now if its reciprocal $Z_{12} = Z_{21}$



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2) [Y] PARAMETERS: SHORT CIRCUIT ADMITTANCE PARAMETERS.

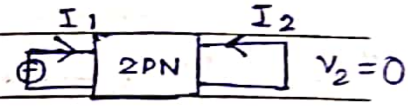
Dependent Variables → (I_1, I_2)

Independent Variables → (V_1, V_2)

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

$$\boxed{\begin{aligned} I_1 &= Y_{11} V_1 + Y_{12} V_2 \rightarrow (1) \\ I_2 &= Y_{21} V_1 + Y_{22} V_2 \rightarrow (2) \end{aligned}}$$

(a) When $V_2 = 0$



i) $Y_{11} = \frac{I_1}{V_1}$; ii) $Y_{21} = \frac{I_2}{V_1}$ (℧)(S)

i) → Driving point i/p admittance with o/p SC

ii) Forward transfer admittance with o/p SC

(b) When $V_1 = 0$

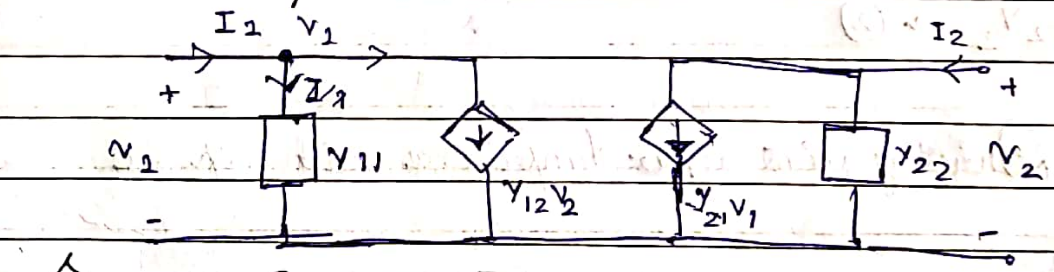
$Y_{12} = \frac{I_1}{V_2}$ = Reverse transfer admittance with i/p SC

$Y_{22} = \frac{I_2}{V_2}$ = Driving point o/p admittance with i/p SC

RECIPROCAL : $Y_{12} = Y_{21}$

SYMMETRICAL : $Y_{11} = Y_{22}$.

2 - GENERATOR EQ CKT



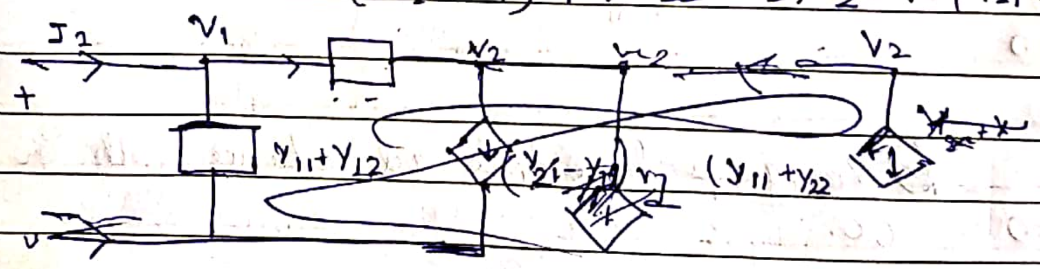
SINGLE GENERATOR

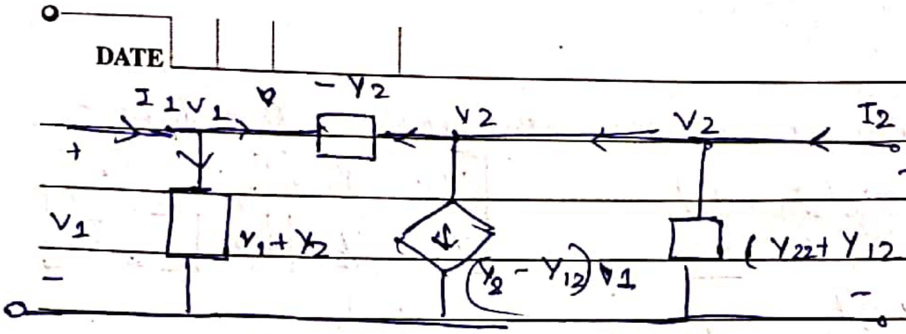
$I_1 = Y_{11}V_1 + Y_{12}V_2 + Y_{12}V_1 - Y_{12}V_1$

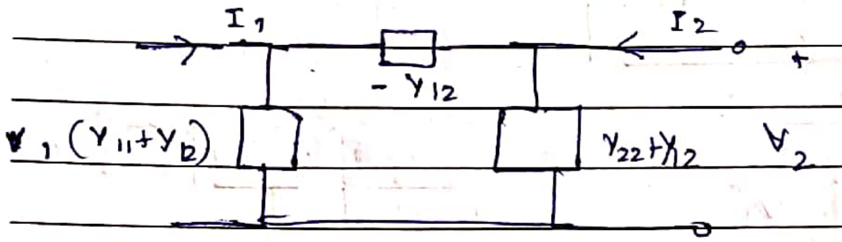
$= -Y_{12}(V_1 - V_2) + (Y_{11} + Y_{12})V_1 \rightarrow (3)$

$I_2 = Y_{21}V_1 + Y_{22}V_2 + Y_{12}V_1 - Y_{12}V_1 + Y_{12}V_2 - Y_{12}V_2$

$= -Y_{12}(V_2 - V_1) + (Y_{22} + Y_{12})V_2 + (Y_{21} - Y_{12})V_1 \rightarrow (4)$







If reciprocal
$Y_{12} = Y_{21}$

22nd Oct'19

3) HYBRID [h] PARAMETERS:

Dependent variables : (V_1, I_2)
Independent " (I_1, V_2)

$$(V_1, I_2) = f(I_1, V_2)$$

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

$$V_1 = h_{11} I_1 + h_{12} V_2 \rightarrow (1)$$
$$I_2 = h_{21} I_1 + h_{22} V_2 \rightarrow (2)$$

$h_{11} = \left.\dfrac{V_1}{I_1}\right|_{V_2=0}$ Driving point input Impedance with o/p SC

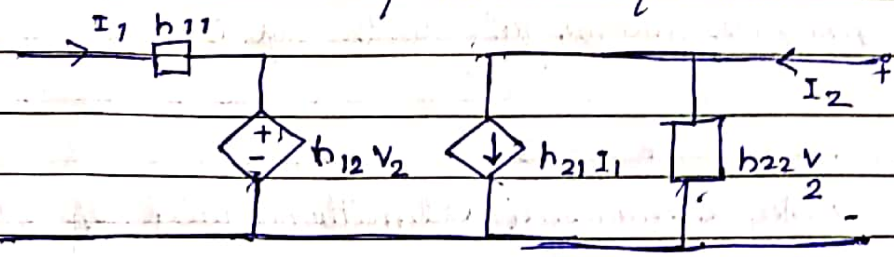
$h_{21} = \left.\dfrac{I_2}{I_1}\right|_{V_2=0}$ Forward current gain with o/p SC $(V_2 = 0)$

$h_{12} = \left.\dfrac{V_1}{V_2}\right|_{I_1=0}$ Reverse voltage gain i/p OC

$h_{22} = \left.\dfrac{I_2}{V_2}\right|_{I_1=0}$ Driving point output admittance with i/p OC.

DATE

2 - Generator equivalent ckt



4> (g) PARAMETER [INVERSE h]:

$(I_1, V_2) = f(V_1, I_2)$

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

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

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

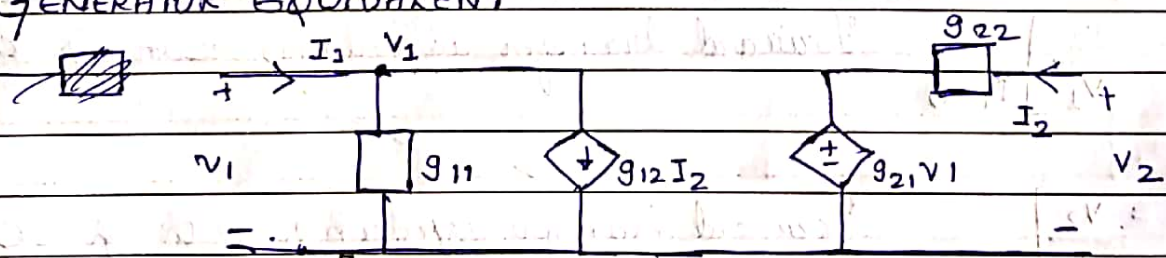
$g_{11} = \left.\frac{I_1}{V_1}\right]_{I_2=0}$ — Driving point input admittance with op OC

$g_{12} = \left.\frac{I_1}{I_2}\right]_{V_1=0}$ Forwardvoltage gain with op OC

$g_{21} = \left.\frac{V_2}{V_1}\right]_{V_1=0}$ Reverse current gain with ip SC.

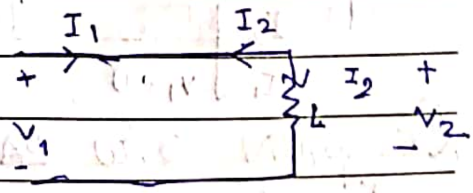
$g_{22} = \left.\frac{V_2}{I_2}\right]_{V_1=0}$ Driving point output impedance with ip SC

2 - GENERATOR EQUIVALENT



5> TRANSMISSION [T or ABCD] PARAMETERS

$(V_1, I_1) = f(V_2, I_2)$



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

$\rightarrow$ current is going in

$V_1 = AV_2 - BI_2 \rightarrow (1)$

$I_1 = CV_2 - DI_2 \rightarrow (2)$

DATE

$A = \left.\frac{V_1}{V_2}\right|_{I_2=0}$ reverse voltage gain with o/p OC

$C = \left.\frac{I_1}{V_2}\right|_{I_2=0}$ reverse transfer admittance with o/p OC

$B = \left.\frac{-V_1}{I_2}\right|_{V_2=0}$ reverse transfer impedance with o/p SC

$D = \left.\frac{-I_1}{I_2}\right|_{V_2=0}$ reverse current gain with o/p SC

6) INVERSE T PARAMETERS
[T' or A'B'C'D' or abcd parameters]

$V_2 I_2 = f(V_1, I_1)$

$$\begin{bmatrix} V_2 \\ I_2 \end{bmatrix} = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} V_1 \\ -I_1 \end{bmatrix}$$

$V_2 = aV_1 - bI_1$
$I_2 = cV_1 - dI_1$

$a = \left.\frac{V_2}{V_1}\right|_{I_1=0}$ Forward voltage gain with i/p OC

$c = \left.\frac{I_2}{V_1}\right|_{I_1=0}$ Forward transfer admittance with i/p OC

$-b = \left.\frac{V_2}{I_1}\right|_{V_1=0}$ Forward transfer impedance with i/p SC

$-d = \left.\frac{I_2}{I_1}\right|_{V_1=0}$ Forward current gain with i/p SC

RELATION B/W PARAMETER SETS.

T' interms of H

$V_1 = h_{11}I_1 + h_{12}V_2 \longrightarrow (1)$ $\quad V_2 = aV_1 - bI_1$

$I_2 = h_{21}I_1 + h_{22}V_2 \longrightarrow (2)$ $\quad I_2 = cV_1 - dI_1$

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$$h_{12} V_2 = V_1 - h_{11} I_1$$

$$V_2 = \frac{V_1}{h_{12}} - \frac{h_{11}}{h_{12}} I_1$$

$$\boxed{a = \frac{1}{h_{12}} \quad \& \quad b = \frac{h_{11}}{h_{12}}}$$

put V_2 in eqn 2

$$I_2 = h_{21} I_1 + h_{22}\left[\frac{V_1}{h_{12}} - \frac{h_{11}}{h_{12}} I_1\right]$$

$$\Rightarrow I_2 = h_{21} I_1 + \frac{h_{22} V_1}{h_{12}} - \frac{h_{22} h_{11}}{h_{12}} I_1$$

$$I_2 = \left[\frac{h_{21} - h_{22} h_{11}}{h_{12}}\right] I_1 + \left[\frac{h_{22}}{h_{12}}\right] V_1$$

$$d = -\left(\frac{h_{21} - h_{22} h_{11}}{h_{12}}\right) \quad \& \; c \; = \frac{h_{22}}{h_{12}}$$

$$\boxed{d = -\left(\frac{-\Delta h}{h_{12}}\right) \quad \& \quad c = \frac{h_{22}}{h_{12}}}$$

Z INTERMS OF Y

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

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

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

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix}^{-1} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \frac{1}{\Delta Y} \begin{bmatrix} Y_{22} & -Y_{12} \\ -Y_{21} & Y_{11} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

$$Z_{11} = \frac{Y_{22}}{\Delta Y} \; ; \; Z_{12} = \frac{-Y_{12}}{\Delta Y} \; ; \; Z_{21} = \frac{-Y_{21}}{\Delta Y} \; ; \; Z_{22} = \frac{Y_{11}}{\Delta Y}.$$

23rd Oct'19

(1) Express [Y] parameters in terms of [h] :-

h) $V_1 = h_{11} I_1 + h_{12} V_2 \rightarrow (1)$

$I_2 = h_{21} I_1 + h_{22} V_2 \rightarrow (2)$

$$I_1 = \frac{V_1 - h_{12} V_2}{h_{11}}$$

$$I_1 = \frac{V_1}{h_{11}} - \frac{h_{12}}{h_{11}} V_2$$

y) $I_1 = Y_{11} V_1 + Y_{12} V_2 \rightarrow (3)$

$I_2 = Y_{21} V_1 + Y_{22} V_2 \rightarrow (4)$

$$\therefore Y_{11} = \frac{1}{h_{11}} \quad \& \quad Y_{12} = \frac{-h_{12}}{h_{11}}$$

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$$I_2 = h_{21}\left(\frac{V_1 - h_{12}V_2}{h_{11}}\right) + h_{22}V_2$$

$$I_2 = \frac{h_{21}V_1}{h_{11}} - \frac{h_{21}h_{12}}{h_{11}}V_2 + h_{22}V_2$$

$$= \frac{h_{21}}{h_{11}}V_1 + V_2\left[h_{22} - \frac{h_{21}h_{12}}{h_{11}}\right]$$

$$\frac{h_{21}}{h_{11}}V_1 + V_2\left[\frac{h_{22}h_{11} - h_{21}h_{12}}{h_{11}}\right]$$

$$Y_{21} = \frac{h_{21}}{h_{11}} \qquad Y_{22} = \frac{\Delta h}{h_{11}}$$

Q: Express $[T]$ in terms of $[T']$:

T': dep

$$\begin{bmatrix} V_2 \\ I_2 \end{bmatrix} = \begin{bmatrix} a & b \\ c & d \end{bmatrix}\begin{bmatrix} V_1 \\ -I_1 \end{bmatrix}$$

T:

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

Rewriting

$$\begin{bmatrix} V_2 \\ -I_2 \end{bmatrix} = \begin{bmatrix} a & -b \\ -c & d \end{bmatrix}\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} \rightarrow \text{Modified } T'$$

$$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} a & -b \\ -c & d \end{bmatrix}\begin{bmatrix} V_2 \\ -I_2 \end{bmatrix}$$

$$\therefore \begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \frac{1}{\Delta T'}\begin{bmatrix} d & b \\ c & a \end{bmatrix}\begin{bmatrix} V_2 \\ -I_2 \end{bmatrix}$$

$$A = \frac{d}{\Delta T'} \quad \& \quad B = \frac{b}{\Delta T'}$$

$$C = \frac{c}{\Delta T'} \quad \& \quad D = \frac{a}{\Delta T'}$$

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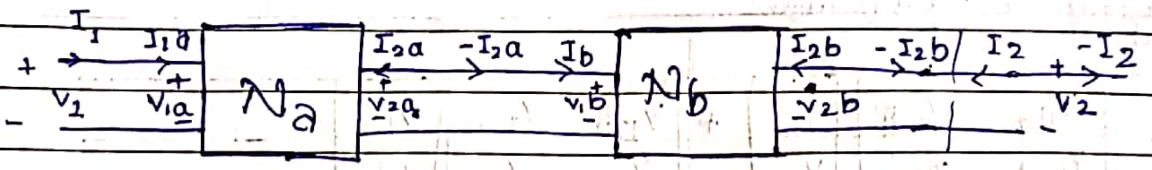
Interconnection of 2 port Networks:

1> Cascade / Tandem Connection:



T parameter is helpfull for Microwave transitions

$$\begin{bmatrix} V_{1a} \\ I_{1a} \end{bmatrix} = \begin{bmatrix} A_a & B_a \\ C_a & D_a \end{bmatrix} \begin{bmatrix} V_{2a} \\ -I_{2a} \end{bmatrix}$$

$-I_{2a} = I_{2a}$

$-I_{2b} = -I_2$

$V_2 = V_{2b}$

$V_{2a} = V_{2b}$

$+I_{1a} = I_1$

$V_{1a} = V_1$

$V_{2a} = V_{1b}$

$$\begin{bmatrix} V_{1a} \\ I_{1a} \end{bmatrix} = \begin{bmatrix} A_a & B_a \\ C_a & D_a \end{bmatrix} \begin{bmatrix} V_{1b} \\ I_{1b} \end{bmatrix}$$

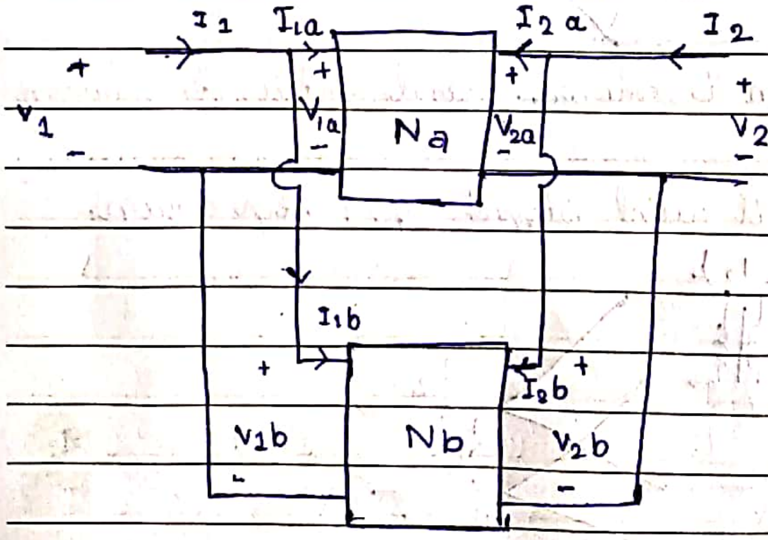
$$\begin{bmatrix} V_{1a} \\ I_{1a} \end{bmatrix} = \begin{bmatrix} A_a & B_a \\ C_a & D_a \end{bmatrix} \begin{bmatrix} A_b & B_b \\ C_b & D_b \end{bmatrix} \begin{bmatrix} V_{2b} \\ -I_{2b} \end{bmatrix}$$

$$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} A_a & B_a \\ C_a & D_a \end{bmatrix} \begin{bmatrix} A_b & B_b \\ C_b & D_b \end{bmatrix} \begin{bmatrix} V_2 \\ -I_2 \end{bmatrix}$$

★ Helpfull in finding parameters of a big network by splitting them and lastly multiplication of matrix to be done here

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

2> Parallel Connection:



$V_1 = V_{1a} = V_{1b}$

$V_2 = V_{2a} = V_{2b}$

$I_1 = I_{1a} + I_{1b} \rightarrow$ (1)

$I_2 = I_{2a} + I_{2b} \rightarrow$ (2)

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$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} I_{1a} \\ I_{2a} \end{bmatrix} + \begin{bmatrix} I_{1b} \\ I_{2b} \end{bmatrix}$$

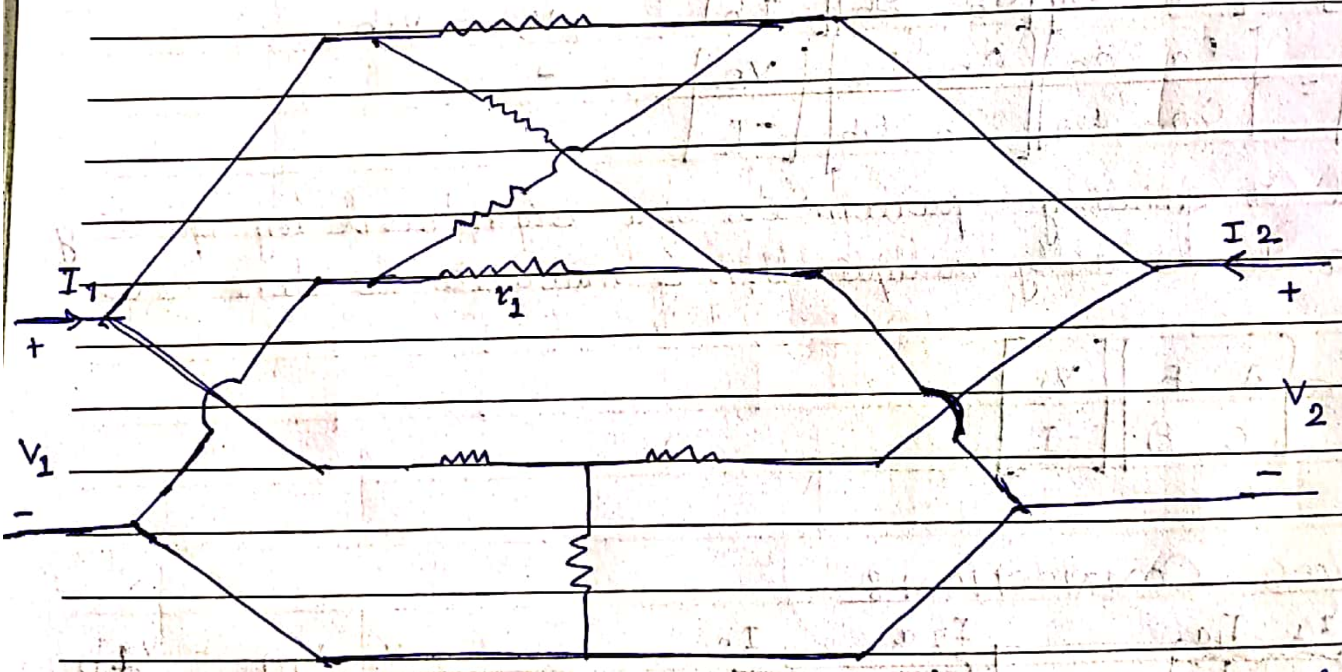
applying Y-parameter

$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} Y_{11a} & Y_{12a} \\ Y_{21a} & Y_{22a} \end{bmatrix} \begin{bmatrix} V_{1a} \\ V_{2a} \end{bmatrix} + \begin{bmatrix} Y_{11b} & Y_{12b} \\ Y_{21b} & Y_{22b} \end{bmatrix} \begin{bmatrix} V_{1b} \\ V_{2b} \end{bmatrix}$$

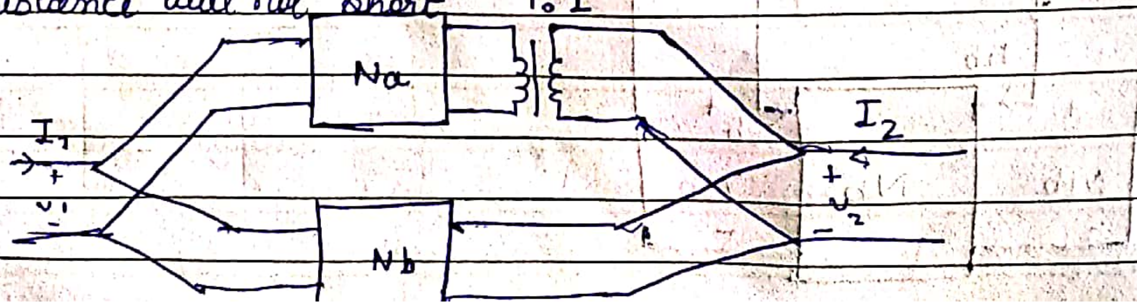
$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} Y_{11a}+Y_{11b} & Y_{12a}+Y_{12b} \\ Y_{21a}+Y_{21b} & Y_{22a}+Y_{22b} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}.$$

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

★ Everywhere we do addition of the parameters except in Cascade (Multiplication)



- r_1 connected to wire bottom is shorted and network remain altered
- Use 1:1 transformers, it wont stepped up / step down i.e, resistance will not short



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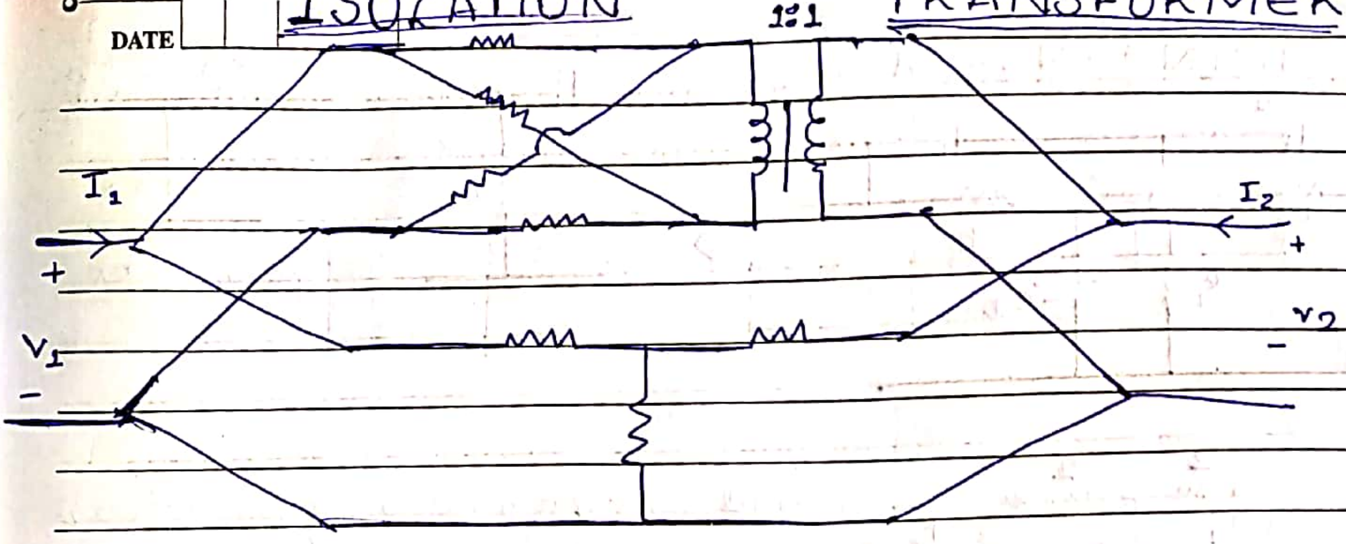
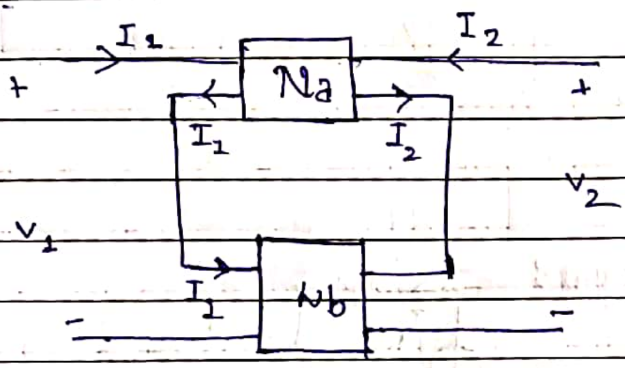
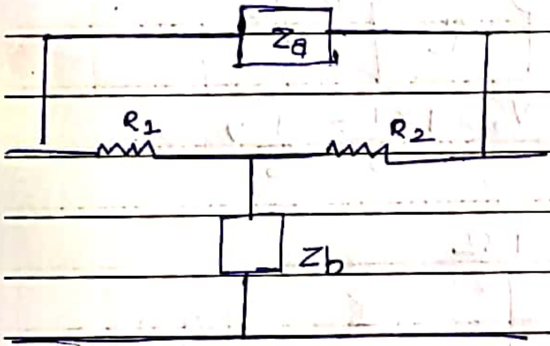
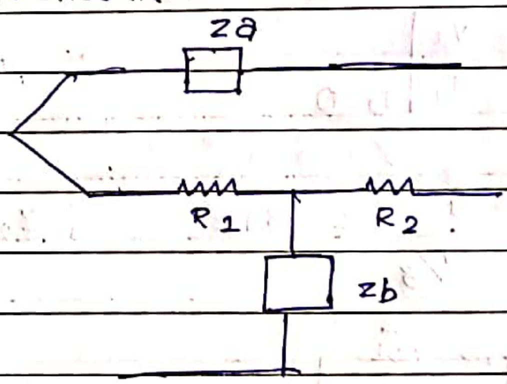
ISOLATION TRANSFORMER

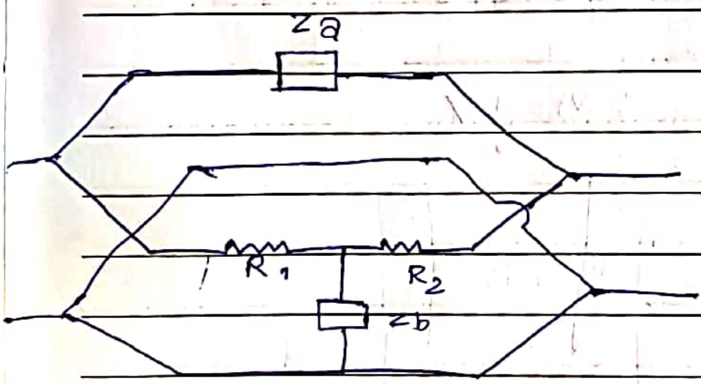


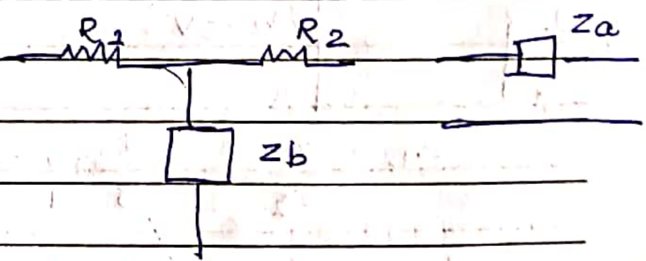


BRIDGETREE NETWORK









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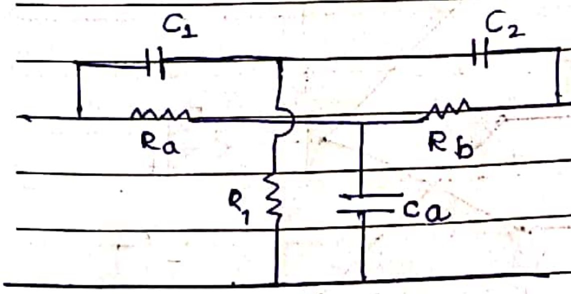
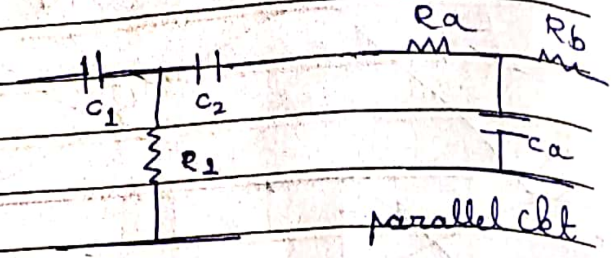
TWIN T-NETWORK

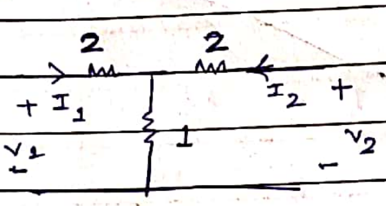


⇒



parallel ckt

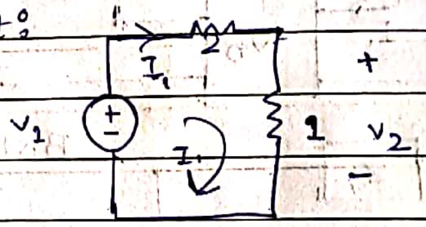
Q: 1 Find Z-parameters of this network



$V_1 = Z_{11} I_1 + Z_{12} I_2 \rightarrow (1)$

$V_2 = Z_{21} I_1 + Z_{22} I_2 \rightarrow (2)$

First part:



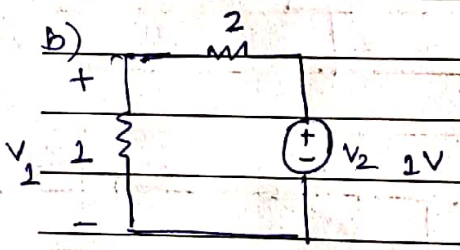
$Z_{11} = \left.\frac{V_1}{I_1}\right]_{I_2=0}$

$Z_{21} = \left.\frac{V_2}{I_1}\right]_{I_2=0}$

$I_1 = \frac{1}{3}A$ $\quad V_2 = 1 \times \frac{1}{3} = \frac{1}{3}V$

$Z_{11} = \frac{1}{1/3} = 3\Omega$; $Z_{21} = \frac{1}{3} \times \frac{3}{1} = 1\Omega$

b)



$V_2 = 1V$

$I_2 = \frac{1}{3}A$; $V_1 = \frac{1}{3}V$

$Z_{12} = \frac{V_1}{I_2} = \frac{1}{3} \times \frac{3}{1} = 1\Omega$

$Z_{22} = \frac{V_2}{I_2} = \frac{1}{1} \times 3 = 3\Omega$

$[Z] = \begin{bmatrix} 3 & 1 \\ 1 & 3 \end{bmatrix}$

$Z_{11} = Z_{22}$
$Z_{12} = Z_{21}$ This network is reciprocal & symmetrical

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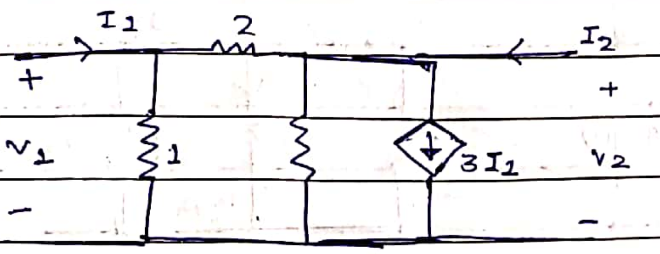
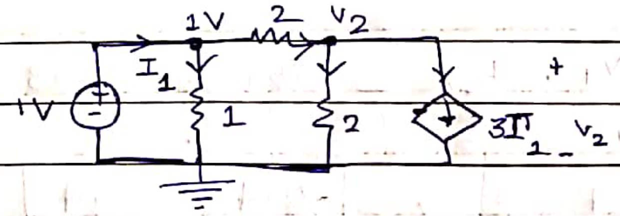
Q:2)



* Nowhere we can connect the independent sources inside the network
diff let^n two port network & usual.

Find Z & Y ?

(1) Z :~ part A : $I_2 = 0$



$Z_{11} = \frac{V_1}{I_1}\Big|_{I_2=0}$ $\qquad Z_{21} = \frac{V_2}{I_1}\Big|_{I_2=0}$

apply KCL at node V_2 $\qquad \frac{1-V_2}{2} = \frac{V_2}{2} + 3I_1$

$\cancel{\frac{V_2-1}{2} + \frac{V_2}{2}}$

$= \cancel{\frac{1-V_2}{2} = \frac{V_2}{2} + \frac{1}{2} + \frac{1}{2} - \frac{V}{2}}$

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

$\cancel{\frac{1}{2} + \frac{V}{2} + \frac{V}{2} - \frac{1}{2}} = \frac{V}{2} + 1$

1

$\cancel{-\frac{V}{2} = 1 \quad = \frac{V}{2} - 2/2}$

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

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

$\frac{1}{2} - \frac{9}{2} = V_2 - \frac{V_2}{2} \quad = +\frac{8}{\cancel{2}} = \frac{V_2}{\cancel{2}}$

$V_2 = 8V$

$I_1 = -2.5$

$Z_{11} = \frac{1}{-2.5} = -0.4$

$Z_{21} = \frac{8}{-2.5} = 3.2\,\Omega$

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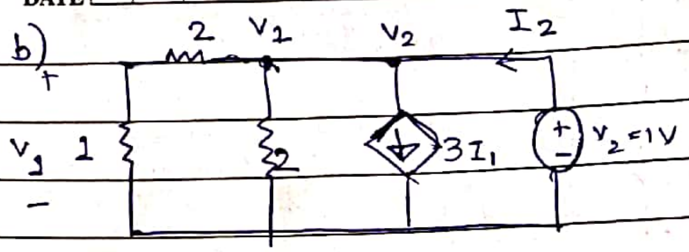
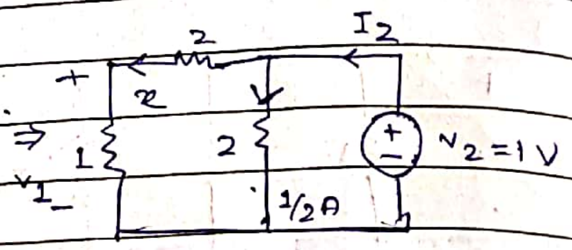
b)





$$I_2 = \frac{1}{6/5} = 0.833$$

$$0.833 = 0.5 + x$$

$$x = 0.33 \qquad V_1 = \frac{1}{3}V \qquad I_2 = 0.833$$

$$Z_{12} = \frac{V_1}{I_2} = \frac{1}{3 \times 0.833} = 0.4$$

$$\begin{bmatrix} -0.4 & 0.4 \\ 3.2 & 1.2 \end{bmatrix}$$

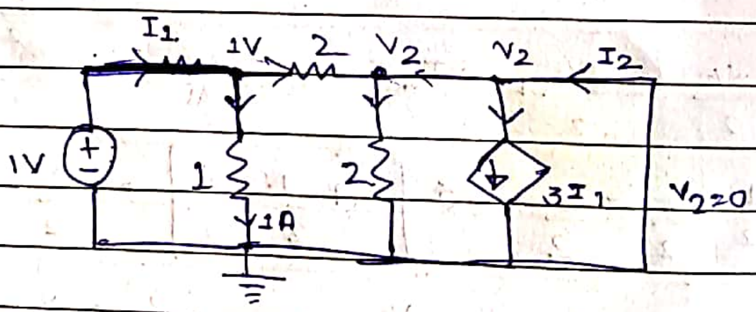
$$Z_{22} = \frac{V_2}{I_2} = \frac{1}{0.833} = 1.2$$

Dependent sources to the ckt means it is not a reciprocal

Y:

$$I_1 = Y_{11}V_1 + Y_{12}V_2$$
$$I_2 = Y_{21}V_1 + Y_{22}V_2$$

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



KCL at node V_2

$$\frac{1-V_2}{2} + I_2 = \frac{V_2}{2} + 3I_1 \qquad V_2 = 0$$

$$\frac{1}{2} + I_2 = 3I_1$$

$$\boxed{3I_1 - I_2 = \frac{1}{2}}$$

$$I_1 = 1 + \frac{1-V_2}{2} = 1 + \frac{1}{2} = 1.5$$

$$3\left(\frac{3}{2}\right) - I_2 = \frac{1}{2} \Rightarrow I_2 = 4A$$

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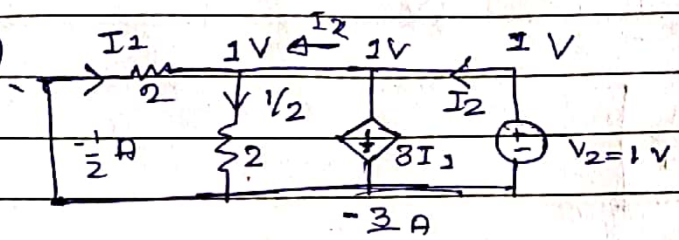
$Y_{11} = \frac{1.5}{1} = \frac{3}{2}$ ℧

$Y_{21} = \frac{I_2}{V_1} = \frac{4}{1} = 4$ ℧

b)



1Ω will also shorted

$I_x + \left(-\frac{1}{2}\right) = \frac{1}{2}$

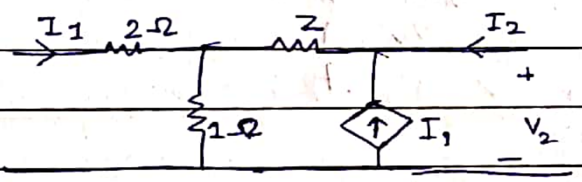
$I_2 = \frac{-3}{2} + 1 = \frac{-1}{2}$ //

$I_x = 1$ A

$Y_{12} = \frac{I_1}{V_2} = \frac{-1}{2}$ ℧

$Y_{22} = \frac{I_2}{V_2} = \frac{-1}{2}$ ℧

(2)



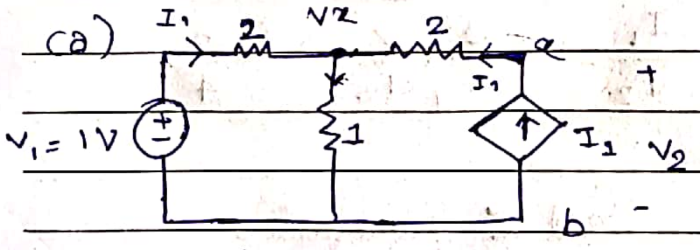
28th Oct '19

Find T :-

$V_1 = AV_2 - BI_2 \rightarrow (1)$

$I_1 = CV_2 - DI_2 \rightarrow (2)$

(a)



$A = \frac{V_1}{V_2}\Big]_{I_2=0}$

$C = \frac{I_1}{V_2}\Big]_{I_2=0}$

KCL at node V_x :-

$\frac{1-V_x}{2} + I_x = V_x \Rightarrow \frac{1-V_x}{2} + \frac{1-V_x}{2} = V_x$

$= 1 - V_x = V_x$

$1 = 2V_x$

$V_x = 1/2$

$\frac{1}{2} - \frac{1}{4} + I_x = \frac{1}{2} \Rightarrow I_x = \frac{1}{4}$ A //

$I_1 = \frac{1-V_x}{2} = \frac{1}{2} - \frac{1}{4} = \frac{1}{4}$ A

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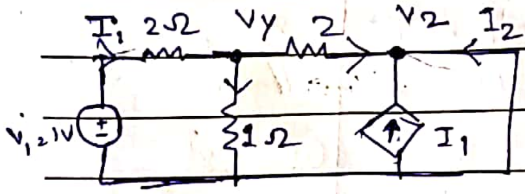
$V_a - 2I_1 - \frac{V_x}{1}(1) - V_b = 0$

$V_{ab} = V_2 = 2I_1 + V_x$

$= \cancel{2}\left(\frac{1}{\cancel{4}_2}\right) + \frac{1}{2} = \frac{1}{2} + \frac{1}{2} = 1V.$

$\boxed{A = \frac{V_1}{V_2} = 1}$ $\boxed{C = \frac{I_1}{V_2} = \frac{1}{4}}$



$(V_2 = 0)$

KCL at V_y

$\frac{1 - V_y}{2} = V_y + \frac{V_y}{2}$

$\frac{1}{2} - \frac{V_y}{2} = V_y + \frac{V_y}{2}$

$\frac{1}{2} = V_y + V_y$

$\frac{1}{2} = 2V_y$

$V_y = \frac{1}{4}$

$I_1 = \frac{1 - V_y}{2} = \frac{1 - \frac{1}{4}}{2} = \frac{3}{8}$

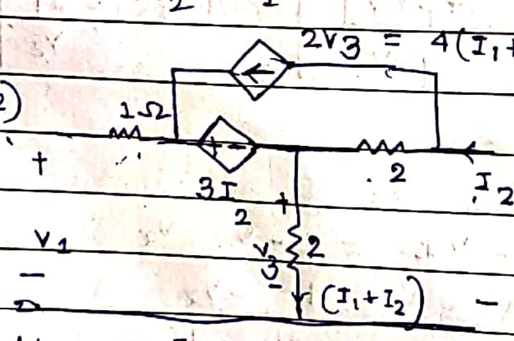
$I_2 + I_1 = \frac{V_2 - V_y}{2}$

$I_2 + \frac{3}{8} = -\frac{1}{8}$

$I_2 = -\frac{1}{8} - \frac{3}{8} = \frac{-\cancel{4}}{\cancel{8}} = -\frac{1}{2}$ //

$B = \frac{-V_1}{I_2} = \frac{-1}{1} \times 2 = 2$ $\quad D = \frac{-I_1}{I_2} = \frac{3}{\cancel{8}_4} \times \frac{\cancel{2}}{1} = \frac{3}{4}$

Q:2)



Find Z parameters

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

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

whatever current is entering there must I_1 current shld return back to their respective ports

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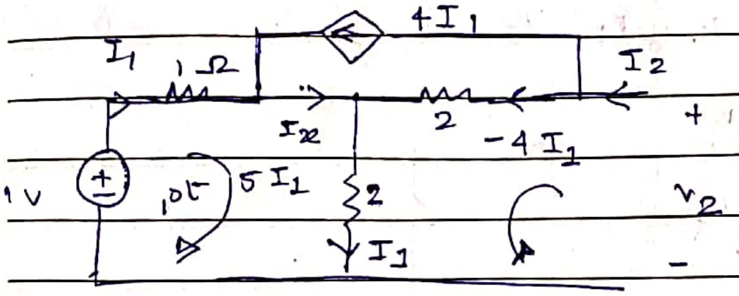
(a) $Z_{11} = \frac{V_1}{I_1}\Big|_{I_2=0}$; $Z_{21} = \frac{V_2}{I_1}\Big|_{I_2=0}$



$I_x = I_1 + 4I_1$
$= 5I_1$

KVL for 1st loop

$1 - 1I_1 - 2I_1 = 0$

$1 - 3I_1 = 0$

$I_1 = \frac{1}{3} A$

$z_{11} = \frac{V_1}{I_1} = 3\,A$

KVL for 2nd loop

$V_2 - 2(-4I_1) - 2I_1 = 0$

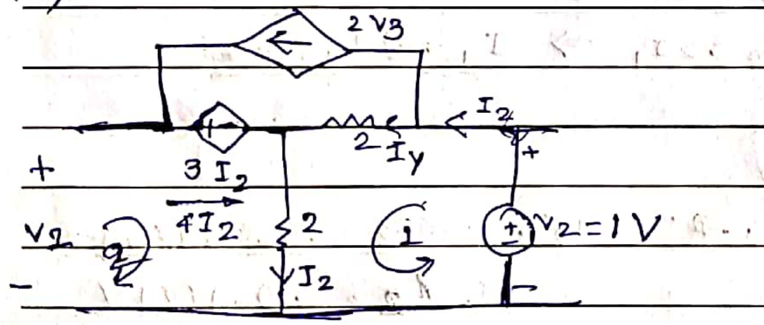
$V_2 + 8I_1 - 2I_1 = 0$

$V_2 + 6I_1 = 0$

$V_2 = -6\left(\frac{1}{3}\right) = -2V$

$\boxed{\frac{V_2}{I_1} = -6\,\Omega = Z_{21}}$

(b) $I_1 = 0$



$I_y + 4I_2 = I_2$

$I_y = -3I_2$

Loop 1

$1 - 2(-3I_2) - 2I_2 = 0$ $\quad 1 + 6I_2 - 2I_2 = 1 + 4I_2$ $\quad I_2 = \frac{-1}{4}$

KVL for Loop 2

$V_1 - 3I_2 - 2I_2 = 0 \Rightarrow V_1 - 5I_2 = 0$ $\quad V_1 = 5I_2 = 5\left(\frac{-1}{4}\right)$

$= -5/4$

$Z_{22} = \frac{V_2}{I_2} = \frac{1}{-1} \times 4 = -4$ $\quad Z_{12} = \frac{V_1}{I_2} = \frac{-5}{4} \times \frac{4}{-1} = 5$

$z = \begin{bmatrix} 3 & 5 \\ -6 & -4 \end{bmatrix}$ It is not symmetric & reciprocal

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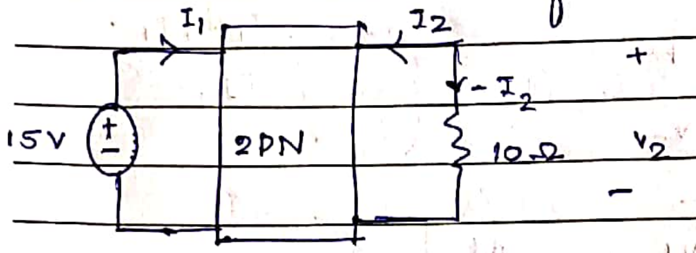
3) i] $I_2 = 0$, $V_1 = 20V$, $I_1 = 2A$, $V_2 = 4V$

ii] $I_1 = 0$, $V_2 = 12V$; $I_2 = 1.5A$; $V_1 = 3V$

When $V_1 = 15V$; $R_L = 10\Omega$, find I_2, I_1, V_2



$Z_{11} = \frac{V_1}{I_1}$	$Z_{12} = \frac{V_1}{I_2}$	$Z_{21} = \frac{V_2}{I_1}$	$Z_{22} = \frac{V_2}{I_2}$
$= \frac{20}{2} = 10$	$\frac{3}{1.5} = 2$	$\frac{4}{2} = 2$	$= \frac{\cancel{120}\ 40}{\cancel{15}\ 5} = 8$

$V_1 = 10I_1 + 2I_2$ $\qquad$ $V_2 = -10I_2$

$V_2 = 2I_1 + 8I_2$

$-10I_2 = 2I_1 + 8I_2 \Rightarrow -18I_2 = 2I_1 \Rightarrow I_1 = -9I_2 \rightarrow (4)$

from eqn (1)

$V_1 = 15 = -90I_2 + 2I_2$ $\quad$ $= \cancel{\cdot}$ $\quad$ $15 = -88I_2 = -0.1704$

$I_2 = -0.1704V$

$15 = \cancel{1.5336}\ 10I_1 + 0.3408$

$15.3408 = 10I_1$

$I_1 = 1.534A$ //

Parameters	Symmetrical	Reciprocal
Z	$Z_{11} = Z_{22}$	$Z_{12} = Z_{21}$
y	$Y_{11} = Y_{22}$	$Y_{12} = Y_{21}$
h	$\Delta h = 1$	$h_{12} = -h_{21}$
T	$A = D$	$\Delta T = 1$
T'	$A' = D'$	$\Delta T' = 1$
g	$\Delta g = 1$	$g_{12} = -g_{21}$

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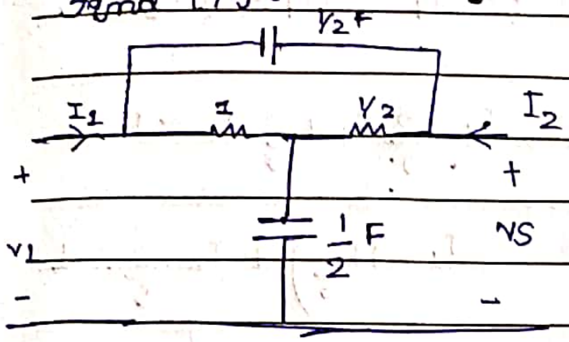
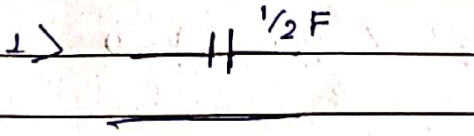
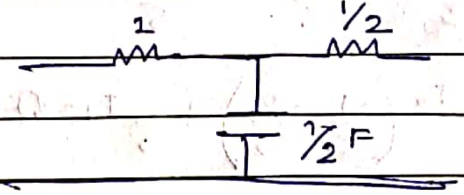
Find [Y] :



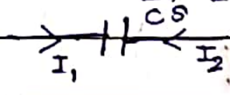
1)



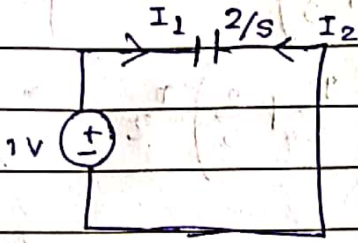
2)



1) $\frac{1}{Cs} = \frac{2}{s}\,\Omega$



(a)



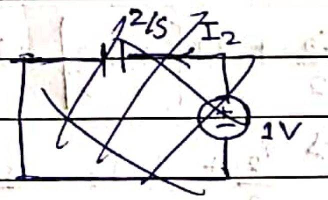
$I_1 = \frac{1}{2/s} = \frac{s}{2}$

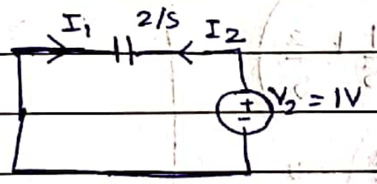
$I_2 = \frac{-s}{2}$ A

$Y_{11} = \left.\frac{I_1}{V_1}\right]_{V_2=0}$ $\qquad Y_{21} = \left.\frac{I_2}{V_1}\right]_{V_2=0}$

$= \frac{s}{2}\,\mho \qquad = \frac{-s}{2}\,\mho$ //

(b)



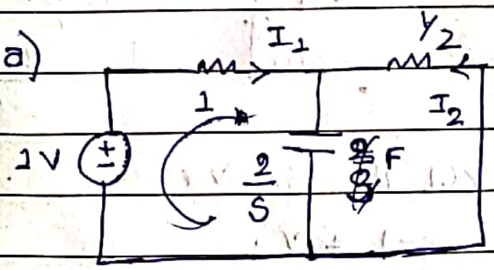


$I_2 = \frac{s}{2}$ A $\quad I_1 = \frac{-s}{2}$ A

$Y_{12} = \frac{I_1}{V_2} = -\frac{s}{2}\,\mho \qquad Y_{21} = \frac{s}{2}\,\mho$

$$Y = \begin{bmatrix} s/2 & -s/2 \\ -s/2 & s/2 \end{bmatrix}$$

2) a)



~~$I_1 = 1 - I_1 - \frac{2}{s} = 0$~~

~~$I_1 = \frac{s-2}{s}$~~

$\Rightarrow \quad 1 - I_1 - \frac{2}{s}(I_1 - I_2) = 0$

$1 - I_1 - \frac{2I_1}{s} + \frac{2}{s}I_2 = 0 \Rightarrow 1 + I_1\left(-1 - \frac{2}{s}\right) + \frac{2}{s}I_2 = 0$

$-\frac{1}{2}I_2 - \frac{2}{s}(I_2 - I_1) = 0$

$\Rightarrow -\frac{1}{2}I_2 - \frac{2}{s}I_2 + \frac{2}{s}I_1 = 0$

$\Rightarrow I_2\left(-\frac{1}{2} - \frac{2}{s}\right) + \frac{2}{s}I_1 = 0$

$\frac{2I_1}{s} = \left(\frac{1}{2}+\frac{2}{s}\right)I_2$

$I_1 = \frac{s}{2}\left(\frac{1}{2}+\frac{2}{s}\right)I_2 \rightarrow (2)$

$1 + \frac{sI_2}{2}\left(\frac{1}{2}+\frac{2}{s}\right)\left(-1-\frac{2}{s}\right)+\frac{2}{s}I_2 = 0$

$\Rightarrow 1+\left(\frac{sI_2}{4}+I_2\right)\left(-1-\frac{2}{s}\right)+\frac{2}{s}I_2=0$

$\Rightarrow 1 - \frac{s}{4}I_2 - \frac{I_2}{2} - I_2 - \frac{I_2}{s} + \frac{2}{s}I_2 = 0$

$\Rightarrow 1 - I_2\left(\frac{s}{4} + \frac{1}{2} + 1 + \frac{1}{s} + \frac{2}{s}\right) = 0$

$\Rightarrow 1 - I_2\left(\frac{s}{4}+\frac{3}{2}+\frac{3}{s}\right)=0$

$I_2 = \frac{1}{(s/4+3/2+3/s)} = \frac{1}{\frac{(s+6+12)}{4s}} = \frac{4s}{s+18}$

$y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0} = \left(\frac{s+4}{s+6}\right)$ $\quad y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0}$ $= \frac{-4}{(s+6)}$

$1 - I_1 - \frac{2}{s}(I_1+I_2) = 0$

$I_1 + \frac{2}{s}I_1 + \frac{2}{s}I_2 = 1$

$I_1\left(1+\frac{2}{s}\right) + I_2 \cdot \frac{2}{s} = 1 \rightarrow (1)$

$I_1 - \frac{I_2}{2} = 1$

$I_1 = \frac{I_2}{2}$

$= \frac{I_2}{2} + \frac{I_2}{s} + \frac{2I_2}{s} = 1$

$\frac{I_2}{s}\cancel{(2+2)} = 1$

$\cancel{I_2 = \frac{s}{4}}$

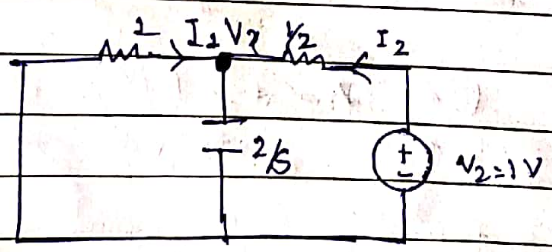
$\Rightarrow \frac{I_2}{2} + I_2\left[\frac{1}{s}+\frac{2}{s}\right] = 1$

$\Rightarrow \frac{I_2}{2} + \frac{3}{s}I_2 = 1$

$\cancel{I_2\left[\frac{1}{2}+\frac{3}{s}\right]=1}$

$\cancel{I_2\left[\frac{s+6}{2s}\right]=1}$

$I_2 = \frac{2s}{s+6}$



KCL at node V_x

$\Rightarrow \frac{V_x - 1}{1/2} + V_x$

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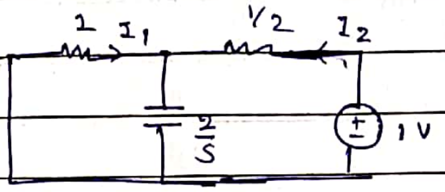
$I_1 + \frac{2}{s}(I_1 + I_2) = 0 \rightarrow (1)$ $I_1 = \frac{s+4}{s+6}$ $I_2 = \frac{s+4}{s+6}$

$I_1 + \frac{I_2}{2} = 1 \rightarrow (2)$

b)



$\Rightarrow 1 = \frac{1}{2}I_2 + \frac{2}{s}(I_1 + I_2)$

$\Rightarrow 1 = \frac{I_2}{2} + \frac{2}{s}I_1 + \frac{2}{s}I_2$

$Y_{12} = \left.\frac{I_1}{V_2}\right] = \frac{-4}{s+6}$ $I_1 = -\frac{4}{s+6}$ $I_2 = \frac{2(s+2)}{s+6}$

$Y_{22} = \frac{2(s+2)}{s+6}$

$$Y = \begin{bmatrix} \frac{s+4}{s+6} & \frac{-4}{s+6} \\ \frac{-4}{s+6} & \frac{2(s+2)}{s+6} \end{bmatrix} \Rightarrow \begin{bmatrix} \frac{s}{2} + \left(\frac{s+4}{s+6}\right) & -\frac{s}{2} - \frac{4}{s+6} \\ -\frac{s}{2} - \left(\frac{+4}{s+6}\right] & \frac{s}{2} + \frac{2(s+2)}{s+6} \end{bmatrix}$$

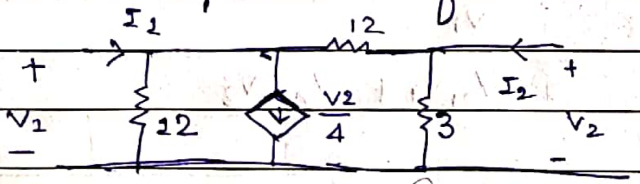
$\frac{s}{2} + \frac{s+4}{s+6} \Rightarrow \frac{s^2+6s+2s+8}{2s+12} \Rightarrow \frac{s^2+8s+8}{2s+12}$

$-\frac{s}{2} - \frac{4}{s+6} \Rightarrow \frac{-s^2-6s-8}{2(s+6)} \Rightarrow \frac{-s^2-6s-8}{2s+12}$

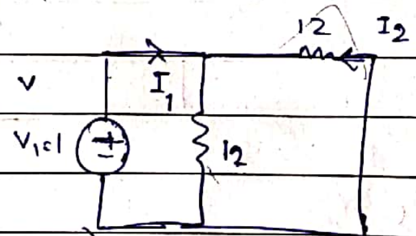
$-\frac{s}{2} - \frac{4}{s+6} \Rightarrow \frac{-s^2-6s-8}{2s+12}$

$\frac{s}{2} + \frac{2s+4}{s+6} \Rightarrow \frac{s^2+6s+4s+8}{2s+12} = \frac{s^2+10s+8}{2s+12}$

Q: Find Y parameters of the network



(a)



$1 - 12(I_1 + I_2) = 0$

$1 = 12(I_1 + I_2) \rightarrow (1)$

$+12 I_2 + 12(I_2 + I_1) = 0$

$24 I_2 + 12 I_1 = 0$

$2I_2 + I_1 = 0$

$I_1 = -12 I_2$

~~$1 = 12(-11 I_2)$~~

$\frac{-1}{132} = I_2$

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$2I_2 + I_1 = 0$

$I_1 = -2I_2$

$1 = 12(I_1 + I_2)$

$= 12(-2I_2 + I_2)$

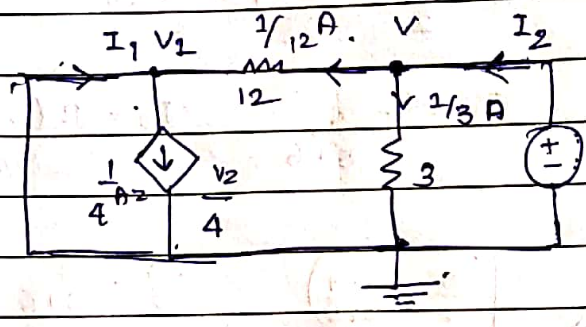
$1 = 12(-I_2)$

$I_2 = \frac{-1}{12}$ A

$I_1 = -\cancel{2}\left(\frac{-1}{\cancel{12}_{6}}\right)$

$= \frac{1}{6}$ A

b)



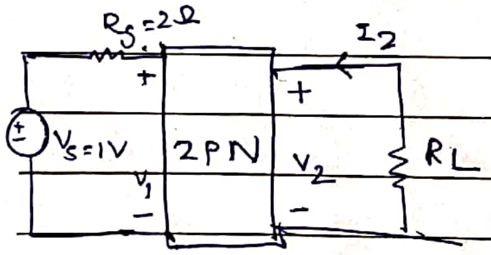
$\Rightarrow I_2 = \frac{1}{12} + \frac{1}{3} = \frac{5}{12}$ A

$I_1 = \frac{V_2}{4} + \frac{V_1 - V_2}{12}$

$I_1 = \frac{V_2}{4} - \frac{V_2}{12} + V_1$

$I_1 = \frac{V_2}{6} + V_1$

Q: Given $V_S = 1V$ & $R_S = 2\Omega$ & $Y = \begin{bmatrix} 2 & -1 \\ -1 & 2 \end{bmatrix}$ for what value of R_L power transfered is max.



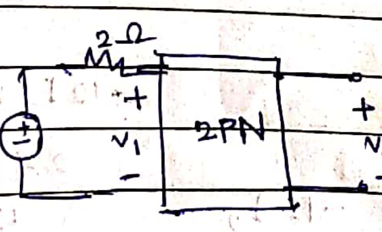
$I_1 = Y_{11}V_1 + Y_{12}V_2$

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

$I_1 = 2V_1 + (-1V_2) \rightarrow (1)$

$I_2 = -1V_1 + 2V_2 \rightarrow (2)$

(a) To find V_{th}



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from ② $V_1 = 2V_2 \rightarrow$ ③

KVL for 1st loop $V_S - 2I_1 - V_1 = 0$

$1 - 2I_1 - V_1 = 0$

$V_1 = 1 - 2I_1 \rightarrow$ ④

$I_1 = 2V_1 - V_2$

$I_1 = 2(2V_2) - V_2 = 4V_2 - V_2 = 3V_2$

$V_1 = 1 - 2(3V_2)$

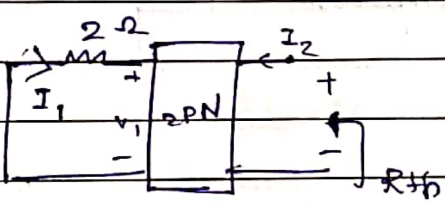
$V_1 = 1 - 6V_2$

$2V_2 + 6V_2 = 1$

$8V_2 = 1$

$V_2 = 1/8$

$R_{th} =$



$I_2 = 0$ $-2I_1 - V_1 = 0$

$V_1 = -2I_1 \rightarrow$ ①

$I_1 = 2V_1 - V_2$

$= 2(-2I_1) - V_2$

$I_1 + 4I_1 = -V_2$

$5I_1 = -V_2$

$I_1 = \frac{-V_2}{5}$

$V_1 = 2V_2$ $I_1 =$

$\cancel{-2I_1 = 2V_2}$

$0 = 2I_1 + 2V_2 = 0$

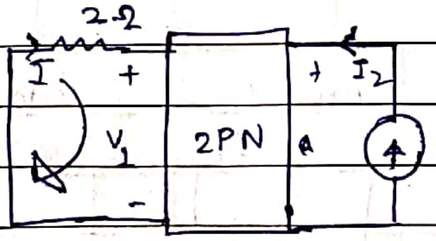
$-2I_1 = 2V_2 = 0$

$\frac{-\cancel{2}I_1}{\cancel{2}} = V_2$

$V_2 = -I_1$

X

$R_{th} =$ 30th Oct'19



+ V_2 +

$I_2 = 1A$

from ③ $1 = -2I_1 + 2V_2$

from ② $I_1 = 2(-2I_1) - V_2$

$I_1 + 4I_1 = -V_2$

$5I_1 = -V_2$

$I_1 = \frac{-V_2}{5}$

$V_1 = -2I_1 \rightarrow$ ①

$I_1 = 2V_1 - V_2 \rightarrow$ ②

$I_2 = -V_1 + 2V_2 \rightarrow$ ③

$\frac{\cancel{8}}{12 \times 8} = -1/12$ $-1/8$

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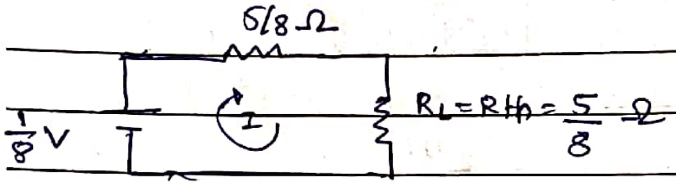
$$1 = 2\left(\frac{-V_2}{5}\right) + 2V_2 \Rightarrow 1 = \frac{2V_2 + 2V_2}{5}$$

$$\Rightarrow 1 = \frac{12 V_2}{5}$$

$$\Rightarrow V_2 = \frac{5}{12} \quad \times \quad 5/8$$

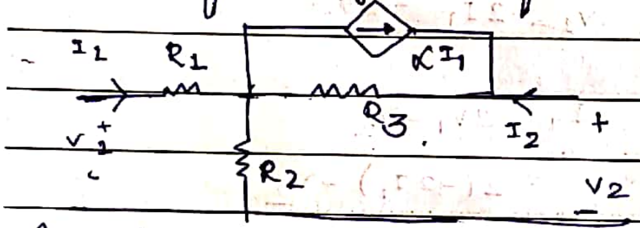
$$R_{th} = \frac{V_2}{I_2} = \frac{5}{8}\,\Omega$$



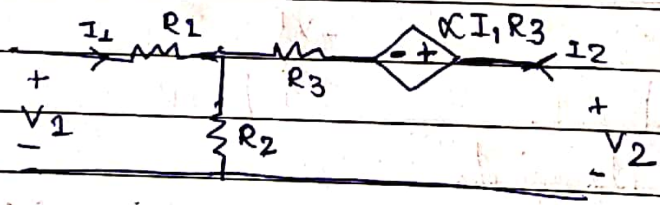
$$I = \frac{1}{10}\,A$$

$$P = 6.25 \times 10^{-3} = \left(\frac{1}{10}\right)^2 \times \frac{5}{8}$$

Q: For the following ckt find h - parameters.



by Source transformation

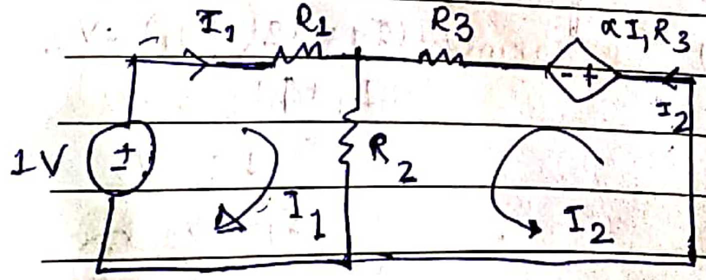


$$V_1 = h_{11} I_1 + h_{12} V_2$$

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

$V_2 = 0$

$$h_{11} = \frac{V_1}{I_1} \qquad h_{21} = \frac{I_2}{I_1}$$



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KVL for loop 1 :

$$1 - R_1 I_1 - R_2 (I_1 + I_2) = 0$$

$$1 - R_1 I_1 - R_2 I_1 - R_2 I_2 = 0$$

$$1 = R_1 I_1 + R_2 I_1 + R_2 I_2 = 0$$

$$1 = I_1 (R_1 + R_2) + I_2 R_2 = 0$$

KVL for 2 :

$$+ \alpha I_1 R_3 + I_2 R_3 + R_2 (I_2 + I_1) = 0$$

$$+ \alpha I_1 R_3 + I_2 R_3 + R_2 I_2 + R_2 I_1$$

$$I_1 (\alpha R_3 + R_2) + I_2 (R_3 + R_2) = 0$$

$$I_1 (\alpha R_3 + R_2) = - I_2 (R_3 + R_2)$$

$$\frac{I_2}{I_1} = - \frac{(\alpha R_3 + R_2)}{(R_3 + R_2)}$$

$$\cancel{1 = I_1 (R_1 + R_2) + I_1 \left(- (\alpha R_3) + R_2 \right.}$$

$$1 = I_1 (R_1 + R_2) - \left[I_1 \frac{(\alpha R_3 + R_2)}{(R_3 + R_2)} \right] R_2$$

$$1 = I_1 (R_1 + R_2) - I_1 R_2 \frac{(\alpha R_3 + R_2)}{(R_3 + R_2)}$$

$$1 = I_1 \left[(R_1 + R_2) - \left(\frac{R_2 \alpha R_3 + R_2^2}{R_3 + R_2} \right) \right]$$

$$1 = I_1 \left[\frac{R_1 R_3 + R_2 R_3 + R_1 R_2 + \cancel{R_2^2} - R_2 \alpha R_3 - \cancel{R_2^2}}{R_3 + R_2} \right]$$

$$1 = I_1 \left[\frac{R_1 R_3 + R_2 R_3 + R_1 R_2 - R_2 \alpha R_3}{R_3 + R_2} \right]$$

$$I_1 = \frac{R_3 + R_2}{R_1 R_3 + R_2 R_3 + R_1 R_2 - R_2 \alpha R_3} = \frac{R_3 + R_2}{R_1 (R_3 + R_2) + R_2 (R_3 - \alpha R_3)}$$

$$h_{11} = \frac{R_1 (R_3 + R_2) + R_2 (R_3 - \alpha R_3)}{R_3 + R_2} = R_1 + \frac{R_2 (R_3 - \alpha R_3)}{R_3 + R_2}$$

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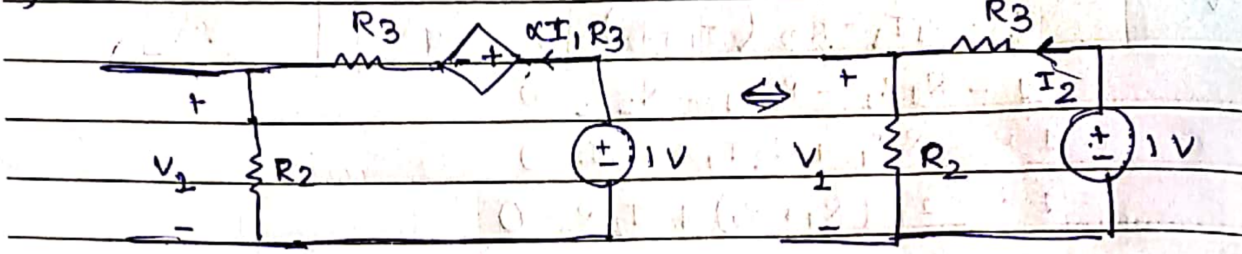
b) $I_1 = 0$



$1 - I_2 R_3 - I_2 R_2 = 0$

$1 - I_2(R_3 + R_2) = 0$

$1 = I_2(R_3 + R_2)$

$I_2 = \dfrac{1}{R_3 + R_2}$

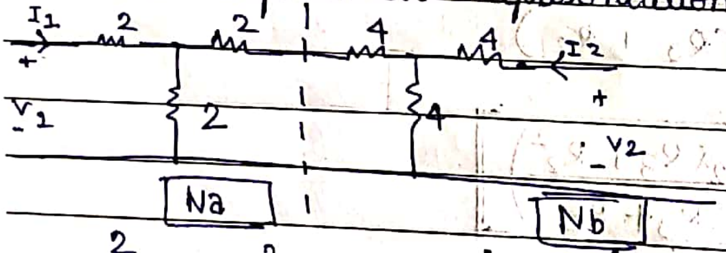
$h_{12} = \dfrac{V_1}{V_2}\Big|_{I_1 = 0}$

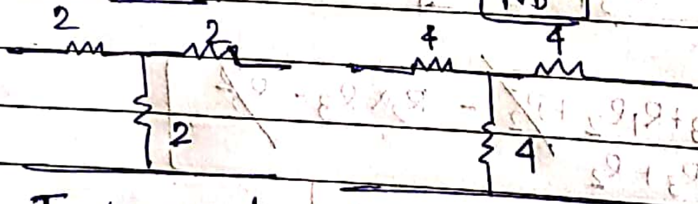
$h_{22} = \dfrac{I_2}{V_2}$

$V_1 = (R_2)\left(\dfrac{1}{R_3 + R_2}\right) = \dfrac{R_2}{R_3 + R_2}$

$h_{12} = \dfrac{R_2}{R_3 + R_2}$ $\qquad h_{22} = \dfrac{1}{R_3 + R_1}$

Find suitable parametric representation for the network given.





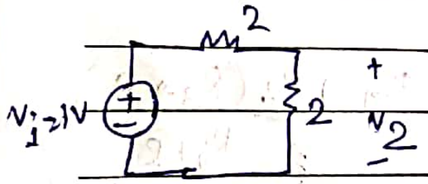
T parameter

$V_1 = AV_2 - BI_2$

$I_1 = CV_2 - DI_2$

$A = \dfrac{V_1}{V_2}$ $\qquad C = \dfrac{I_1}{V_2}$

1) $I_2 = 0$



$I_1 = \dfrac{1}{4}$ A $\qquad V_2 = 2\left(\dfrac{1}{4}\right) = \dfrac{1}{2}$ V

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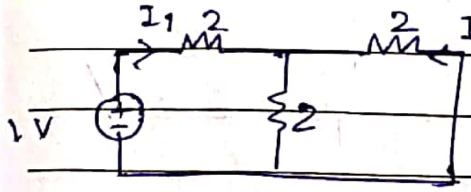
$A = \frac{1\times 2}{1} = 2 \qquad C = \frac{1'}{4/2} \times \frac{2}{1} = \frac{1}{2}$

b) $V_2 = 0$



$1 = \cancel{+2I_1 + 2(I_1+I_2)}$

$R_{eq} = (2\|2)+2$

$= 3\Omega$

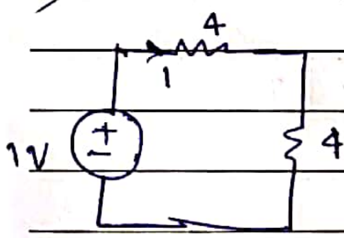
$I_1 = \frac{1}{3} A$

$I_2 = -\frac{1}{3} \times \frac{2}{4} = \frac{-2}{12}$

$B = \frac{-V_1}{I_2} = \frac{-1}{-2} \times 12 = 6 \qquad D = \frac{-I_1}{I_2} = \frac{-1}{\cancel{3}} \times \frac{\cancel{12}^{4}{}^{2}}{-\cancel{2}} = 2$

$$\begin{bmatrix} 2 & 6 \\ 1/2 & 2 \end{bmatrix}$$

b) $I_2 = 0$

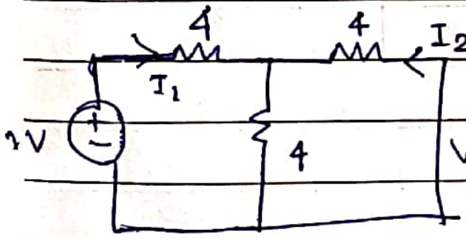


$I_1 = \frac{1}{8} \qquad V_2 = 4\left(\frac{1}{8}\right) = \frac{1}{2}$

$A_b = \frac{V_1}{V_2} = \frac{1\times 2}{1} = 2$

$C_b = \frac{I_1}{V_2} = \frac{1}{8} \times \frac{2}{1} = \frac{1}{4}$

$V_2 = 0$



$R_{eq} = (4\|4)+4$

$= 2+4$

$= 6$

$I_1 = \frac{1}{6} A \qquad I_2 = -\frac{1}{\cancel{6}_{3}} \times \frac{\cancel{4}}{\cancel{8}_{4}} = \frac{-1}{12} A$

$B_b = \frac{-V_1}{I_2} = \frac{-1}{-1} \times 12 = 12$

$D_b = \frac{-I_1}{I_2} = -\frac{1}{6} \times \frac{12}{1} = 2$

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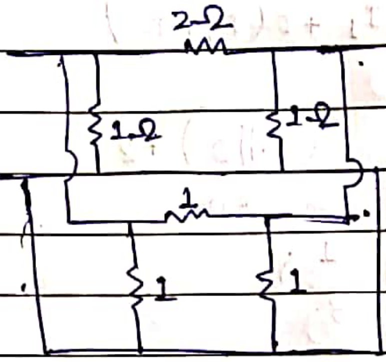
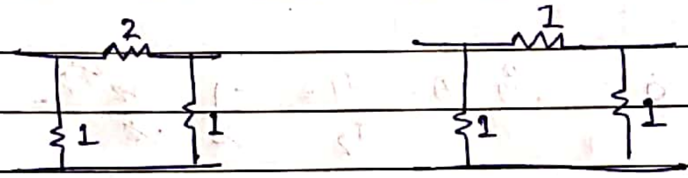
$$\begin{bmatrix} 2 & 6 \\ 1/2 & 2 \end{bmatrix} \begin{bmatrix} 2 & 12 \\ 1/4 & 2 \end{bmatrix} = \begin{bmatrix} 4 + \frac{6}{4} & 24 + 12 \\ \frac{1}{8} + \frac{1}{2} & 6 + 4 \end{bmatrix}$$

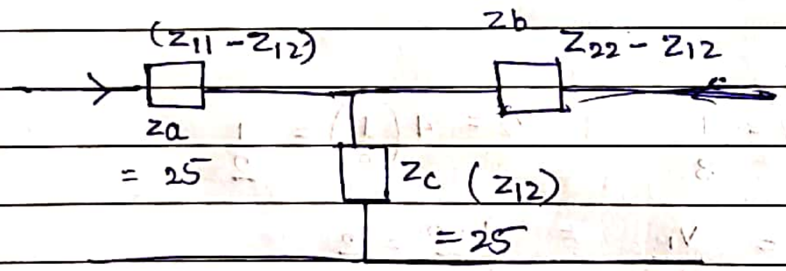
Q:2)



parallel - Y



Q:3) $Z = \begin{bmatrix} 50 & 25 \\ 25 & 100 \end{bmatrix}$ $z_{12} = z_{21}$ reciprocal



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