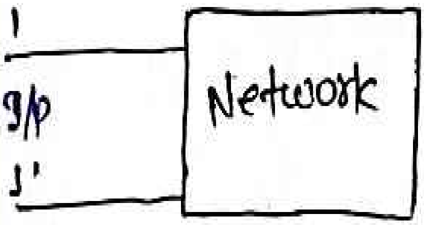
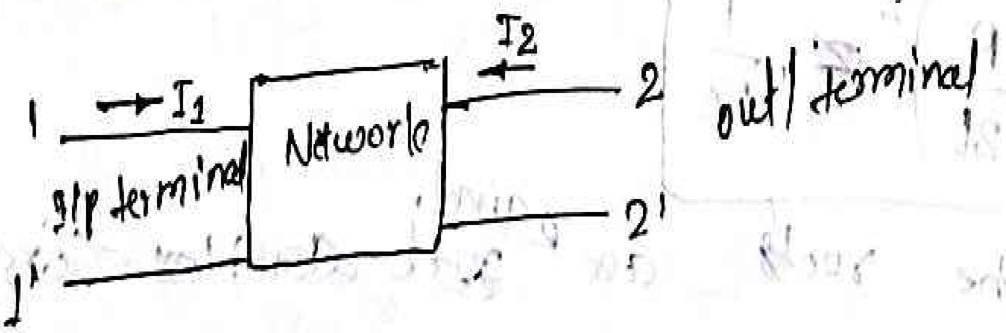
UNIT-IV Two Port Networks

* **One port Network:-** A port is defined as any pair of terminals into which energy is drawn or which energy is supplied.



A network having only one pair of terminals (11') is known as one port network.

* **Two port Network:-** A Network which has two pairs of Terminals one is input terminal and second one is output terminals the two terminals as port are (11'), (22')



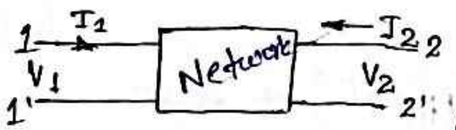
Active Networks :- If two ports have Sources in their trances is known as Active ports.

Passive ports :- If the two ports do not content any Sources in their trances is known as passive ports.

* To described two port Network their are Six parameter.

(i) open circuit impedance parameters (or) Z parameters.
(ii) Short circuit admittance " (or) Y "
(iii) Transmission " (or) ABCD "
(iv) Inverse Transmission " (or) A'B'C'D' "
(v) Hybrid Parameter (or) h Parameters.
(vi) Inverse hybrid " (or) g "

(i) open circuit impedance parameters (or) Z parameters.



The generalise equ for Z parameters is given by

$$\boxed{V_1 = Z_{11} I_1 + Z_{12} I_2} \quad \text{— (i)}$$

$$\boxed{V_2 = Z_{21} I_1 + Z_{22} I_2} \quad \text{— (ii)}$$

Where

$\begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix}$ Are the network functions are also called as Impedance parameters

To calculate this parameter two Variables are defined by equating to zero.

let $I_2 = 0$ in equ (i) then

$V_1 = Z_{11} I_1$ $\qquad Z_{11} = \frac{V_1}{I_1}$ / Where $I_2 = 0$

(Input driving Point impedance)

Where Z_{11} is driving point impedance at ~~for~~ port $22'$ by open circuiting second port. It is called as open circuit input impedance.

IIIly

Put $I_2 = 0$ in (ii)

then $Z_{21} = \frac{V_2}{I_1}$ / where $I_2 = 0$ (open ckt forward transfer impedance)

This Z_{21} is called as open circuit forward transfer impedance.

By open circuiting input pole $(11')$ that is $I_1 = 0$ in (i)

$$V_1 = Z_{12} I_2$$

$$\boxed{Z_{12} = \frac{V_1}{I_2} \Big/ \text{Where } I_1 = 0}$$

Where Z_{12} is known as open circuit Reverse transfered impedance.

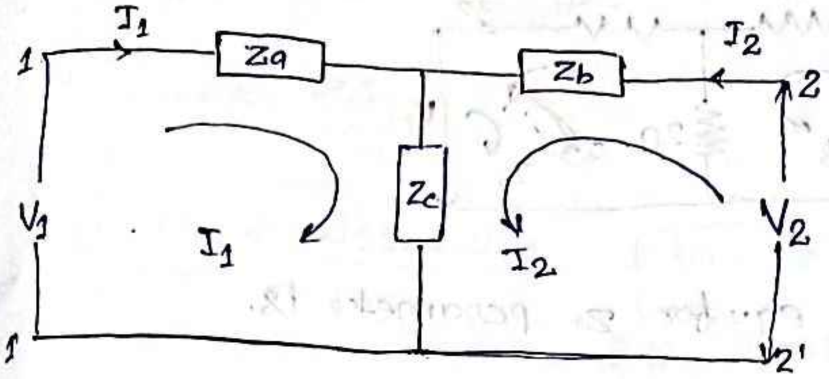
By substituting $I_2 = 0$ in equ (ii)

$$V_2 = Z_{22} I_2$$

$$\boxed{Z_{22} = \frac{V_2}{I_2} \Big/ \text{where } I_2 = 0}$$

Where Z_{22} is known as open circuit output impedance.

* for the given network determine z parameters :-



The generalise equ for z parameters is,

$$\boxed{z_{11} I_1 + z_{12} I_2 = V_1}$$
$$\boxed{z_{21} I_1 + z_{22} I_2 = V_2}$$

By ~~applying~~ taking loop equ.
In loop (i)

$$I_1 z_a + (I_1 + I_2) z_c = V_1$$

$$\boxed{V_1 = I(z_a + z_c) + I_2 z_c} \quad \text{--- (i)}$$

In loop (ii)nd.

$$z_b I_2 + (I_2 + I_1) z_c = V_2$$

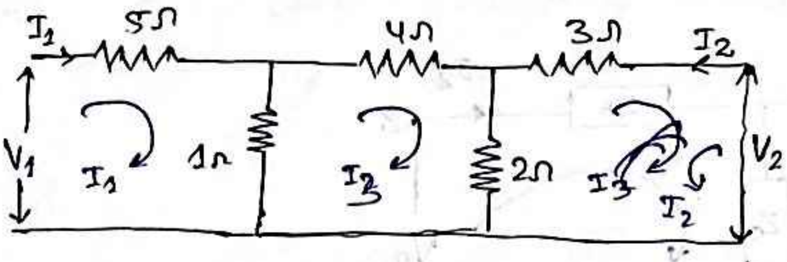
$$\boxed{(z_b + z_c) I_2 + (z_c) I_1 = V_2} \quad \text{--- (ii)}$$

By Comparing (i) & (ii) from generalise equ of z - parameters.

$$z_{11} = (z_a + z_c), \quad z_{12} = z_c$$

$$z_{21} = z_c, \quad z_{22} = z_b + z_c$$

Determine z- perameters for given problem.



The generalise equ for z- perameter is.

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

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

<u>loop equ</u>

$$V_1 = 5I_1 + 1(I_1 - I_3)$$

$$\boxed{V_1 = 6I_1 - I_3} \quad \text{— (i)}$$

$$\boxed{\cancel{I_3 = 6I_1} - V_1}$$

$$V_2 = 3I_2 + 2I_2 + 2I_3$$

$$\boxed{V_2 = 5I_2 + 2I_3} \quad \text{— (ii)}$$

$$\cancel{V_2 = 5I_2 + 2(6I_1 - V_1)}$$

$$4I_3 + 2I_3 + 2I_2 + I_3 - I_1 = 0$$

$$\cancel{7I_3 =} I_1 \quad -I_1 + 2I_2 + 7I_3 = 0$$

$$\boxed{I_3 = \frac{I_1 - 2I_2}{7}} \quad \text{— (iii)}$$

Sub (iii) in (i) & (ii),

$$V_1 = 6I_1 - \frac{I_1 + 2I_2}{7}$$

$$V_1 = \frac{42I_1 - I_1 + 2I_2}{7}$$

$$V_1 = \frac{41I_1 + 2I_2}{7}$$

$$\boxed{V_1 = 5.85I_1 + 0.285I_2}$$

By Comparing generalise equ of Z para → $Z_{11} = 5.85$, $Z_{12} = 0.285$

Sub (iii) in (ii).

$$V_2 = 5I_2 + 2\left(\frac{I_1 - 2I_2}{7}\right)$$

$$V_2 = \frac{35I_2 + 2I_1 - 4I_2}{7}$$

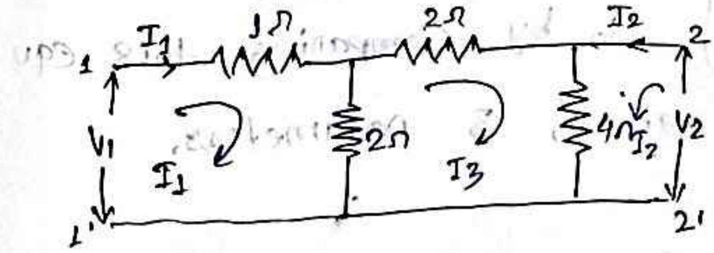
$$V_2 = \frac{31I_2 + 2I_1}{7}$$

$$\boxed{V_2 = 4.42I_2 + 0.285I_1}$$

By Comparing gen equ of Z - parameters.

$$\boxed{Z_{21} = 0.285, \quad Z_{22} = 4.42}$$

* Determine Z- Parameters for given problem.



The generalise equ for Z Parameter.

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

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

Applying KVL for loop (i)

$$1I_1 + 2(I_1 - I_3) = V_1$$

$$\boxed{3I_1 - 2I_3 = V_1} \quad \text{— (i)}$$

Applying KVL for loop (ii)

$$\boxed{4I_2 + 4I_3 = V_2} \quad \text{— (ii)}$$

Applying KVL for loop (iii)

$$2(I_3 - I_1) + 2I_3 + 4I_3 + 4I_2 = 0$$

$$-2I_1 + 8I_3 + 4I_2 = 0$$

$$\boxed{I_3 = \frac{-4I_2 + 2I_1}{8}} \quad \text{— (iii)}$$

Sub (iii) in (i) & (ii)

sub (iii) in (i)

$$3I_1 - \cancel{2}\left(\frac{-4I_2 + 2I_1}{\cancel{8}4}\right) = V_1$$

$$\frac{1\cancel{3}2I_1 + 4I_2 - 2I_1}{4} = V_1$$

$$\frac{10I_1 + 4I_2}{4} = V_1$$

$$\boxed{2.5I_1 + I_2 = V_1}$$ So by Comparing this equ with generalise equ of z parameters.

$$\boxed{\begin{aligned} Z_{11} &= 2.5 \\ Z_{12} &= 1 \end{aligned}}$$

Sub (iii) in (ii),

$$4I_2 + 4\left[\frac{-4I_2+2I_1}{\frac{8}{2}}\right] = V_2$$

$4I_2 - 2I_2 + I_1 = V_2$; $2I_2 + I_1 = V_2$

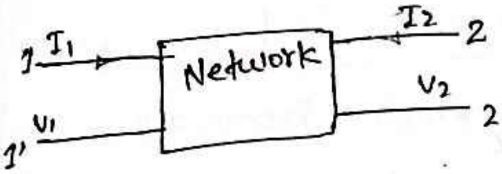
$$\boxed{I_1 + 2I_2 = V_2}$$

By Comparing this equ with generalise equ of Z parameters,

$$\boxed{Z_{21} = 1, \quad Z_{22} = 2}$$

Short Circuit Admitance (or) Y Parameters :-

Y - Parameter



Here V_1, V_2 - independent Variable.

$I_1 I_2$ — Dependent Variable.

The generalised equations are.

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

$I_2 = Y_{21}V_1 + Y_{22}V_2$ --- (ii)

Short Circuiting the o/p port

Put $V_2 = 0$ in equ(i)

then $I_1 = Y_{11}V_1$

$$\boxed{Y_{11} = \frac{I_1}{V_1} \Big/ V_2 = 0}$$

Y_{21} – input transfer admitance.

Y_{11} - Short circuit I/P admitance.

Put V_2

$V_2 = 0$ in equ(ii)

$I_2 = Y_{21}V_1$

$$\boxed{Y_{21} = \frac{I_2}{V_1} \Big/ V_2 = 0}$$

Put $V_1 = 0$ in equ (i) Short circuiting the i/p ~~shorted~~ port.

$$I_1 = Y_{12} V_2$$

$$\boxed{Y_{12} = \frac{I_1}{V_2} \Big/ V_1 = 0}$$

$Y_{12} \rightarrow$ output transfer admitance

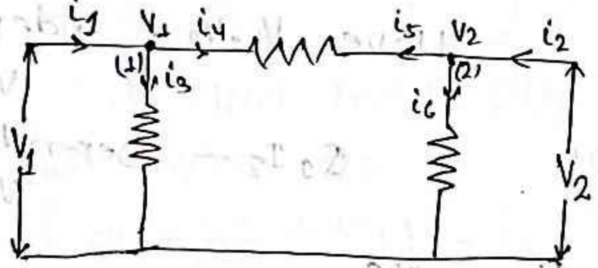
Put $V_1 = 0$ in equ (ii)

$$I_2 = Y_{22} V_2$$

$$\boxed{Y_{22} = \frac{I_2}{V_2} \Big/ V_1 = 0}$$

$Y_{22} \rightarrow$ Short Circuit output admitance.

* Determine Y- Parameter for the CKT Shown in fig.



Assuming at from node (1) i_3 & (i_4)

& at node (2) i_5 & i_6.

At node 1, applying KCL

$$i_1 = i_3 + i_4$$

$$i_1 = i_3 + i_4$$

$$i_1 = \frac{V_1}{2} + \frac{V_1 - V_2}{2}$$

$$\boxed{i_1 = V_1 - \frac{V_2}{2}} \quad \text{—(i)}$$

At node 2:- Applying KCL

$$i_2 = i_5 + i_6$$

$$i_2 = \frac{V_2 - V_1}{2} + \frac{V_2}{6}$$

$$\text{(ii)—} \quad \boxed{i_2 = \frac{-V_1}{2} + V_2}$$

The generalised equ of Y- Parameter are.

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

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

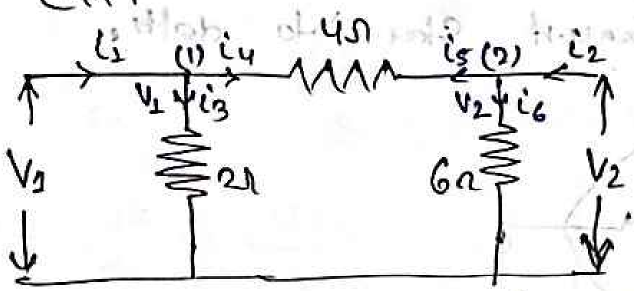
$\boxed{Y_{11} = 1℧, \quad Y_{12} = -0.5℧}$

$\boxed{Y_{21} = -0.5℧, \quad Y_{22} = 1℧}$

Here $Y_{11} = Y_{22}$ this Condition is called as Condition for Symmetric.

& $Y_{12} = Y_{21}$ then this is called as Condition for reciprocity.

* Determine the Y- Parameters for the given CKT



Assumed i_3, i_4 at node (1) &

i_5, i_6 at node (2)

At node (1) applying KCL,

$$i_1 = i_3 + i_4$$

$$\boxed{i_1 = \frac{V_1}{2} + \frac{V_1 - V_2}{4}} \quad -①$$

$$i_1 = \frac{2V_1 + V_1 - V_2}{4}$$

$$\boxed{i_1 = \frac{3V_1}{4} - \frac{V_2}{4}}$$

At node (2) by applying KCL

$$i_2 = i_5 + i_6$$

$$i_2 = \frac{V_2 - V_1}{4} + \frac{V_2}{6}$$

$$i_2 = \frac{3V_2 - 3V_1 + 2V_2}{12}$$

$$i_2 = \frac{5V_2 - 3V_1}{12}$$

$$i_2 = \frac{5V_2}{12} - \frac{V_1}{4}$$

$$\boxed{i_2 = -\frac{V_1}{4} + \frac{5V_2}{12}}$$

The generalise equ for Y-parameters :

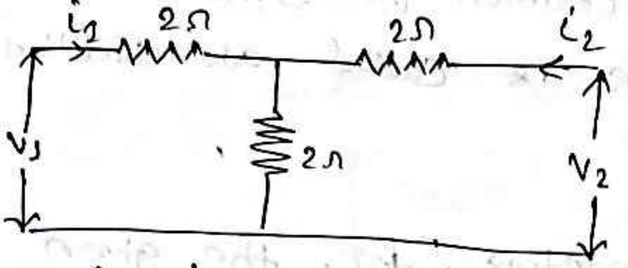
$\boxed{I_1 = Y_{11}V_1 + Y_{12}V_2}$

$\boxed{I_2 = Y_{21}V_1 + V_{22}V_2}$

$Y_{11} = 0.75℧ , Y_{12} = 0.25℧$

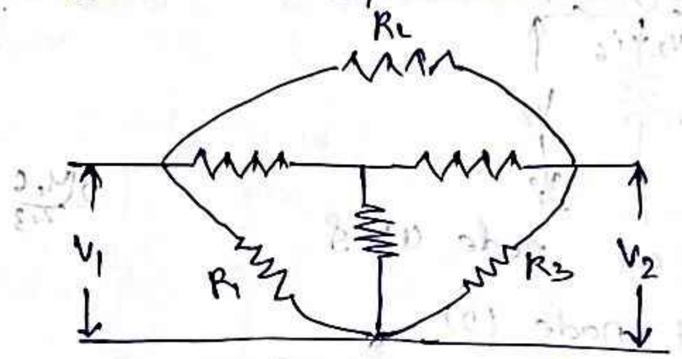
$Y_{21} = -0.25℧ , Y_{22} = 0.416℧$

Determine Y- parameters for the given CKT.



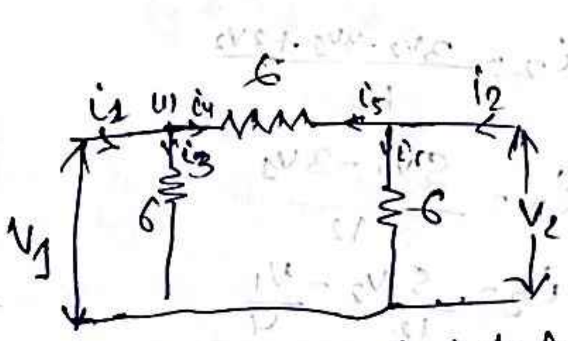
~~Applying KCL at node (1)~~

By Convert Star into delta.



$$R_1 = \frac{R_1R_2 + R_2R_3 + R_3R_1}{}$$

$$R_1 = \frac{2\times2 + 2\times2 + 2\times2}{2} = 6\ Ω$$



Applying KCL at Node (1).

$$i_1 = \frac{V_1}{6} + \frac{V_1 - V_2}{6}$$

$$i_1 = \frac{2V_1}{6} - \frac{V_2}{6}$$

$$\boxed{i_1 = \frac{V_1}{3} - \frac{V_2}{6}} - (1)$$

Apply KCL at node (2)

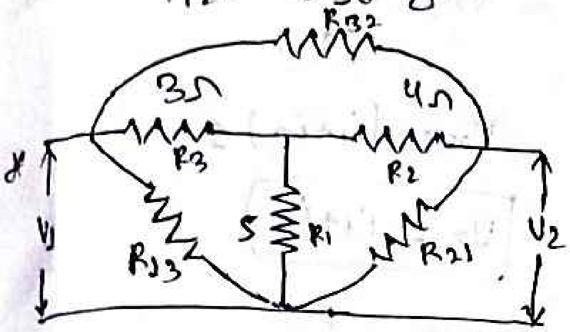
$$i_2 = \frac{V_2}{6} + \frac{V_2 - V_1}{6}$$

$$i_2 = \frac{2V_1}{6} - \frac{V_1}{6}$$

$$i_2 = -\frac{V_1}{6} + \frac{V_2}{3}$$

$Y_{11} = 0.33\ \mho$ $\quad Y_{21} = -0.16\ \mho$

$Y_{12} = -0.16\ \mho$ $\quad Y_{22} = 0.33\ \mho$

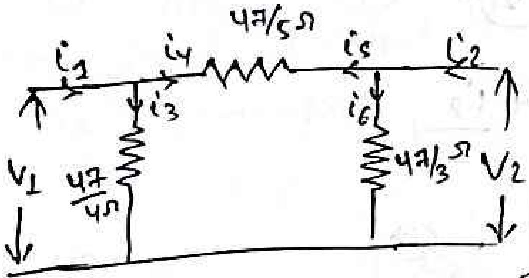


$$R_{13} = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_2} = \frac{5\times4 + 4\times3 + 3\times5}{4}$$

$$R_{13} = \frac{20+12+15}{4} = \frac{47}{4} =$$

$$R_{21} = \frac{47}{R_3} = \frac{47}{3}$$

$$R_{32} = \frac{47}{R_1} = \frac{47}{5}$$



Applying KCL at node ①

$$i_1 = \frac{4V_1}{47} + \frac{5(V_1 - V_2)}{47}$$

$$i_1 = \frac{4V_1 + 5V_1 - 5V_2}{47}$$

$$i_1 = \frac{9V_1}{47} - \frac{5V_2}{47}$$

Applying KCL at node (ii)

$$i_2 = \frac{3V_2}{47} + \frac{(V_2 - V_1)5}{47}$$

$$i_2 = \frac{3V_2 + 5V_2 - 5V_1}{47}$$

$$i_2 = \frac{8V_2 - 5V_1}{47}$$

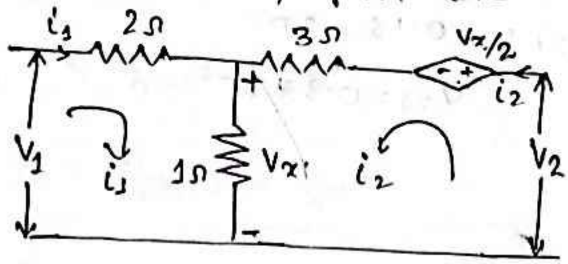
$$i_2 = \frac{-5V_1}{47} + \frac{8V_2}{47}$$

Generalize equ for Y-Paramete

$I_1 = Y_{11}V_1 + Y_{12}V_2$ $\quad = Y_{11} = 9/47 = 0.19125,\ Y_{12} = -0.106$

$I_2 = Y_{21}V_1 + Y_{22}V_2$ $\quad Y_{21} = -0.106,\ Y_{22} = 0.170$

* Determine y parameter for the given CKT.



V_x = Voltage drop across 1Ω

$V_x = (i_1+i_2)\,1$

$\boxed{V_x = i_1+i_2}$

~~Vx= Voltage~~ drop

At loop (i) By applying KVL,

$2i_1 + 1(i_1+i_2) = V_1$

$\boxed{3i_1 + i_2 = V_1}$ --- (i)

At loop (ii) By applying KVL

$3i_2 + 1(i_1+i_2) + \frac{V_x}{2} = V_2$

$V_x = i_1+i_2$; $3i_2 + i_1 + i_2 + \frac{i_1}{2} + \frac{i_2}{2} = V_2$

$\boxed{V_2 = i_1 + 4i_2 + \frac{V_x}{2}}$ — (i)

$V_2 = i_1 + 4i_2 + \frac{i_1}{2} + \frac{i_2}{2}$

$\boxed{V_2 = \frac{3i_1}{2} + \frac{9}{2} i_2}$ ← (ii)

By (i) & (ii) 3/2 multiply in (i)

~~$V_2 = i_1$~~ ~~$3i_1 + i_2 = V_1 \times 3/2$~~

$\frac{9}{2} i_1 + \frac{3}{2} i_2 = \frac{3}{2} V_1$

$\frac{3}{2} - \frac{7}{2}$

$\frac{3 i_1}{2} + \frac{7}{2} i_2 = V_2$

$\frac{3-7}{2} = -\frac{4}{2}$

$\frac{3}{2} i_2 - \frac{7}{2} i_2 = \frac{3}{2} V_1 - V_2$

$-2 i_2 \quad \frac{3}{2} V_1 = V_2$

$i_2 = -V_1 + V_2$

ABCD (or) transmissions parameters.

Let us consider a network consisting of input variables at port 1 1' and output variables V_2 & I_2 at port 2 2' the port 1 1' is called as sending end port and the port 2 2' is called as Receiving end port.

The ABCD parameters provied a direct relationship between input & output.

The generallise equations for ABCD parameter is given by.

$$\boxed{V_1 = AV_2 - BI_2}$$

$$\boxed{I_1 = CV_2 - DI_2}$$

Procedure :- By making the port 2 2' open that is $i_2 = 0$.

$$\boxed{V_1 = AV_2 - BI_2} \quad \text{--- (i)}$$

$$\boxed{I_1 = CV_2 - DI_2} \quad \text{--- (ii)}$$

By open ckt at port 2 2',

Then equ. (i) becomes

$V_1 = AV_2 - B(0)$; $V_1 = AV_2$

$$\boxed{A = \frac{V_1}{V_2} \Big/ I_2 = 0}$$

Substitute $I_2 = 0$ in equ (ii)

$I_1 = CV_2 - D(0)$

$I_1 = CV_2$

$$\boxed{C = \frac{I_1}{V_2} \Big/ I_2 = 0}$$

By Short circuiting the port 2 2' that is; $V_2=0$ in equ(i)

$V_1 = A(0) - B(I_2)$:

$$\boxed{B = \frac{-V_1}{I_2}\Big/_{V_2=0}}$$

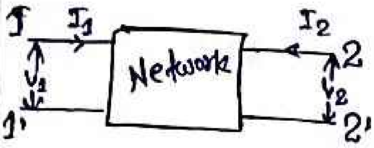
then ~~in eq~~ eq

By Sub the $V_2=0$ in equ(ii)

$I_1 = 0 - DI_2$

$$\boxed{D = \frac{-I_1}{I_2}\Big/_{V_2=0}}$$

* Inverse transmission parameters (or) A'B'C'D' parameters.



Let us consider a network consisting of input variable at port 11' and output variable 22' the port 11' is called as Sending end port and the port 22' is called as Receiving end port.

The A'B'C'D' parameters provided a direct relationship btw i/ps o/p.

The generalise equ for A'B'C'D' parameter is given by,

$V_2 = A'V_1 - B'I_1$

$I_2 = C'V_1 - D'I_1$

procedure:- By making the port 11' open that is, $i_1=0$

Then equ(i) becomes;

$V_2 = A'V_1 - B'(0)$

$$\boxed{A' = \frac{V_2}{V_1}\Big/_{i_1=0}}$$

Sub $I_1=0$ in (ii).

$I_2 = C'V_1$

$$\boxed{C' = \frac{I_2}{V_1}\Big/_{I_1=0}}$$

By Short CKT at port 11'

then $V_1=0$

Sub $V_1=0$ in (I)

$V_2 = -B'I_1$

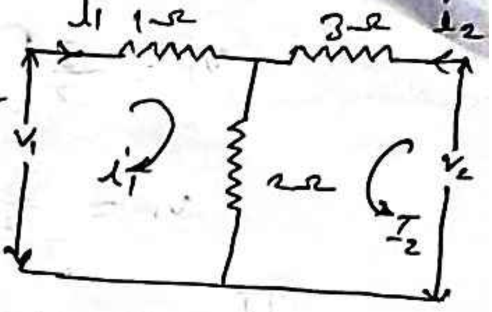
$$\boxed{B' = \frac{-V_2}{I_1}\Big/_{V_1=0}}$$

$V_1=0$ in (ii)

$I_2 = -D'I_1$

$$\boxed{D' = \frac{-I_2}{I_1}\Big/_{V_1=0}}$$

Q. Determine transmission parameter for the given circuit



By applying KVL for the loop ①

$$1i_1 + 2(i_1+i_2) = V$$

$$3i_1 + 2i_2 = V_1 \quad \text{——} ①$$

By applying KVL for the loop

$$3i_2 + 2(i_1+i_2) = V_2$$

$$2i_1 + 5i_2 = V_2 \quad \text{——} ②$$

The generalised equation for ABCD are

$$V_1 = AV_2 - BI_2$$

$$I_1 = CV_2 - DI_2$$

From eqn ①,

$$3i_1 + 2i_2 = V_1$$

$$3i_1 = V_1 - 2i_2$$

$$i_1 = \frac{V_1 - 2i_2}{3}$$

value of i_1 put in eqn ②

$$2\left(\frac{V_1-2i_2}{3}\right) + 5i_2 = V_2$$

$$\frac{2V_1}{3} - \frac{4i_2}{3} + 5i_2 = V_2$$

$$\frac{4i_2 + 15i_2}{3} = V_2 - \frac{2V_1}{3}$$

$$11i_2 = 3V_2 - 2V_1$$

$$V_1 = \frac{3}{2}\left[V_2 + - \frac{11}{3} I_2\right]$$

$$V_1 = \frac{3}{2}V_2 - \frac{11}{2} I_2$$

The generalised eq^n with comparing

$$V_1 = AV_2 - BI_2$$

$$I_1 = CV_2 - DI_2$$

$$\boxed{A = 3/2 \;,\; B = 11/2}$$

$$3I_1 + 2I_2 = \frac{3}{2}V_2 - 11/2\, I_2$$

$$3I_1 = 3/2\, V_2 - \frac{11}{2} I_2 - 2I_2$$

$$3I_1 = \frac{3}{2}V_2 - \left[\frac{15}{2} I_2\right]$$

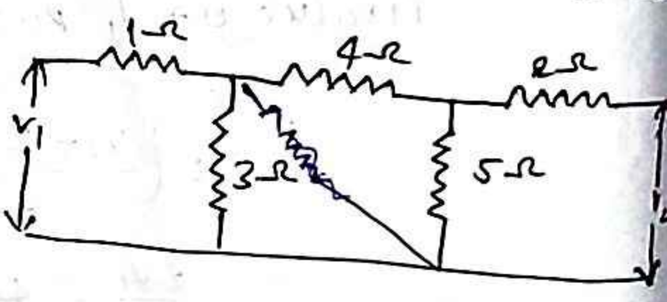
$$I_1 = 1/2\, V_2 - 5/2\, I_2$$

The gene By comparising eq^n with generalised eq^n $\quad C = 1/2 \;\; D = -5/2$

$$I_1 = CV_2 - DI_2$$

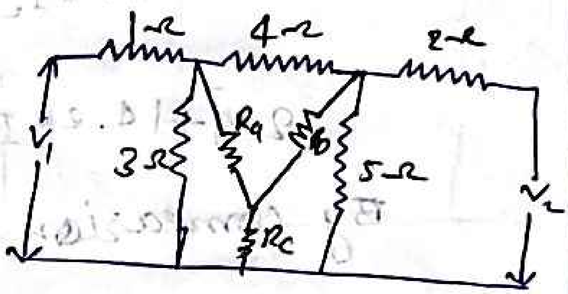
$$\boxed{C = 1/2 \;,\; D = -5/2}$$

Q. For the given circuit calculate ABCD parameters



convert the star connected system

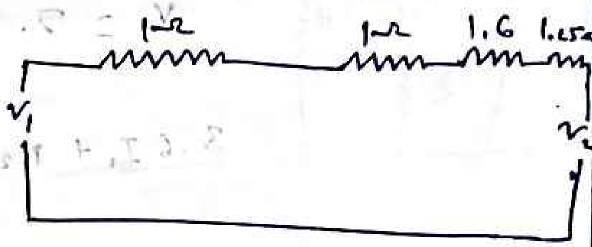
$$R_a = \frac{3 \times 4}{3+4+5} = 1\,\Omega$$



$$R_b = \frac{4 \times 5}{3+4+5} = 1.6\,\Omega$$

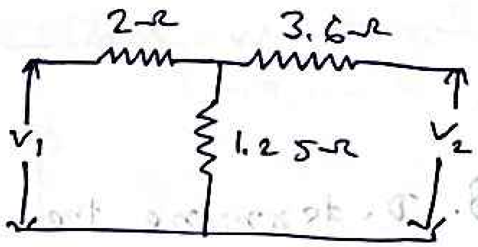
$$R_c = \frac{5 \times 3}{3+4+5} = 1.25\,\Omega$$

By applying KVL



$$V_1 = 2I_1 + 1.25(I_1+I_2)$$

$$V_1 = 3.25 I_1 + 1.25 I_2 \quad \text{--- (1)}$$



By applying KVL

$$V_2 = 3.6 I_2 + 1.25(I_1+I_2) =$$

$$V_2 = 4.85 I_2 + 1.25 I_1 \quad \text{--- (2)}$$

From eqn (1),

$$3.25 I_1 + 1.25 I_2 = V_1$$

$$3.25 I_1 = V_1 - 1.25 I_2$$

$$I_1 = \frac{V_1 - 1.25 I_2}{3.25} \quad (a)$$

From eqn (2)

$$1.25\left(\frac{V_1 - 1.25 I_2}{3.25}\right) + 4.85 I_2 = V_2$$

$$\frac{1.25 V_1 - 1.56 I_2}{3.25} + 4.85 I_2 = V_2$$

$$1.25 V_1 - 1.56 I_2 + 15.76 = 3.25 V_1$$

$$2 V_1 + 14.22 I_2 =$$

By comparison the generalised eqn

$$A = 2, \quad B = -14.2$$

From

$$V_1 = 2.6 V_2 - 11.36 I_2$$

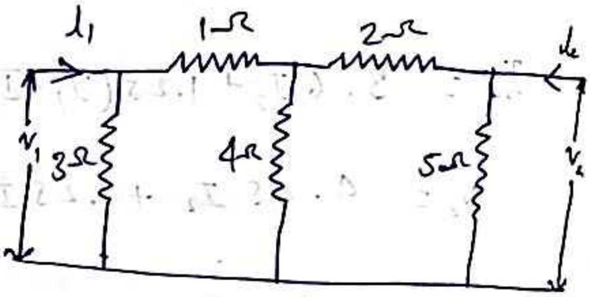
$$3.6 I_1 + 1.25 (I_1 + I_2) v = v_2$$

Q. Determine the

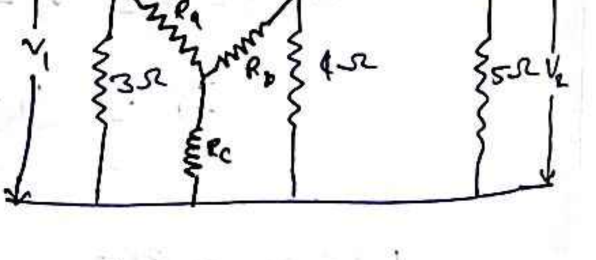
(1) Z parameters

(2) Y parameters

(3) ABCD parameters



Detemine the z parameters following the given circuit



$$R_a = \cancel{\frac{1\times3 + 1\times4 + 4\times3}{7+3+4}}$$

$$= \cancel{2.3}$$

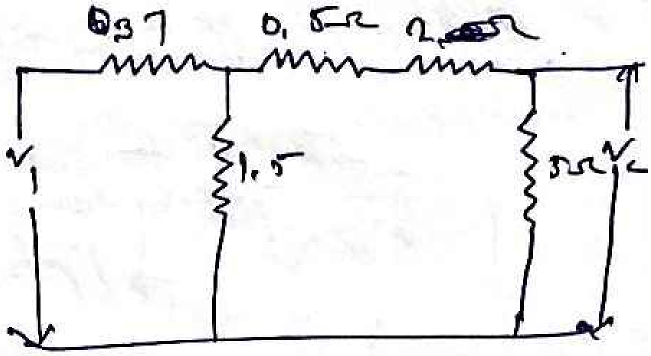
$$R_b = \cancel{1\times3+}$$

$$R_a = \frac{1\times3}{1+3+4} = 3/8 = 0.37\Omega$$

$$b = \frac{1\times4}{1+3+4} = 4/8 = 0.5\Omega$$

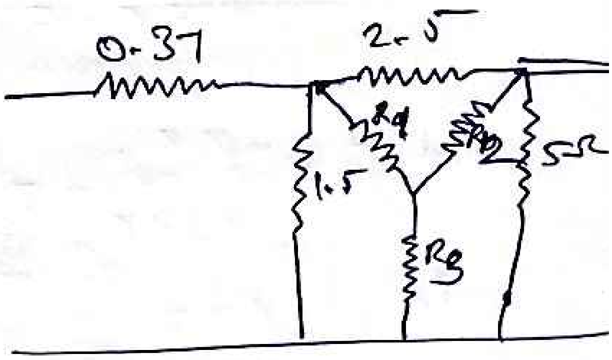
$$c = \frac{4\times3}{1+3+4} = 12/8 = 3/2 = 1.5\Omega$$

$$R_1 = \frac{1.5 \times 2.5}{1.5 + 2.5 + 5} = 0.416\,\Omega$$



$$R_2 = \frac{2.5 \times 5}{1.5 + 2.5 + 5} = 1.389\,\Omega$$

$$R_3 = \frac{5 \times 1.5}{1.5 + 2.5 + 5} = 0.83\,\Omega$$



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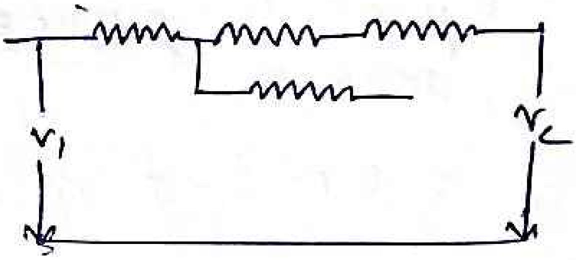
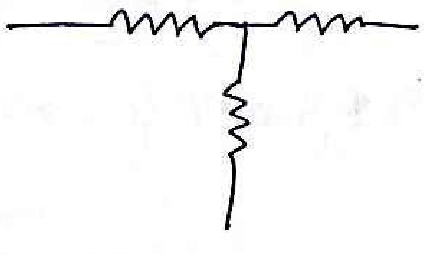
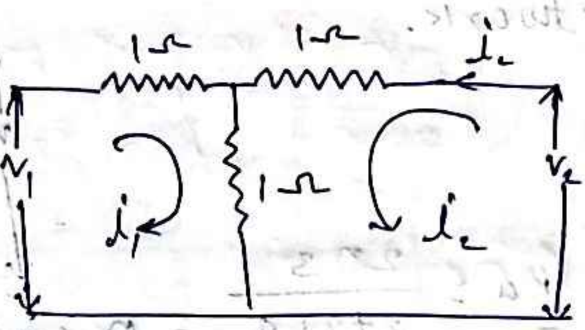




11(a) Determine inverse ABCD parameters for the given network.



By applying KVL for loop ①

$$i_1 + 1(i_1 + i_2) = V_1$$

$$2i_1 + i_2 = V_1 \quad — ①$$

By applying KVL for loop ②

$$i_2 + (i_2 + i_1) = V_2$$

$$i_1 + 2i_2 = V_2 \quad — ②$$

from eqn ①,

$$i_2 = V_1 - 2i_1 \quad — ③$$

comparing eqn with generalised eqn then

$$\boxed{C' = 1, \text{ and } D' = 2}$$

~~fromer~~ By substituting eqn ③ in eqn ②

$$i_1 + 2(V_1 - 2i_1) = V_2$$

$$i_1 + 2V_1 - 2i_1 = V_2$$

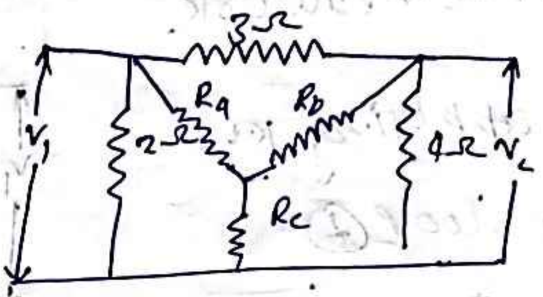
$$2V_1 - i_1 = V_2$$

$$\boxed{A' = 2, \quad B' = 1}$$

$A' = 2$, $B' = 1\,\Omega$

$C' = 1\,\mho$

Q. Calculate A' B' C' D' parameters for the given network.

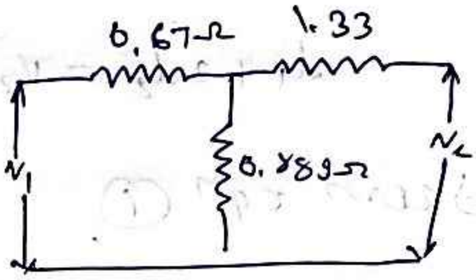


$$R_a = \frac{2 \times 3}{2+3+4} = 0.67\,\Omega$$

0.50 62

$$R_b = \frac{3 \times 4}{2+3+4} = 0.85$$

$$R_c = \frac{4 \times 2}{2+3+4} = 0.57$$



By applying KVL for loop ①,

$$0.67\, i_1 + 0.889(i_1 + i_2) = V_1$$

$$1.559\, i_1 + 0.889\, I_2 = V_1 \quad \text{--- ①}$$

By applying KVL for loop ②

$$1.33\, i_2 + 0.889(i_2 + i_1) = V_2$$

$$0.889\, i_1 + 2.219\, i_2 = V_2 \quad \text{--- ①}$$

from eqn ①,

$$0.889\, I_2 = V_1 - 1.559\, i_1$$

$$I_2 = \frac{V_1 - 0.559\, i_2}{0.889} \quad \text{--- (iii)}$$

comparing eqn with generallised b/w 2 parameters.

$$C' = 1.126, \quad D' = \cancel{0.50}\ 1.74\,\mho$$

substituting eqn (3) in eqn (2)

$$\cancel{1.33 I_2} +$$

$$0.889 I_1 + 2.219\left(\frac{V_1 - 0.559 I_1}{\cancel{0.889}\ 0.889}\right)$$

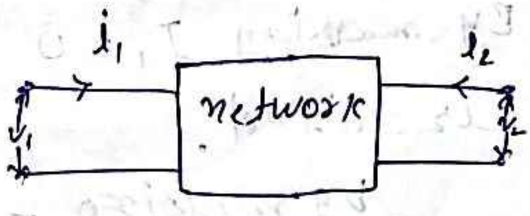
$$= 0.889 I_1 + \frac{2.219}{0.889} V_1 - \frac{2.219 \times 0.559 I_1}{0.889}$$

$$= 2.49 V_1 - 0.506 I_1$$

Comparing

$$= \quad A^1 = 2.49\mho, \quad B = 0.506\mho$$

Let us consider a networ with two por terminal (1-1'), (2-2'). The (1-1') port terminal the $V_1 I_1$ and (2 2') port terminal are $V_2 I_2$. In Hybridge parameter the voltage at (1-1') and current at (2-2') are dependent variable Then the standard eqn of H-parameters are given by.



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

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

$h_{11}, h_{12}, h_{21}, h_{22}$ are called Hybrid parameters

In matrix form

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

Procedure :-

by making $V_2 = 0$ i.e. eq^n (2-2') port is short circuited.

$$V_1 = h_{11} I_1$$

$$\boxed{h_{11} = \frac{V_1}{I_1} \Big/ V_2 = 0}$$

h_{11} is called as short circuit input impedance.

By substituting $V_2 = 0$ in eq^n 2

$$I_2 = h_{21} I_1$$

$$\boxed{h_{21} = \frac{I_2}{I_1} \Big/ V_2 = 0}$$

h_{21} is called as short circuit forward current gain.

By making $I_1 = 0$ i.e (1-1') port is open circuited.

by making $I_1 = 0$ in eq^n 1

$$V_1 = h_{12} V_2$$

$$\boxed{h_{12} = \frac{V_1}{V_2} \Big/ I_1 = 0}$$

h_{12} is called as open circuit reviers voltag ~~be~~ gain.

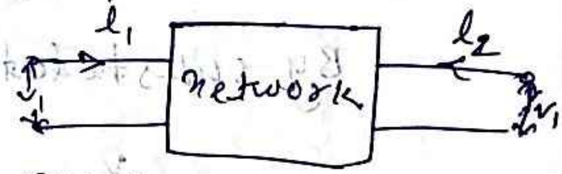
By substituting $I_1 = 0$ in eqn (2) then,

$$I_2 = h_{22} V_2$$

$$\boxed{h_{22} = \frac{I_2}{V_2} \Big/ I_1 = 0}$$

h_{22} is called as open circuit output admitance.

* INVERSE PARAMETER or g parameters



let us consider a two port network with input terminal I_1 V_1 at (1-1') and o/p terminals V_2 I_2 at (2-2') to calculate g parameter for the given network.

Then current at (1-1') and voltage at (2-2') are dependent variable then the standard eqn of g parameter are given by

$$I_1 = g_{11} V_1 + g_{12} I_2 \quad \text{—— (1)}$$

$$V_2 = g_{21} V_1 + g_{22} I_2 \quad \text{—— (2)}$$

where, $g_{11}, g_{12}, g_{21}, g_{22}$ or ~~are calle~~ invers hybrid parameter.

In matrix form:-

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

* produceste

By making $I_2 = 0$ it (2-2') port is open circuited.

$$I_1 = g_{11} V_1$$

$$\boxed{g_{11} = \frac{I_1}{V_1} / I_2 = 0}$$

g_{11} is called open circuit input admittance.

By substituting $I_2 = 0$ in eqn (2)

$$V_2 = g_{21} V_1$$

$$\boxed{g_{21} = \frac{V_2}{V_1} / I_2 = 0}$$

g_{21} is called as open circuit gain.

By making $V_1 = 0$ i.e port (1-1') is short circuited.

the substituting $V_1 = 0$

$$I_1 = g_{12} I_2$$

$$g_{12} = I_1 / I_2 / V_1 = 0$$

g_{12} is called short circuit reverse current gain.

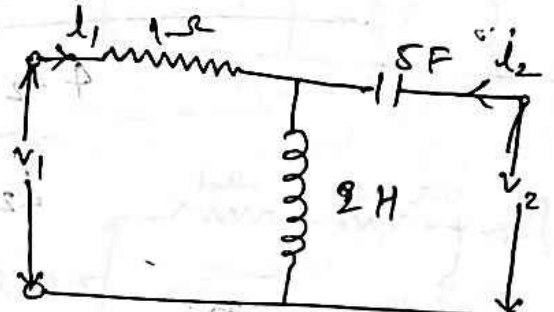
By substituting $v_1 = 0$ in eqn ②

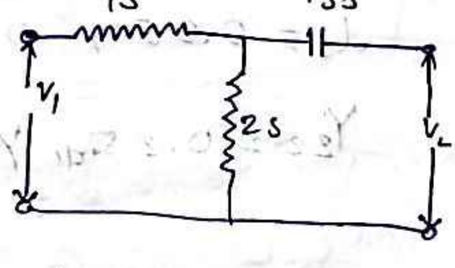
$V_2 = g_{22} I_2$

$$\boxed{g_{22} = \frac{V_2}{I_2} \Big/ V_1 = 0}$$

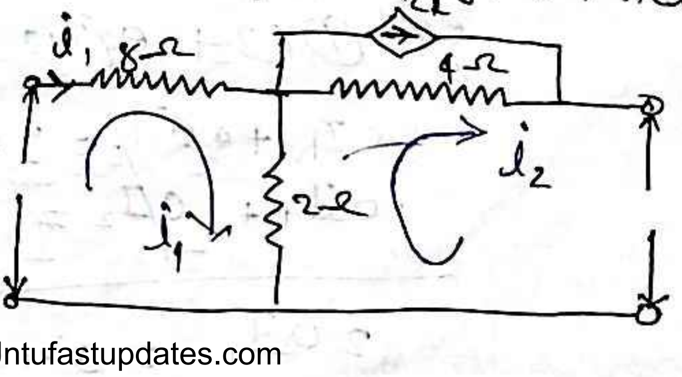
g_{22} is called is short circuit output impedance.

* Calculate Z parameter for the given network.





Obtain Y-Parameters for the given network



By applying KVL for loop ①

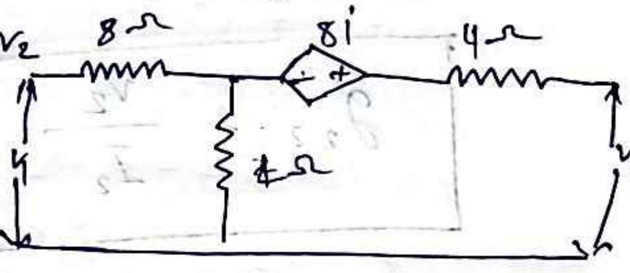
$$8 i_1 + 2(I_1 + I_2) = V_1$$

$$10 i_1 + 2 i_2 = V_1 \quad \text{—— ①}$$

By applying KVL for loop ②

$$2(i_1 + i_2) + 4 i_2 + 8 i_1 = V_2$$

$$10 i_1 + 6 i_2 = V_2 \quad \text{—— ②}$$



eqn ① + eqn ⑪

$$10 i_1 + 2 i_2 = V_1$$
$$10 i_1 + 6 i_2 = V_2$$
$$- \qquad - \qquad -$$

$$4 i_2 = V_1 - V_2$$

$$i_2 = 0.25 V_1 - 0.25 V_2$$

comparing eqn with general lised between

$$i_2 = 0.25 V_1 - 0.25 V_2$$

$$Y_{22} = 0.25, \quad Y_{21} = 0.25 \, \mho$$

Again,

eqn ① × 3 + eqn ②

$$30 I_1 + 6 I_2 = 3 V_1$$
$$10 I_1 + 6 I_2 = V_2$$
$$- \qquad - \qquad -$$

$$20 I_1 = 3V_1 - V_2$$

$$I_1 = \frac{3}{20} V_1 - \frac{1}{20} V_2$$

$$= 0.15V, -0.05$$

comparision eqn with generalised eqn

$$Y_{11} = 0.15 \mho$$

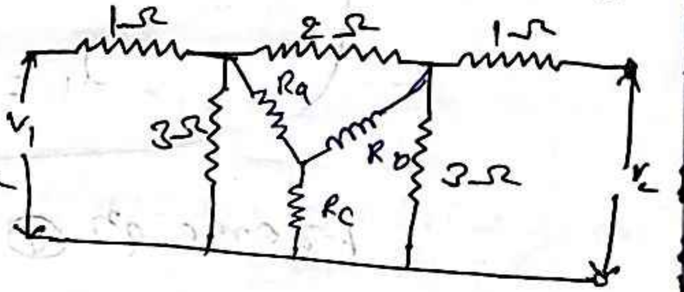
$$Y_{12} = -0.05 \mho$$

$$Y_{21} = 0.25 \mho$$

$$Y_{22} = 0.25$$

18/09/19

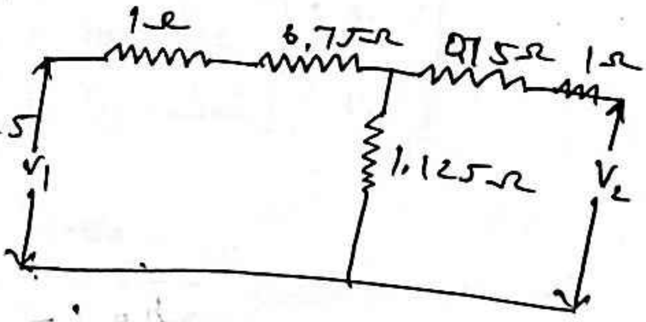
Q. Determine h-parameter for the given circuit



$$R_a = \frac{2 \times 3}{2+3+3} = 0.75\Omega$$

$$R_b = \frac{2 \times 3}{2+3+3} = 0.75$$

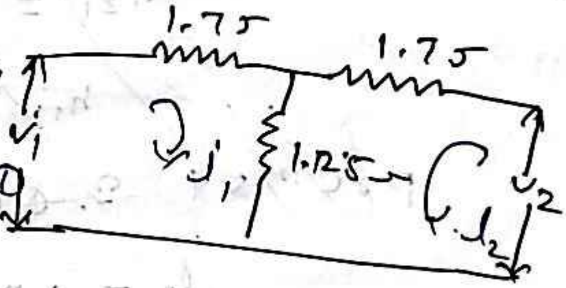
$$R_c = \frac{3 \times 3}{2+3+3} = 1.125$$



Apply KVL loop ①

$$1.75 I_1 + 1.125(I_1+I_2) = V_1$$

$$2.875 I_1 + 1.125 I_2 = V_1 \quad \text{—①}$$



By apply KVL loop ②

$$1.75 I_2 + 1.125(I_2+I_1) = V_2$$

$$1.125 I_1 + 2.875 I_2 = V_2 \quad \text{—— ②}$$

The generalised eqn b/w h-parameters

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

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

comparing eqn with standard equation

frome eqn (1),

$$\boxed{\begin{aligned} 2.875 I_1 + 1.75 I_2 &= V_1 \\ I_1 &= \frac{V_1 - 1.75 I_2}{2.875 I_1} \\ I_1 &= 0.347 V_1 - 0.608 I_2 \end{aligned}}$$

frome eqn (2)

$1.125 I_1 + 2.875 I_2 = V_2$

$2.875 I_2 = V_2 - 1.125 I_1$

$I_2 = 0.347 V_2 - 0.391 I_1$

~~$h_{21} = 0.347$, $h_{22} = 0.391$~~

~~$h_{11} = 2.875$, $h_{12} = 1.125$~~

~~frome eqn~~ $\cancel{2.875 I_1}$

$I_2 = -0.391 I_1 + 0.347 V_2$

$h_{21} = -0.391$, $h_{22} = 0.347$

$h_{11} = 2.$

* Relation between Z-parameters and Y-parameters

Let us consider the standard eqn of Z-parameter

$$V_1 = Z_{11} I_1 + Z_{12} I_2 \quad \text{--- (1)}$$

$$V_2 = Z_{21} I_1 + Z_{22} I_2 \quad \text{--- (2)}$$

Let us consider the standard equation of Y-parameters

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

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

The ~~ma~~ Y-parameters in matrix form is given by,

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

By using cramers ~~rote~~ rule

$$V_1 = \frac{\begin{vmatrix} I_1 & Y_{12} \\ I_2 & Y_{22} \end{vmatrix}}{\begin{vmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{vmatrix}} = \frac{Y_{22} I_1 - Y_{12} I_2}{\Delta Y} \quad \text{--- (3)}$$

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

By comparing ③ & ④ with ① & ②

$$z_{11} = \frac{Y_{22}}{\Delta Y}, \quad z_{12} = -\frac{Y_{12}}{\Delta Y}$$

$$z_{21} = \frac{-Y_{21}}{\Delta Y}, \quad z_{22} = \frac{Y_{11}}{\Delta Y}$$

Q. For a given Y-matrix $Y_{11} = 3\,℧$, $Y_{12} = 1\,℧$, $Y_{21} = 2\,℧$, $Y_{22} = 1\,\Omega$. Find the (1) ~~admittance~~ (2) impedance matrix (ii) Find the product of ΔY and ΔZ

$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 3 & 1 \\ 2 & 1 \end{bmatrix} = \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} \qquad \begin{vmatrix} 3 & 1 \\ 2 & 1 \end{vmatrix}$$

By using cramers rule:-

$$3-2 \Rightarrow 1$$

$$V_1 = \frac{\begin{vmatrix} I_1 & 1 \\ I_2 & 1 \end{vmatrix}}{\begin{vmatrix} 3 & 1 \\ 2 & 1 \end{vmatrix}}$$

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

$$\boxed{V_1 = I_1 - I_2} \qquad \Delta Y = 1$$

$$V_2 = \frac{\begin{vmatrix} 3 & I_1 \\ 2 & I_2 \end{vmatrix}}{\begin{vmatrix} 3 & 1 \\ 2 & 1 \end{vmatrix}}$$

$$\boxed{V_2 = \frac{3I_2 - 2I_1}{}} = \Delta Y = 1$$

* Expression of Y parameter in terms of Z parameter,

Let us consider the standard equation Z- parameters

$$I_1 = Z_{11} V_1 + Z_{12} V_2 \quad \text{--- (1)}$$

$$I_2 = Z_{21} V_1 + Z_{22} V_2 \quad \text{--- (2)}$$

Let us consider the standard equation of Y parameter

$$I_1 = Y_{11} V_1 + Y_{12} V_2 \quad \text{--- (1)}$$

$$I_2 = Y_{21} V_1 + Y_{22} V_2 \quad \text{--- (2)}$$

Then the Z- parameter in form is given by,

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

By applying cramers rule :-

$$I_1 = \frac{\begin{vmatrix} V_1 & Z_{12} \\ V_2 & Z_{22} \end{vmatrix}}{\begin{vmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{vmatrix}} = \frac{Z_{22} V_1 - Z_{12} V_2}{\Delta Z}$$

$$= \frac{Z_{22}}{\Delta Z} V_1 - \frac{Z_{12}}{\Delta Z} V_2 \quad \text{--- (3)}$$

$$I_2 = \frac{\begin{vmatrix} Z_{11} & V_1 \\ Z_{21} & V_2 \end{vmatrix}}{\begin{vmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{vmatrix}} = \frac{Z_{11} V_2 + Z_{21} V_1}{\Delta Z}$$

$$= \frac{Z_{11}}{\Delta Z} V_2 - \frac{Z_{21}}{\Delta Z} V_1 \quad (4)$$

By comparing eqn ③ & ④ with ① & ②
then,

$$Y_{11} = \frac{Z_{22}}{\Delta Z} \quad Y_{12} = -\frac{Z_{12}}{\Delta Z}$$

$$Y_{21} = -\frac{Z_{21}}{\Delta Z}, \quad Y_{22} = \frac{Z_{11}}{\Delta Z}$$

Q. The Z-parameter of two port network $Z_{11} = 5\Omega$, $Z_{12} = 4\Omega$, $Z_{22} = 10\Omega$, $Z_{21} = 5\Omega$ calculate Y-parameter,

$$Y_{11} = \frac{10}{30} = \frac{1}{3} = 0.33$$

$$Y_{12} = -\frac{4}{30} = 0.133$$

$$Y_{21} = \frac{5}{30} = \frac{1}{6} = 0.167.$$

$$Y_{22} = \frac{5}{30} = 0.167$$

Q. A two port network is desicribed by $V_1 = I_1 + 2I_2$, $V_2 = 2I_1 + 3I_2$ Determine the admitance matrix

Given that,

$$V_1 = I_1 + 2I_2 \quad — ①$$

$$V_2 = 2I_1 + 3I_2$$

$$Z_{11} = 1, \quad Z_{12} = 2$$

$$Z_{21} = 2, \quad Z_{22} = 3$$

$Y_{11} = -\frac{3}{1} = -3$ $\qquad \begin{vmatrix} 1 & 2 \\ 2 & 3 \end{vmatrix} = -1$

$Y_{12} = -\frac{2}{1} = -2$

$Y_{21} = -\frac{2}{1} = -2$

$Y_{22} = -\frac{1}{1} = -1$

* Interconnection of two port network

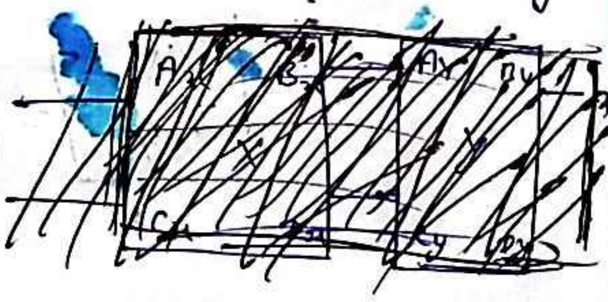
(i) Casaked connecation of two port network

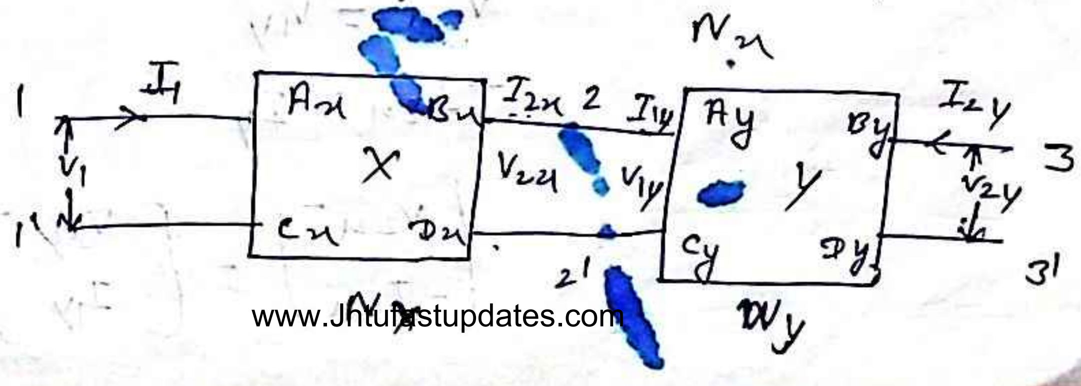
(ii) Series ,, ,, ,, ,, ,,

(iii) Parallel ,, ,, ,, ,, ,,

* ~~Caseses~~ cascad connection of two port network :-

let us consider to two por network Nx and Ny which are connected in casceed connecation with port voltage and current





Then the standard equation for the network N_x ~~netw~~ is given by,

$$V_1 = A_x V_{2x} - B_x I_{2x}$$

$$I_1 = CV_2 - DI_2$$

Then the ABCD parameters in materix form is given by,

$$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} A_x & B_x \\ C_x & D_x \end{bmatrix} \begin{bmatrix} V_{2x} \\ -I_{2x} \end{bmatrix} \quad — (1)$$

The standard equation of ABCD parameters for N_y network is given by,

$$V_{1y} = A_y V_{2y} - B_y I_{2y}$$

$$I_{1y} = C_y V_{2y} - D_y I_{2y}$$

Then the ABCD parameter in materix form is given by,

$$\begin{bmatrix} V_{1y} \\ I_{1y} \end{bmatrix} = \begin{bmatrix} A_y & B_y \\ C_y & D_y \end{bmatrix} \begin{bmatrix} V_{2y} \\ -I_{2y} \end{bmatrix} \quad — (2)$$

$$V_{2x} = V_{1y}$$

$$-I_{2x} = I_y$$

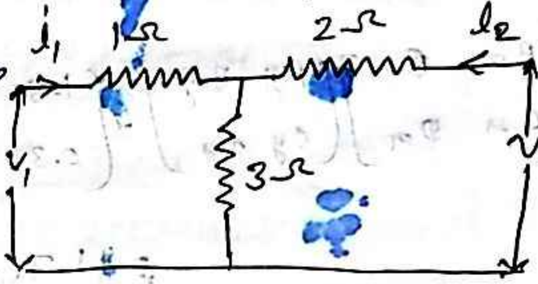
$$\begin{bmatrix} V_{2x} \\ -I_{2x} \end{bmatrix} = \begin{bmatrix} V_{1y} \\ I_{1y} \end{bmatrix}$$

$$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} A_x & B_x \\ C_x & D_x \end{bmatrix} \begin{bmatrix} A_y & B_y \\ C_y & D_y \end{bmatrix} \begin{bmatrix} V_{2y} \\ -I_{2y} \end{bmatrix}$$

$$\boxed{\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} A & B \\ C & D \end{bmatrix} \begin{bmatrix} V_{2y} \\ -I_{2y} \end{bmatrix}}$$

19/04/19

Q. Two identical network shown in fig. are connected is cascade connection calculate the ABCD parameters of the given cascade connection.



By applying KVL for loop ①,

$$V_1 = i_1 + 3(i_1 + i_2)$$

$$V_1 = 4i_1 + 3i_2 \quad \text{—— ①}$$

for loop ②,

$$V_2 = 2i_2 + 3(i_2 + i_1)$$

$$V_2 = 3i_1 + 5i_2 \quad \text{—— ②}$$

from eqⁿ ②,

$$3i_1 + 5i_2 = V_2$$

$$3i_1 = V_2 - 5i_2$$

$$i_1 = \frac{1}{3}V_2 - \frac{5}{3}i_2 \quad \text{—— ③}$$

comparing with generalised eqⁿ ③ then,

$$C = 0.33 \qquad D = 1.66$$

From eqⁿ ①,

$$4i_1 + 3i_2 = V_1$$

$$4\left(\frac{1}{3}V_2 - \frac{5}{3}i_2\right) + 3i_2 = V_1$$

Substuting eqn ③ in eqn ①,

$$4\left(\tfrac{1}{3}V_2 - \tfrac{5}{3}I_2\right) + 3I_2 = V_1$$

$$1.33V_2 - 6.66I_2 + 3I_2 = V_1$$

$$1.33V_2 - 3.66I_2 = V_1$$

Comparing with generalised standard eqn

$$A = 1.33, \quad B = 3.66$$

In matrix form

$$\begin{bmatrix} A_x & B_x \\ C_x & D_x \end{bmatrix} = \begin{bmatrix} 1.33 & 3.66 \\ 0.33 & 1.66 \end{bmatrix}$$

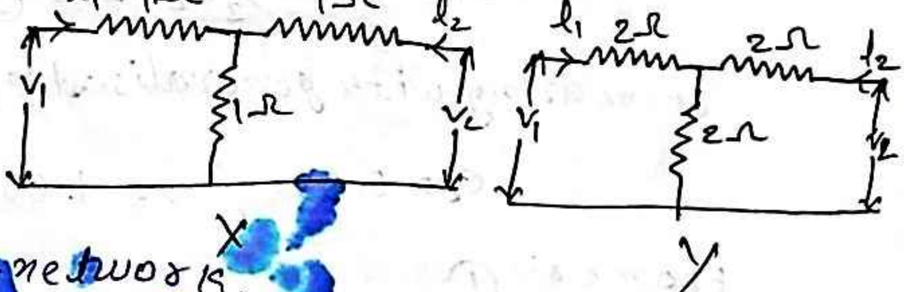
Ay

$$\begin{bmatrix} A_x & B_x \\ C_x & D_x \end{bmatrix}\begin{bmatrix} A_y & B_y \\ C_y & D_y \end{bmatrix} = \begin{bmatrix} 1.33 & 3.66 \\ 0.33 & 1.66 \end{bmatrix}\begin{bmatrix} 1.33 & 3.66 \\ 0.33 & 1.66 \end{bmatrix}$$

$$= \begin{bmatrix} 1.76+1.2 & 4.86+6.07 \\ 0.43+0.54 & 1.2+2.75 \end{bmatrix}$$

$$= \begin{bmatrix} 2.95 & 10.93 \\ 0.97 & 3.95 \end{bmatrix}$$

Q. Two network x and y are connected in cascade connection then calculate ABCD parameters of cascade connection when x and y are cascade



Consider X-network,

By applying KVL for loop ①,

$$I_1 + (I_1 + I_2) = V_1$$

$$2I_1 + I_2 = V_1 \quad —— ①$$

from loop ②,

$$i_2 + (i_2 + i_1) = V_2$$

$$i_1 + 2i_2 = V_2 \quad \text{--- ②}$$

from eqⁿ ②,

$$i_1 + 2i_2 = V_2 \quad \text{--- ③}$$

$$i_1 = V_2 - 2i_2$$

comparing eqⁿ with generalised standard eqⁿ

$$C = 1, \quad D = 2$$

substituting eqⁿ ③ in eqⁿ ①,

$$2(V_2 - 2i_2) + i_2 = V_1$$

$$2V_2 - 3i_2 = V_1$$

comparing eqⁿ with generalised standard eqⁿ

$$A = 2, \quad B = 3$$

In materix form

$$\begin{bmatrix} A_x & B_y \\ C_y & D_x \end{bmatrix} = \begin{bmatrix} 2 & 3 \\ 1 & 2 \end{bmatrix}$$

Again ~~loo~~ consider a y-network.

By applying KVL for loop ①,

$$2i_1 + 2(i_1 + i_2) = V_1$$

$$4i_1 + 2i_2 = V_1$$

for loop ②,

$$2i_2 + 2(i_2 + i_1) = V_2$$

$$2i_1 + 4i_2 = V_2$$

$$2i_1 = V_2 - 4i_2$$

$$I_1 = \frac{1}{2}V_2 - 2I_2 \quad — ③$$

comparing eqn with generalised standard eqn

$$\therefore C = 0.5 \quad , \quad D = 2$$

substituting eqn ③ in eqn ①,

$$4\left(\frac{1}{2}V_2 - 2I_2\right) + 2I_2 = V_1$$

$$2V_2 - 6I_2 = V_1$$

comparing eqn with generalised standard eqn

$$A = 2, \quad B = 6$$

In matrix form,

$$\begin{bmatrix} A_y & B_y \\ C_y & D_y \end{bmatrix} = \begin{bmatrix} 2 & 6 \\ 0.5 & 2 \end{bmatrix}$$

The network interconnection,

$$\begin{bmatrix} A_x & B_x \\ C_x & D_x \end{bmatrix}\begin{bmatrix} A_y & B_y \\ C_y & D_y \end{bmatrix} = \begin{bmatrix} 2 & 3 \\ 1 & 2 \end{bmatrix}\begin{bmatrix} 2 & 6 \\ 0.5 & 2 \end{bmatrix}$$

$$= \begin{bmatrix} 4+1.5 & 12+6 \\ 2+1 & 6+4 \end{bmatrix}$$

$$= \begin{bmatrix} 5.5 & 18 \\ 3 & 10 \end{bmatrix}$$

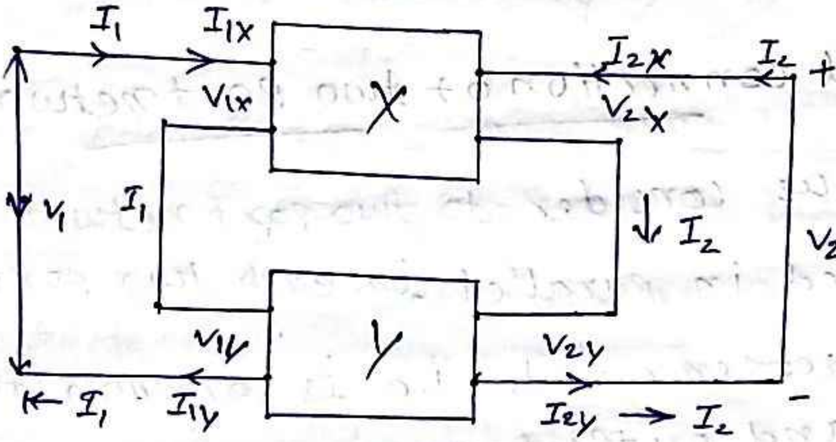
* series connection of two port network :-

The transmission parameter are used to calculate the parameters of cascade connection in the similar away the z-parameters can be

used to decrived the parameters of series connected two port network and Y-parameters can be used to decrived the parameters of parallel connected two port network.

Let us consider x-network then the standard eqn of z-parameters for x-network is given by

$$V_{1x} = z_{11x} I_{1x} + z_{12x} I_{2x}$$



$$V_{2x} = z_{21x} I_{1x} + z_{22x} I_{2x}$$

Let us consider Y-network then the standard eqn of z-parameters for Y-network

$$V_{1y} = z_{11y} I_{1y} + z_{12y} I_{2y}$$

$$V_{2y} = z_{21y} I_{1y} + z_{22y} I_{2y}$$

Then the inter connection of

$$\left\{ \begin{array}{ll} I_{1x} = I_{1y} = I_1 & V_1 = V_{1x} + V_{1y} \\ I_{2x} = I_{2y} = I_2 & V_2 = V_{2x} + V_{2y} \end{array} \right\}$$

$$V_1 = z_{11x} I_1 + z_{12x} I_2 + z_{11y} I_1 + z_{12y} I_2$$

$$V_1 = (z_{11x} + z_{11y}) I_1 + (z_{12x} + z_{12y}) I_2$$

$$V_2 = z_{21x} I_1 + z_{22x} I_2 + z_{21y} I_1 + z_{22y} I_2$$

$$V_2 = (z_{21x} + z_{21y}) I_1 + (z_{22x} + z_{22y}) I_2$$

By comaring the above eqn with standard eqn i.e

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

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

$$Z_{11} = (Z_{11x} + Z_{11y}) \qquad Z_{12} = (Z_{12x} + Z_{21y})$$

$$Z_{21} = (Z_{21x} + Z_{21y}) \qquad Z_{22} = (Z_{22x} + Z_{22y})$$

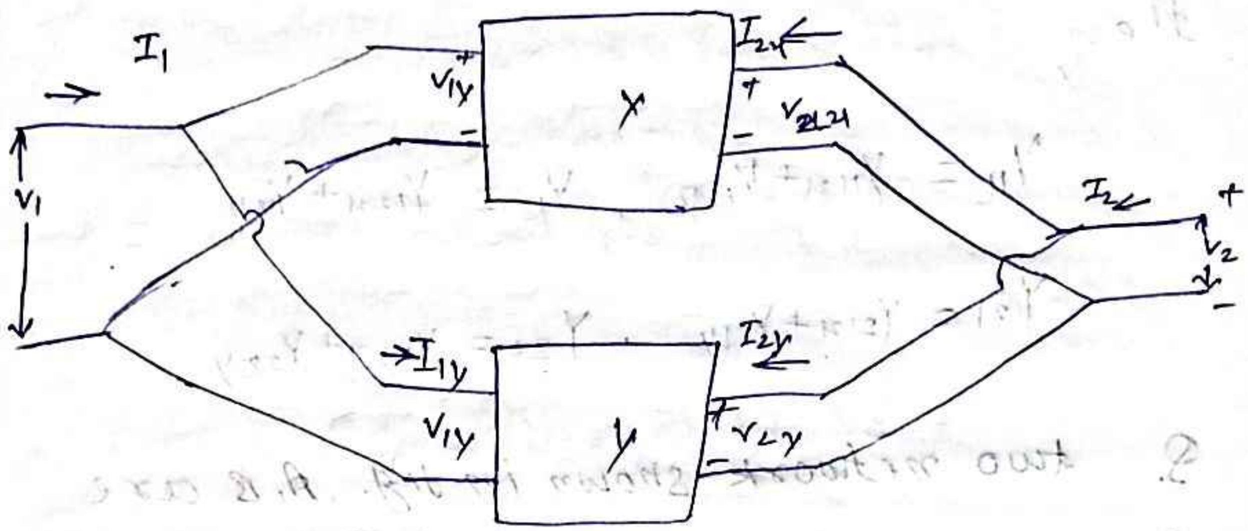
* Parallel connection of two port network:-

Let us consider to two port network connected in parallel in each two port in has a reference node. i.e is common to input and output port. and if the two port ~~of~~ the connected show that the have common reference node then, the parallel connection of two port network can be decrived by using Y-parameters. then the Y-parameter of x-network are given by

$$\left.\begin{aligned} I_{1x} &= Y_{11x} V_{1x} + Y_{12x} V_{2x} \\ I_{2x} &= Y_{21x} V_{1x} + Y_{22x} V_{2x} \end{aligned}\right\} \text{—(1)}$$

Then the standard eqn of Y-parameters for Y-network are given by,

$$\left.\begin{aligned} I_{1y} &= Y_{11y} V_{1y} + Y_{12y} V_{2y} \\ I_{2y} &= Y_{21y} V_{1y} + Y_{22y} V_{2y} \end{aligned}\right\} \text{—(2)}$$



From the interconnection of the two port network

$$\left.\begin{aligned} V_1 &= V_{1x} = V_{1y} \\ V_2 &= V_{2x} = V_{2y} \end{aligned}\right\} \text{——— } (3)$$

$$\left.\begin{aligned} I_1 &= I_{1x} + I_{1y} \\ I_2 &= I_{2x} + I_{2y} \end{aligned}\right\} \text{——— } (4)$$

By substituting eqn (3) & (4) in eqn (1) & (2)

$$I_1 = I_{1x} + I_{1y}$$

$$= Y_{11x} V_1 + Y_{12x} V_2 + Y_{11y} V_1 + Y_{12y} V_2$$

$$I_1 = (Y_{11x} + Y_{11y}) V_1 + (Y_{12x} + Y_{12y}) V_2 \text{ ——— } 5$$

$$I_2 = I_{2x} + I_{2y}$$

$$= Y_{21x} V_1 + Y_{22} V_2 + Y_{21y} V_1 + Y_{22} V_2$$

$$I_2 = (Y_{21x} + Y_{21y}) V_1 + (Y_{22x} + Y_{22y}) V_2 \text{ ——— } (6)$$

The stand eqn of Y parameters are given by

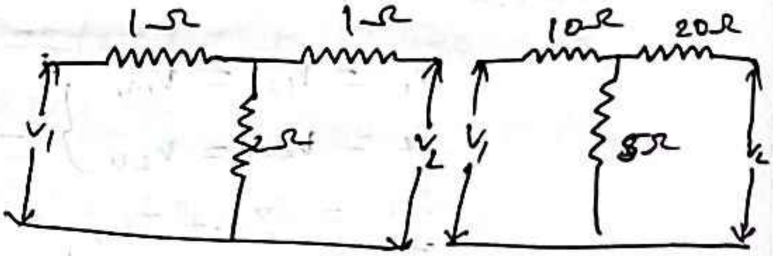
$$\left.\begin{aligned} I_1 &= Y_{11} V_1 + Y_{12} V_2 \\ I_2 &= Y_{21} V_1 + Y_{22} V_2 \end{aligned}\right\} \text{——— } (7)$$

By comparying equations (5), (6) with (7) then,

$$Y_{11} = Y_{11x} + Y_{11y} \quad , \quad Y_{12} = Y_{12x} + Y_{12y}$$

$$Y_{21} = Y_{21x} + Y_{21y} \quad , \quad Y_{22} = Y_{22x} + Y_{22y}$$

Q. two network shown in fig. A, B are connected series obtained the z- parameter of the combination.



(a) (b)

consider (a) network.

By applying KVL for loop, (1)

$$i_1 + 2(i_1 + i_2) = V_1$$

$$3 i_1 + 2 i_2 = V_1 \quad \text{— (1)}$$

from loo (2),

$$i_2 + 2(i_1 + i_2) = V_2$$

$$2 i_1 + 3 i_2 = V_2 \quad \text{— (2)}$$

from eqn (2)

$$z_{11} = 3, \quad z_{12} = 2$$

$$z_{21} = 2, \quad z_{22} = 3$$

consider (b) network of z parameter,

KVL loop ①

$$10I_1 + 5(I_1 + I_2) = V_1$$

$$15I_1 + 5I_2 = V_1 \quad \text{—①}$$

loop ②,

$$20I_2 + 5(I_2 + I_1) = V_2$$

$$5I_1 + 20I_2 = V_2$$

comparing with the eqn standard eqn.

$$Z_{11} = 15, \quad Z_{12} = 5,$$

$$Z_{21} = 5, \quad Z_{22} = 25$$

in series interconnection of network.

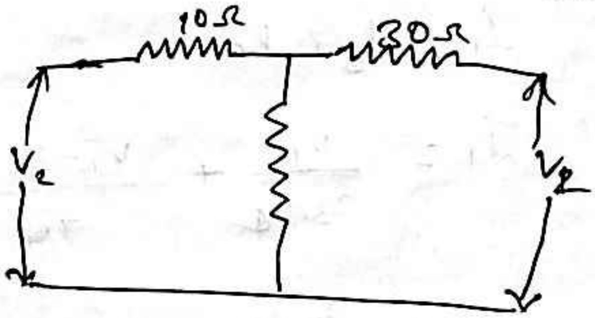
$$Z_{11} = 3 + 15 = 18$$

$$Z_{12} = 2 + 5 = 7$$

$$Z_{21} = 2 + 5 = 7$$

$$Z_{22} = 3 + 25 = 28$$

Q. Two identical sucession of the network shown in fig. are connected in parallel calculate the parameter of the final combination



By applying KVL for loop ①,

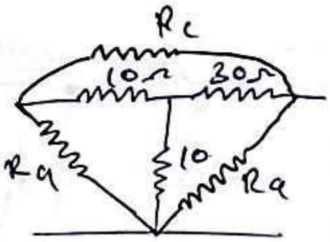
$$10i_1 + 10(i_1+i_2) = V_1$$

$$20i_1 + 10i_2 = V_1 \quad \text{— ①}$$

loop ②,

$$30i_2 + 10(i_2+i_1) = V_2$$

$$10i_1 + 40i_2 = V_2 \quad \text{— ②}$$



$$Ra = \frac{10\times30+30\times10+10\times10}{\cancel{10+10+}30}$$

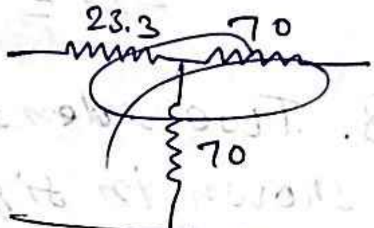
$$= 23.33$$

$$Rb = \frac{10\times30+30\times10+10\times10}{10}$$

$$= 70$$

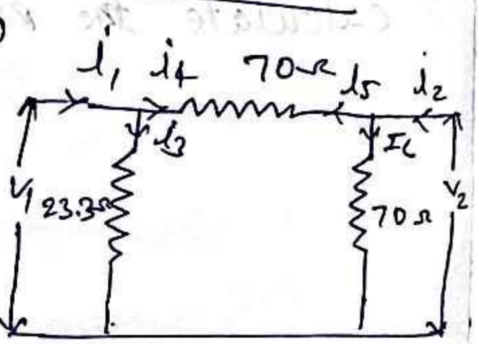
$$Rc = \frac{10\times30+30\times10+10\times10}{10}$$

$$= 70$$



Applying KCL for loop ①

$$i_1 = i_3 + i_4$$



$$i_1 = \frac{V_1}{23.34} + \frac{V_1 - V_2}{70}$$

$$= \frac{(V_1)70 + 23.34V_1 - 23.34V_2}{23.34\times70}$$

$$i_1 = \frac{46.66 V_1 - 23.34 V_2}{1633.8}$$

$$i_1 = 0.0285 V_1 - 0.014 V_2$$

By applying KCL at nod ②

$$i_2 = i_5 + i_6$$

$$i_2 = \frac{V_2}{70} + \frac{V_1 - V_2}{23.33}$$

$$i_2 = \frac{23.34 V_2 + 70 V_1 - 70 V_2}{1633.8}$$

$$= \frac{70 V_1 - 46.34 V_2}{1633.8}$$

$$= 0.0428 V_1 - 0.0285$$

$$Y_{11} = 0.0285 + 0.0285 = 0.057$$

$$Y_{12} = -0.028$$

24/09/19 $Y_{21} = 0.0856$

* Poles and zeros of network function :-

The network function $N(s)$ is given by.

$$N(s) = \frac{P(s)}{Q(s)} = \frac{a_0 s^n + a_1 s^{n-1} + a_2 s^{n-2} + a_3 s^{n-3} - \dots a_{n-1} s + a_n}{b_0 s^m + b_1 s^{m-1} + b_2 s^{m-2} + b_3 s^{m-3} + \dots b_{m-1} s^{m-1} + b_m}$$

where, $a_0, a_1, a_2, a_3, \dots a_n$ are the co-efficients of polynomial of $P(s)$.

$b_0, b_1, b, \dots b$ are the co-efficient of polynomial of $Q(s)$

The given numerator and denominator polynomial $N(s)$ is factorised, then,

$$N(s) = \frac{a(s-z_0)(s-z_1)(s-z_2)\ldots}{b(s-P_0)(s-P_1)(s-P_2)\ldots}$$

here, z_1, z_2, z_3 are known as zero (0) and P_1, P_2, P_3 are known as poles of the network function.

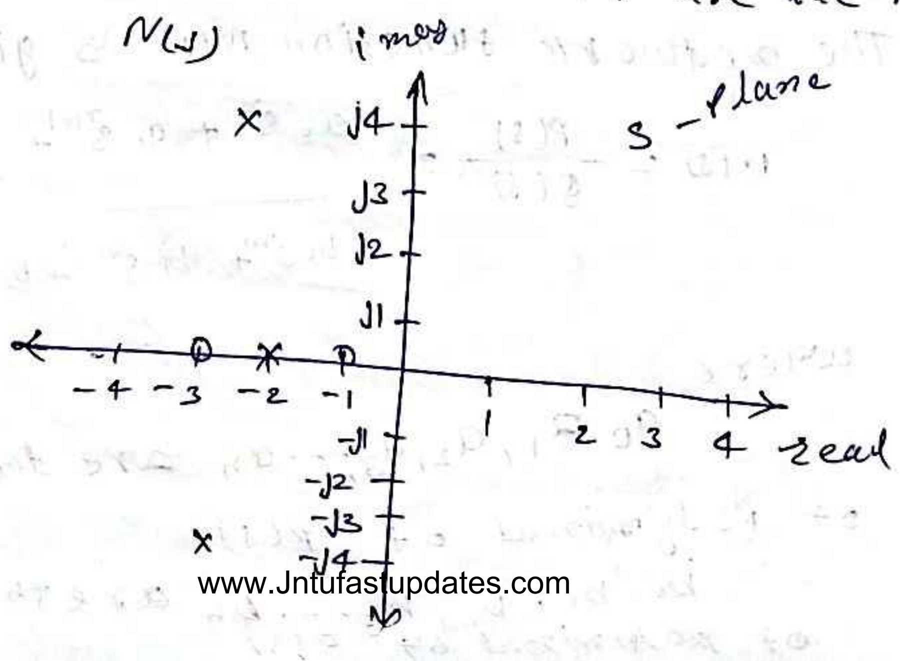
The zeros of the network function are determined zero (0)

The poles of the function are determined by (x)

Ex. $$N(s) = \frac{(s+1)(s+3)}{(s+2)(s+3+j4)(s+3-j4)}$$

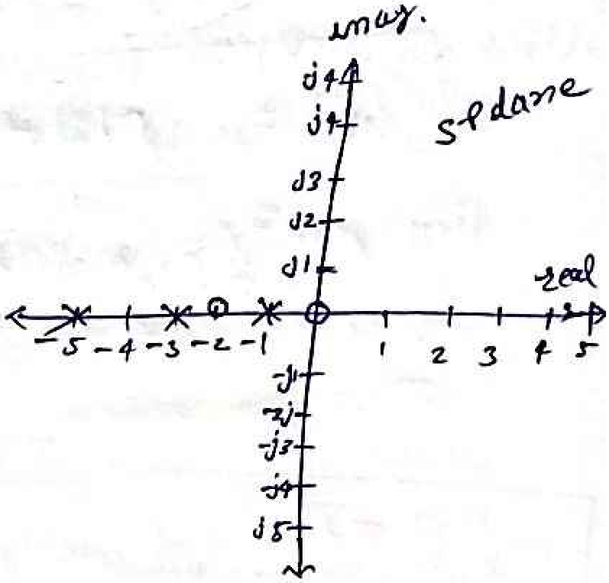
$-1, -3$ are zero's of $N(s)$

then, $-2, -3-j4, -3+j4$ are the poles $N(s)$



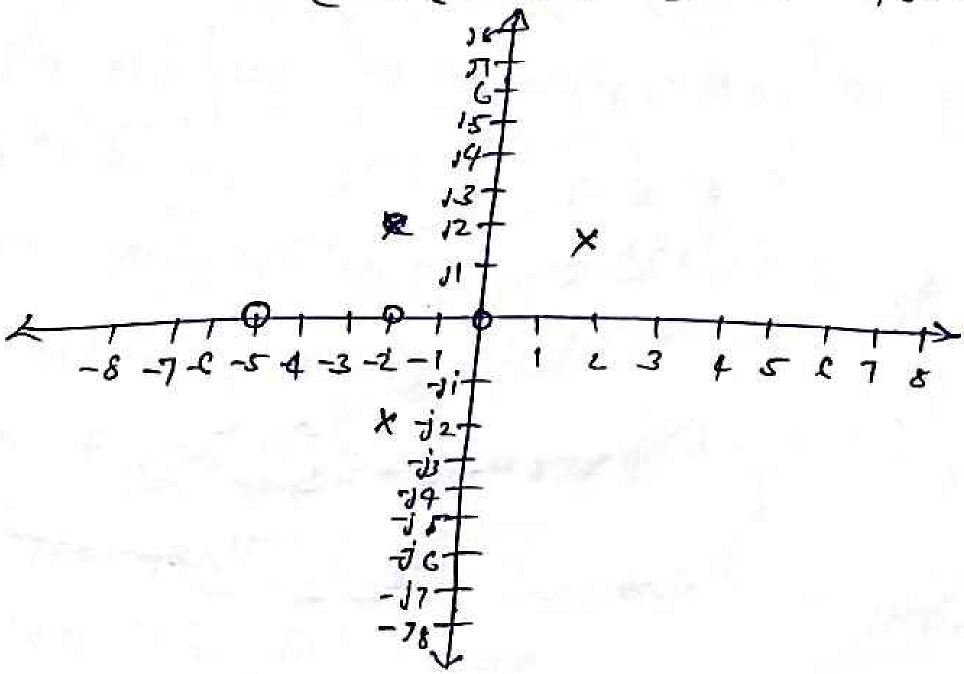
Draw the pole zero diagram for the given network. V(s)

$$V(s) = \frac{s(s+2)}{(s+1)(s+3)(s+5)}$$



For the given network function draw the poles, zero's diags.

$$I(s) = \frac{5s}{(s+1)(s^2+4s+5)}$$



$$= \frac{-4^2 \pm \sqrt{(4)^2 - 4 \cdot 1 \cdot 8}}{2 \cdot 1} = \frac{4 \pm j4}{2}$$

$$\frac{4 \pm \sqrt{16}}{2 \cdot 1} = 2 + j2,\ 2 - j2$$