Two port networks

Q. Define Z-parameters (Impedance parameters) (open Circuit impedance parameters)

Sol: These are also called impedance parameters. These are obtained by expressing voltages at two ports in terms of currents at two ports. Thus I_1 & I_2 are independent variables, while V_1 & V_2 are dependent variables. thus we have

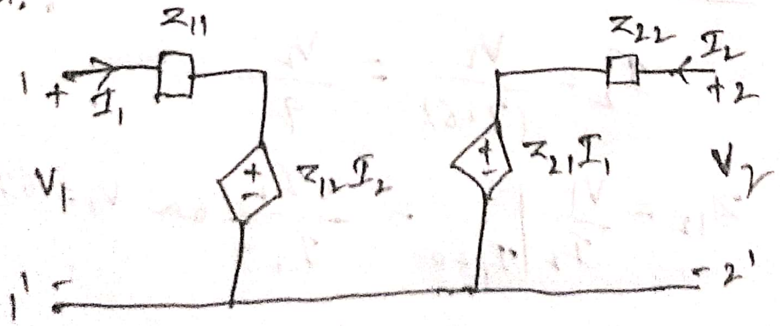
$$V_1 = Z_{11} I_1 + Z_{12} I_2$$
$$V_2 = Z_{21} I_1 + Z_{22} I_2$$

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

$$Z_{11} = \left.\frac{V_1}{I_1}\right|_{I_2=0} (\Omega) \qquad Z_{12} = \left.\frac{V_1}{I_2}\right|_{I_1=0} (\Omega)$$

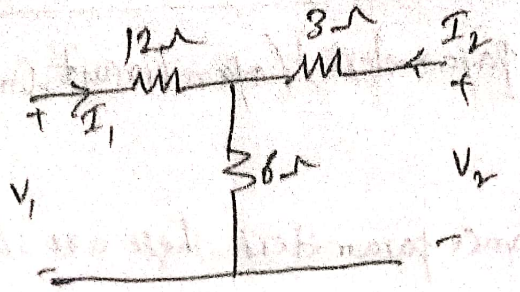
$$Z_{21} = \left.\frac{V_2}{I_1}\right|_{I_2=0} (\Omega) \qquad Z_{22} = \left.\frac{V_2}{I_2}\right|_{I_1=0} (\Omega)$$

These parameters are defined only when the current in one of the ports is zero. This corresponds to the conditions that one of the ports is open circuited. Hence Z-parameters are named as open circuit impedance parameters.

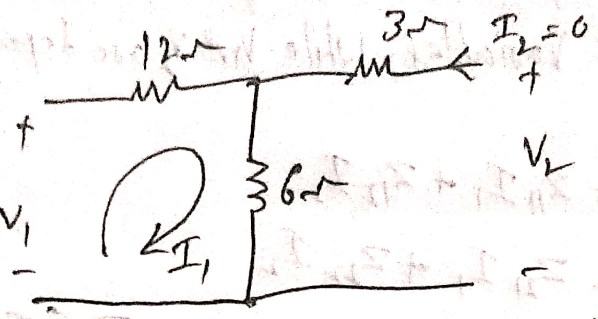


Equivalent network of a two port network in terms of Z-parameters

Q. Find the Z-parameters for the circuit shown in the figure.



Sol: $\underline{I_2 = 0}$

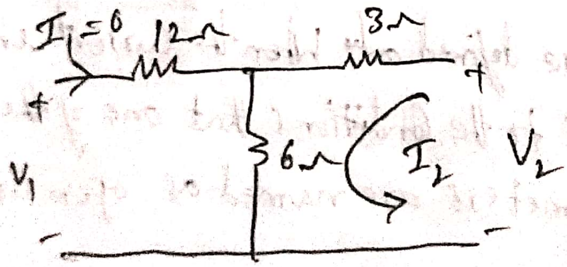


$$I_1 = \frac{V_1}{(12+6)} = \frac{V_1}{18}$$

$$Z_{11} = \left.\frac{V_1}{I_1}\right|_{I_2=0} = \frac{V_1}{\frac{V_1}{18}} = 18\Omega$$

$$Z_{21} = \left.\frac{V_2}{I_1}\right|_{I_2=0} = \frac{6I_1}{I_1} = 6\Omega \quad V_2 = 6I_1$$

$\underline{I_1 = 0}$



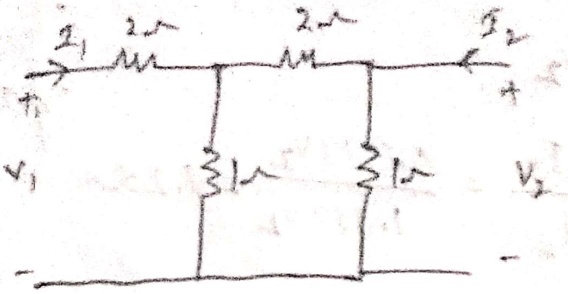
I_2 should always be taken in anticlockwise direction.

$$I_2 = \frac{V_2}{(3+6)} = \frac{V_2}{9}$$

$$Z_{12} = \left.\frac{V_1}{I_2}\right|_{I_1=0} = \frac{6I_2}{I_2} = 6\Omega \quad V_1 = 6I_2$$

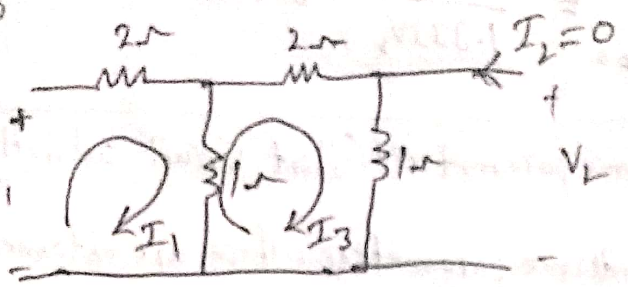
$$Z_{22} = \left.\frac{V_2}{I_2}\right|_{I_1=0} = \frac{V_2}{\frac{V_2}{9}} = 9\Omega$$

Q For the network shown in the figure determine the open circuit impedance parameters.



Sol:

$I_2 = 0$



$(3) I_1 + (-1) I_3 = V_1$

$(-1) I_1 + (4) I_3 = 0$

In calculator for $c_1 = 1$ (Coefficient of V_1)
Attach V_1 in answers for I_1 & I_2

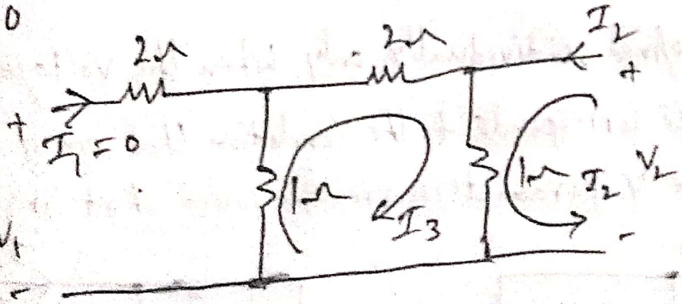
$I_1 = 0.3636 V_1$

$I_3 = 0.090 V_1$

$$Z_{11} = \left.\frac{V_1}{I_1}\right|_{I_2=0} = \frac{V_1}{0.3636 V_1} = 2.75\Omega$$

$$Z_{21} = \left.\frac{V_2}{I_1}\right|_{I_2=0} = \frac{1 I_3}{I_1} = \frac{0.090 V_1}{0.3636 V_1} = 0.247\Omega \qquad V_2 = 1 I_3$$

$I_1 = 0$



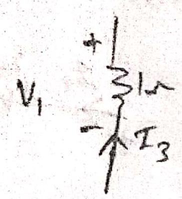
$(4) I_3 + (+1) I_2 = 0$

$(+1) I_3 + (1) I_2 = V_2$

off-diagonal elements are +ve. ∵ I_3 & I_2 are in the same direction in 1Ω

$$I_3 = -0.333\,V_2$$

$$I_2 = 1.333\,V_2$$



$V_1 = -1 I_3$

$$Z_{12} = \left.\frac{V_1}{I_2}\right|_{I_1=0} = \frac{-1 I_3}{I_2} = \frac{0.333\,V_2}{1.333\,V_2} = 0.25\,\Omega$$

$$Z_{22} = \left.\frac{V_2}{I_2}\right|_{I_1=0} = \frac{V_2}{1.333V_2} = 0.75\,\Omega$$

Q. Define Y-parameters (Admittance parameters) (Short Circuit admittance parameters)

Sol: These are also called admittance parameters. These are obtained by expressing currents at two ports in terms of voltages at two ports. Thus, voltages V_1 & V_2 are independent variables, while I_1 & I_2 are dependent variables. We have

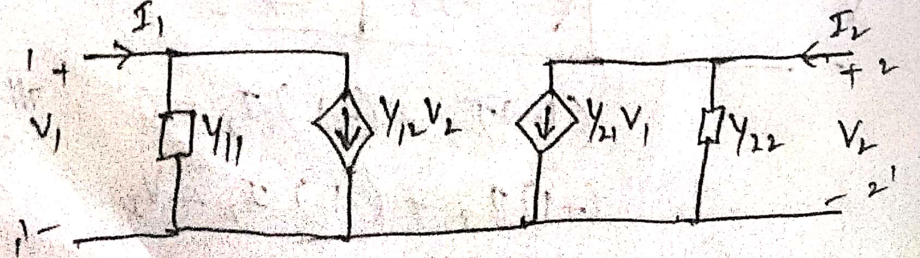
$$I_1 = Y_{11}V_1 + Y_{12}V_2$$
$$I_2 = Y_{21}V_1 + Y_{22}V_2$$

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

$$Y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0} (\mho) \qquad Y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1=0} (\mho)$$

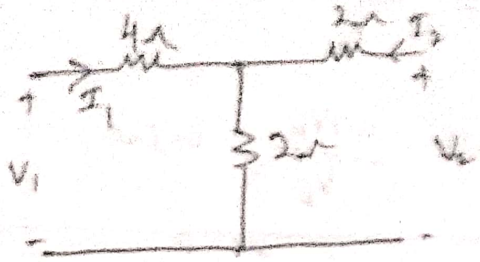
$$Y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0} (\mho) \qquad Y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1=0} (\mho)$$

These parameters are defined individually only when the voltage in any one of the ports is zero. This corresponds to the condition that one of the ports is short circuited. Hence Y-parameters are also called short circuit admittance parameters.

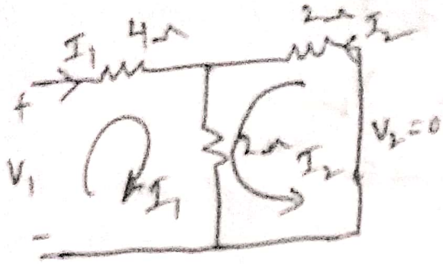


Equivalent network of a two port n/w in terms of Y-parameters

Determine the admittance parameters of the T network shown in figure



Sol: $\underline{V_2 = 0}$



$(6) I_1 + (+2) I_2 = V_1$

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

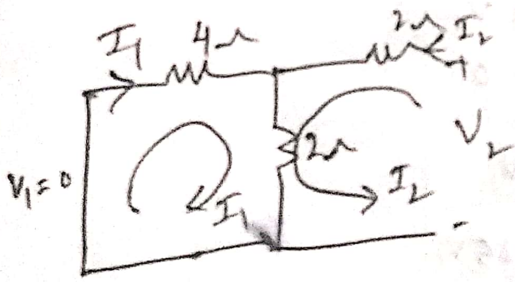
$I_1 = 0.2 V_1$

$I_2 = -0.1 V_1$

$$Y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0} = \frac{0.2 V_1}{V_1} = 0.2 \mho$$

$$Y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0} = \frac{-0.1 V_1}{V_1} = -0.1 \mho$$

$\underline{V_1 = 0}$



$(6) I_1 + (+2) I_2 = 0$

$(+2) I_1 + (4) I_2 = V_2$

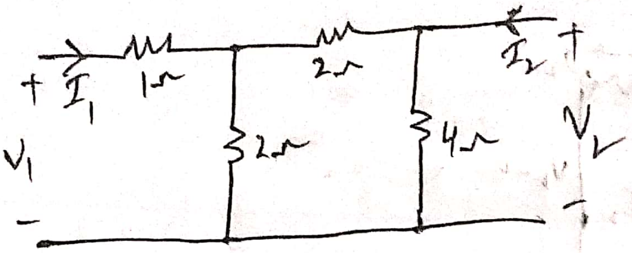
$I_1 = -0.1 V_2$

$I_2 = 0.3 V_2$

$$Y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1=0} = \frac{-0.1V_2}{V_2} = -0.1\,℧$$

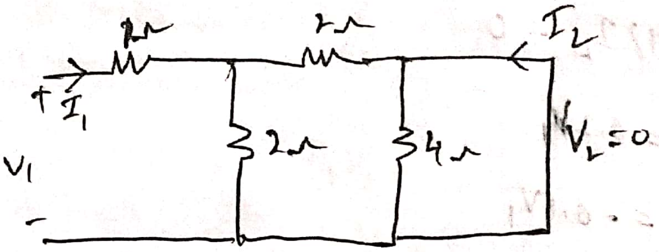
$$Y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1=0} = \frac{0.3V_2}{V_2} = 0.3\,℧$$

Q. Find the Y-parameters for the network shown in figure.

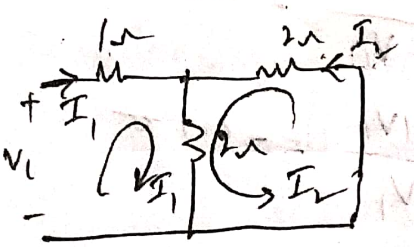


Sol:

$V_2 = 0$



Remove 4Ω
(Short is across 4Ω)



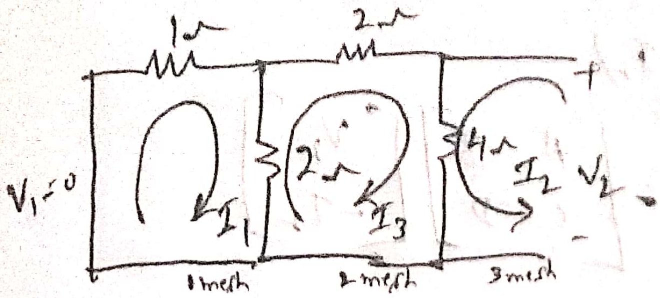
$$(3)I_1 + (+2)I_2 = V_1$$
$$(+2)I_1 + (4)I_2 = 0$$

$$I_1 = 0.5V_1$$
$$I_2 = -0.25V_1$$

$$Y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0} = \frac{0.5V_1}{V_1} = 0.5\,℧$$

$$Y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0} = \frac{-0.25V_1}{V_1} = -0.25\,℧$$

$V_1 = 0$



$$(3)I_1 + (-2)I_3 + (0)I_2 = 0$$

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

$$(0)I_1 + (+4)I_3 + (4)I_2 = V_2$$

$$I_1 = -0.25V_2$$

$$I_3 = -0.375V_2$$

$$I_2 = 0.625V_2$$

$$Y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1=0} = \frac{-0.25V_2}{V_2} = -0.25℧$$

$$Y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1=0} = \frac{0.625V_2}{V_2} = 0.625℧$$

Q. Define ABCD parameters (Transmission parameters) (Chain parameters) (T)

Sol: These parameters are known as transmission parameters. These are generally used in the analysis of power transmission in which the input port is referred as the sending end and the output port is referred as receiving end.

These are obtained by expressing voltage V_1 & current I_1 at input port in terms of voltage V_2 and current I_2 at output port. Thus, voltage V_2 & current I_2 are independent variables while voltage V_1 & current I_1 are dependent variables. Thus we have,

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$$V_1 = AV_2 + B(-I_2)$$

$$I_1 = CV_2 + D(-I_2)$$

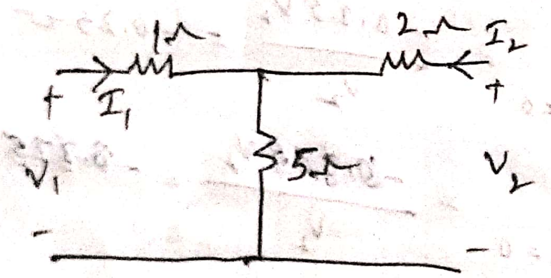
In matrix form
$$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} A & B \\ C & D \end{bmatrix} \begin{bmatrix} V_2 \\ -I_2 \end{bmatrix}$$

$$A = \left.\frac{V_1}{V_2}\right|_{I_2=0} \qquad B = \left.\frac{V_1}{-I_2}\right|_{V_2=0} (\Omega)$$

$$C = \left.\frac{I_1}{V_2}\right|_{I_2=0} (\mho) \qquad D = \left.\frac{I_1}{-I_2}\right|_{V_2=0}$$

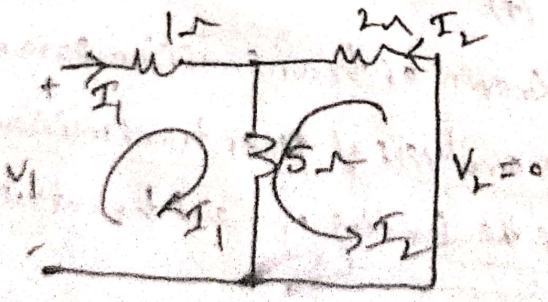
The equivalent circuit of a two port network is not possible in terms of T-parameters.

Q. Find the transmission parameters for the circuit shown in figure.



Sol:

$V_2 = 0$



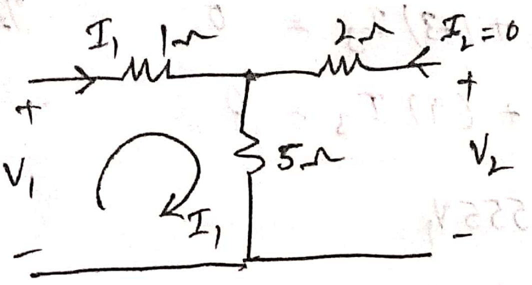
$$(6)I_1 + (+5)I_2 = V_1$$
$$(+5)I_1 + (7)I_2 = 0$$

$$I_1 = 0.411V_1$$
$$I_2 = -0.2941V_1$$

$$B = \left.\frac{V_1}{-I_2}\right|_{V_2=0} = \frac{V_1}{0.2941V_1} = 3.4\,\Omega$$

$$D = \left.\frac{I_1}{-I_2}\right|_{V_2=0} = \frac{0.411V_1}{0.2941V_1} = 1.4$$

$I_2 = 0$

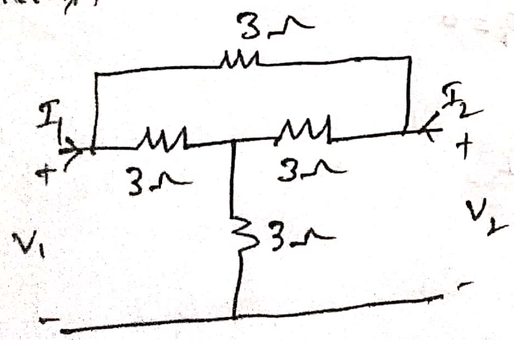


$$I_1 = \frac{V_1}{(1+5)} = \frac{V_1}{6}$$

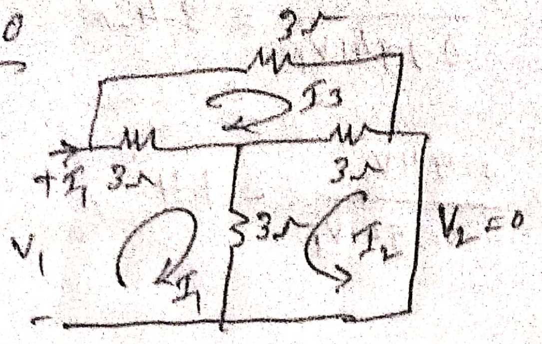
$$A = \left.\frac{V_1}{V_2}\right|_{I_2=0} = \frac{V_1}{5I_1} = \frac{V_1}{5\times\frac{V_1}{6}} = 1.2 \qquad V_2 = 5I_1$$

$$C = \left.\frac{I_1}{V_2}\right|_{I_2=0} = \frac{I_1}{5I_1} = 0.2\,\mho$$

Q. Refer the bridge Circuit shown in the figure. Find the transmission parameters.



Sol: $\underline{V_2 = 0}$



$$(6)I_1 + (+3)I_2 + (-3)I_3 = V_1$$
$$(+3)I_1 + (6)I_2 + (+3)I_3 = 0$$
$$(-3)I_1 + (+3)I_2 + (9)I_3 = 0$$

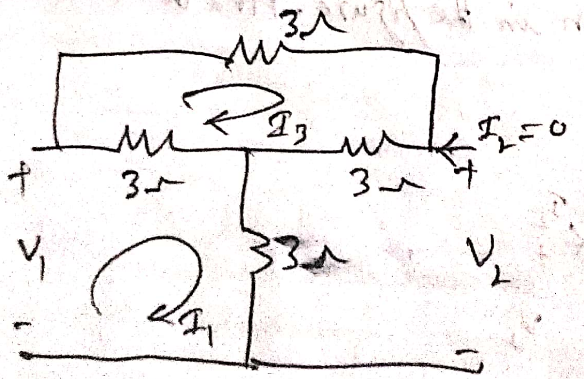
Note the sign for off-diagonal elements

$$I_1 = 0.555V_1$$
$$I_2 = -0.444V_1$$
$$I_3 = 0.333V_1$$

$$B = \left.\frac{V_1}{-I_2}\right|_{V_2=0} = \frac{V_1}{0.444V_1} = 2.25\,\Omega$$

$$D = \left.\frac{I_1}{-I_2}\right|_{V_2=0} = \frac{0.555V_1}{0.444V_1} = 1.25$$

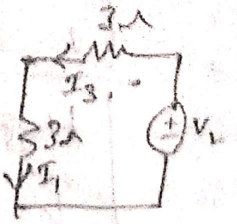
$\underline{I_2 = 0}$



$$(6)I_1 + (-3)I_3 = V_1$$
$$(-3)I_1 + (9)I_3 = 0$$

$$I_1 = 0.2V_1$$
$$I_3 = 0.066V_1$$

$$A = \frac{V_1}{V_2} = \frac{V_1}{3I_1 + 3I_3} = \frac{V_1}{3\times 0.2V_1 + 3\times 0.066V_1}$$



$$A = \frac{V_1}{V_1(3\times 0.2 + 3\times 0.066)} = 1.25$$

$3I_3 + 3I_1 - V_2 = 0$

$V_2 = 3I_1 + 3I_3$

$$C = \left.\frac{I_1}{V_2}\right|_{I_2=0} = \frac{I_1}{3I_1 + 3I_3} = \frac{0.2V_1}{3\times 0.2V_1 + 3\times 0.066V_1}$$

$C = 0.25\ \mho$

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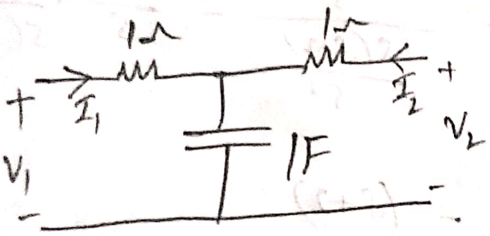
6. Determine the transmission parameters in the s-domain for the network shown in the figure.

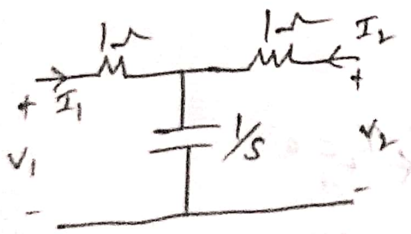


Sol: In s-domain : $L \rightarrow SL \rightarrow S\times 1 = 1S$ — If $L = 1H$, $C = 1F$

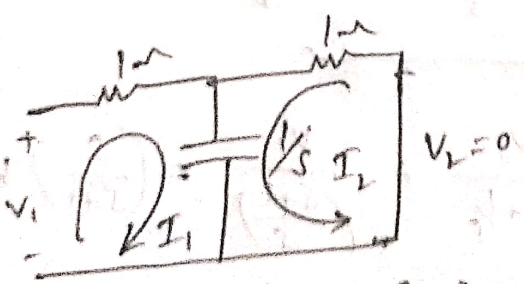
$C \rightarrow \frac{1}{CS} \rightarrow \frac{1}{1\times S} = \frac{1}{S}$

If $L = 2H \rightarrow 2S$

$C = 2F \rightarrow \frac{1}{2S}$



$V_2 = 0$



$(1 + 1/s)I_1 + (1/s)I_2 = V_1$

$(1/s)I_1 + (1 + 1/s)I_2 = 0$

$$I_1 = \frac{\begin{vmatrix} V_1 & \frac{1}{s} \\ 0 & 1+\frac{1}{s} \end{vmatrix}}{\begin{vmatrix} 1+\frac{1}{s} & \frac{1}{s} \\ \frac{1}{s} & 1+\frac{1}{s} \end{vmatrix}} = \frac{V_1\left(\frac{s+1}{s}\right)}{\left(\frac{s+1}{s}\right)^2 - \frac{1}{s^2}}$$

$$I_1 = \frac{V_1\left(\frac{s+1}{s}\right)}{\frac{s^2+2s+1}{s^2} - \frac{1}{s^2}} = \frac{V_1\left(\frac{s+1}{s}\right)}{\frac{s^2+2s+1-1}{s^2}} = V_1\left(\frac{s+1}{s}\right) \times \frac{s^2}{s(s+2)}$$

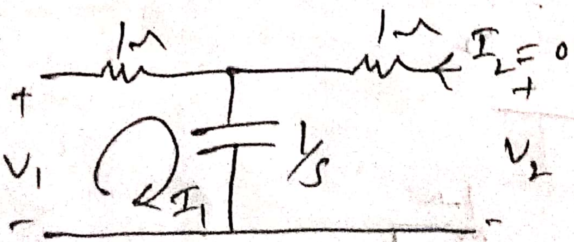
$$I_1 = \frac{(s+1)}{(s+2)} V_1$$

$$I_2 = \frac{\begin{vmatrix} 1+\frac{1}{s} & V_1 \\ \frac{1}{s} & 0 \end{vmatrix}}{\frac{s^2+2s}{s^2}} = \frac{-\frac{V_1}{s}}{\frac{s(s+2)}{s^2}} = \frac{-V_1}{s} \times \frac{s^2}{s(s+2)} = -\frac{1}{(s+2)}$$

$$B = \left.\frac{V_1}{-I_2}\right|_{V_2=0} = \frac{V_1}{\left(\frac{1}{s+2}\right)V_1} = (s+2)$$

$$D = \left.\frac{I_1}{-I_2}\right|_{V_2=0} = \frac{(s+1)}{(s+2)} \times \frac{(s+2)}{1} = s+1$$

$\underline{I_2 = 0}$

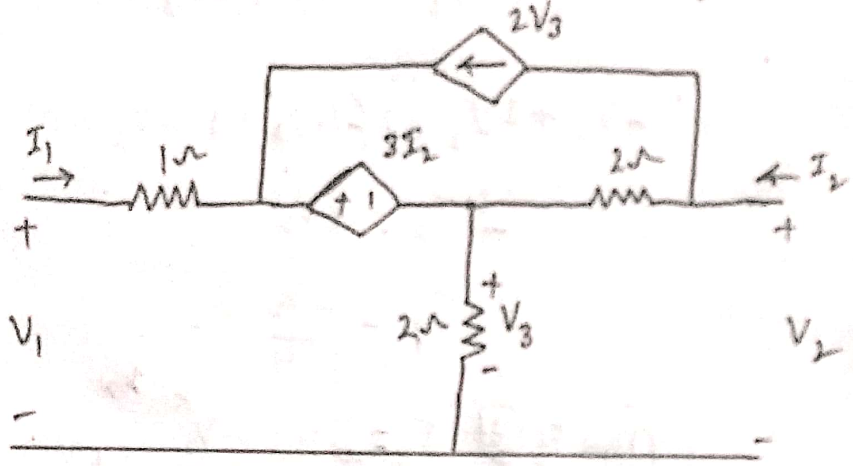


$$I_1 = \frac{V_1}{1+\frac{1}{s}} = \frac{V_1}{\left(\frac{s+1}{s}\right)} = \left(\frac{s}{s+1}\right) V_1$$

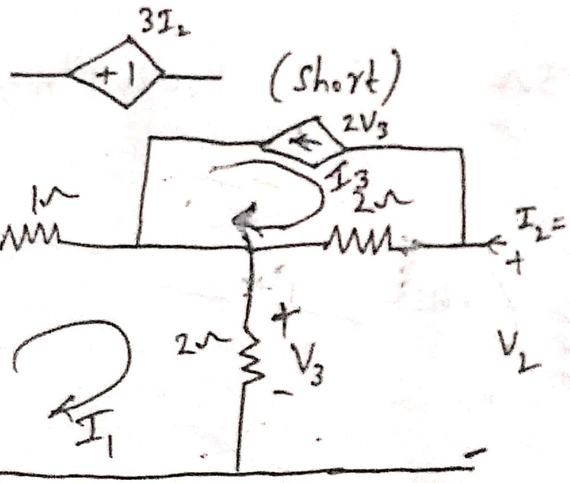
$$A = \left.\frac{V_1}{V_2}\right|_{I_2=0} = \frac{V_1}{\frac{1}{s}I_1} = \frac{V_1}{\frac{1}{s} \times \left(\frac{s}{s+1}\right) V_1} = (s+1) \qquad V_2 = \frac{1}{s} I_1$$

$$C = \left.\frac{I_1}{V_2}\right|_{I_2=0} = \frac{I_1}{\frac{1}{s}I_1} = s$$

For the two port network shown in the figure below find Z parameters



$I_2 = 0$



Control variable

$V_3 = +2I_1$

KCL to Non essential mesh: $I_3 = -2V_3 = -2(+2I_1) = -4I_1$ — (1)

KVL to essential mesh: $-V_1 + 1I_1 + 2I_1 = 0$ — (2)

$3I_1 = V_1$

$I_1 = V_1/3$, $I_3 = \frac{-4V_1}{3}$

$$Z_{11} = \left.\frac{V_1}{I_1}\right|_{I_2=0} = \frac{V_1}{V_1/3} = 3\Omega$$

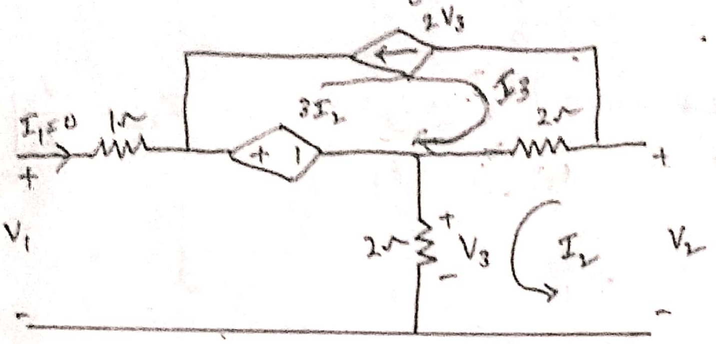
$$Z_{21} = \left.\frac{V_2}{I_1}\right|_{I_2=0} = \frac{2I_1+2I_3}{I_1}$$

KVL to mesh 2 : $-V_2+2I_3+2I_1=0$

$V_2 = 2I_1+2I_3$

$$= \frac{2\times\frac{V_1}{3} + 2\times\frac{-4V_1}{3}}{V_1/3} = \frac{\frac{V_1}{3}(2-8)}{V_1/3} = -6\Omega$$

$\underline{I_1=0}$



$V_3 = 2I_2$

KCL to nonessential mesh: $I_3 = -2V_3 = -2(+2I_2) = -4I_2$ — (3)

KVL to essential mesh: $-V_2+2(I_2+I_3)+2I_2=0$

$$-V_2+2I_2+2I_3+2I_2=0$$

$$-V_2+2I_2+2(-4I_2)+2I_2=0 \qquad \text{from (3)}$$

$$-4I_2 = +V_2$$

$$I_2 = \frac{-V_2}{4}$$

From Eq (3) $I_3 = -4\times\frac{-V_2}{4} = +V_2$

$$Z_{12} = \left.\frac{V_1}{I_2}\right|_{I_1=0} = \frac{5I_2}{I_2} = 5\Omega$$

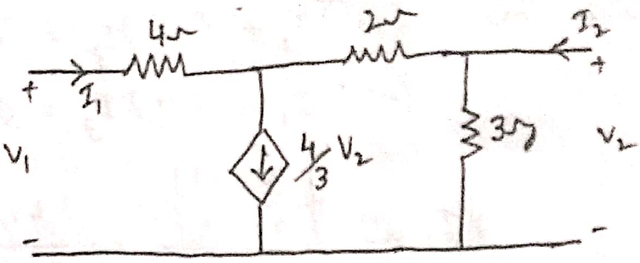
KVL to 1st mesh : $-V_1+3I_2+2I_2=0$

$V_1 = 5I_2$

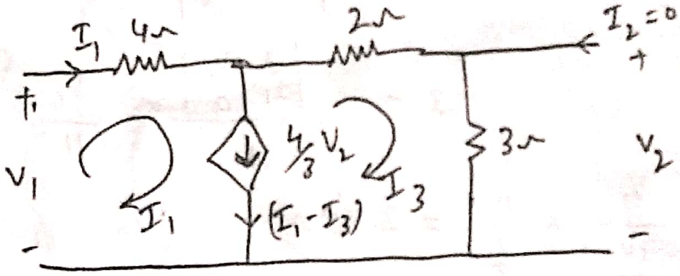
$$Z_{22} = \left.\frac{V_2}{I_2}\right|_{I_1=0} = \frac{V_2}{-V_2/4} = -4\Omega$$

$$Z = \begin{bmatrix} 3 & 5 \\ -6 & -4 \end{bmatrix}$$

Prob 5 : Determine Z and Y parameters for the two port network shown in the figure



Sol : $I_2 = 0$



KCL to supermesh : $I_1 - I_3 = \frac{4}{3} V_2$ But $V_2 - 3I_3 = 0$

$V_2 = 3I_3$

$I_1 - I_3 = \frac{4}{3}(3I_3)$

$I_1 - I_3 = 4I_3$

$I_1 - 5I_3 = 0$ — ①

KVL to supermesh $-V_1 + 4I_1 + 2I_3 + 3I_3 = 0$

$+4I_1 + 5I_3 = +V_1$ — ②

From equations ① & ②

Use calculator

$a_1 = 1, b_1 = -5, c_1 = 0$

$a_2 = 4, b_2 = 5, c_2 = 1$

Attach V_1 for answers

Coefficient of V_1

$(1)I_1 + (-5)I_3 = 0$

$(4)I_1 + (5)I_3 = V_1$

$\therefore I_1 = 0.2V_1$

$I_3 = 0.04V_1$

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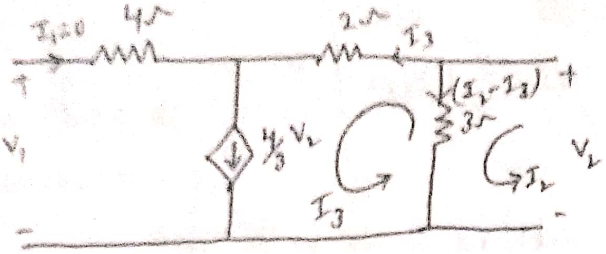
$$Z_{11} = \left.\frac{V_1}{I_1}\right|_{I_2=0} = \frac{V_1}{0.2V_1} = 5\Omega$$

$$Z_{21} = \left.\frac{V_2}{I_1}\right|_{I_2=0} = \frac{3I_3}{I_1} = \frac{3\times 0.04V_1}{0.2V_1} = 0.6\Omega$$

$I_1 = 0$



KCL eq. to non essential mesh: $I_3 = \frac{4}{3}V_2$

But $-V_2 + 3(I_2 - I_3) = 0$

$V_2 = 3I_2 - 3I_3$

$$I_3 = \frac{4}{3}(3I_2 - 3I_3)$$

$$I_3 = 4I_2 - 4I_3$$

$$4I_2 - 5I_3 = 0 \quad - ①$$

KVL to essential mesh: $V_2 - 3(I_2 - I_3) = 0$

$$+3I_2 - 3I_3 = V_2 \quad - ②$$

Solving ① & ② $(4)I_2 + (-5)I_3 = 0$

$$(3)I_2 + (-3)I_3 = V_2$$

$$I_2 = 1.66V_2 \quad I_3 = 1.33V_2$$

$$Z_{12} = \left.\frac{V_1}{I_2}\right|_{I_1=0} = \frac{3I_2 - 5I_3}{I_2}$$

$-V_1 - 2I_3 + 3(I_2 - I_3) = 0$

$V_1 = -2I_3 + 3I_2 - 3I_3$

$V_1 = 3I_2 - 5I_3$

$$= \frac{3\times1.66V_2 - 5\times1.33V_2}{1.66V_2}$$

$$= \frac{\cancel{V_2}(3\times1.66 - 5\times1.33)}{1.66\cancel{V_2}}$$

$$= -1\Omega$$

$$Z_{22} = \left.\frac{V_2}{I_2}\right|_{I_1=0} = \frac{V_2}{1.66V_2} = 0.6\Omega$$

$$Z = \begin{bmatrix} 5 & -1 \\ 0.6 & 0.6 \end{bmatrix}$$

$$Y = [Z]^{-1} = \frac{\text{adj } z}{|Z|} = \frac{\begin{bmatrix} 0.6 & +1 \\ -0.6 & 5 \end{bmatrix}}{5 \times 0.6 + 1 \times 0.6}$$

$$Y = \frac{\begin{bmatrix} 0.6 & +1 \\ -0.6 & 5 \end{bmatrix}}{3.6}$$

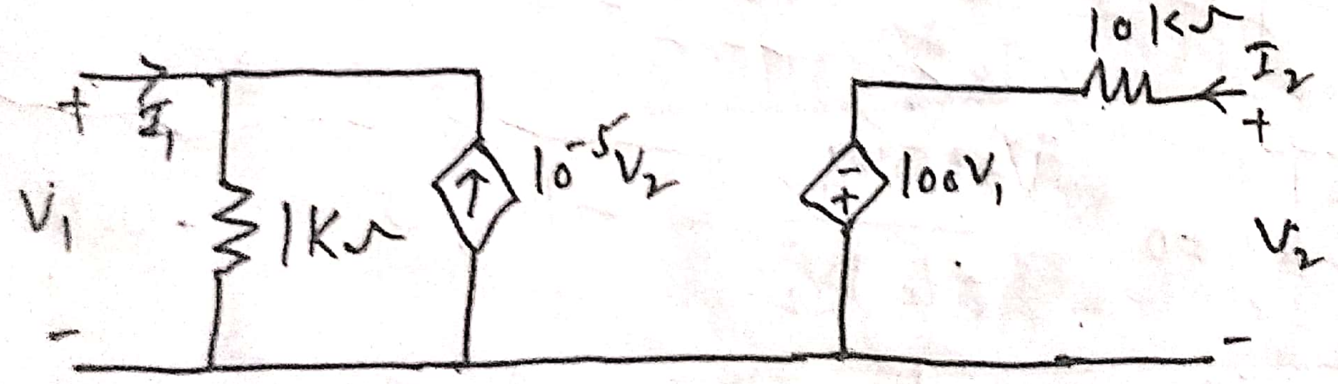
$$Y = \begin{bmatrix} 0.1666 & 0.2777 \\ -0.1666 & 1.3888 \end{bmatrix} \mho$$

To get adj z : Interchange the diagonal elements of [Z] & change the signs of off-diagonal elements of [Z]

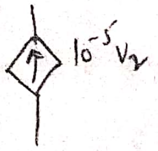
or directly use Calculator to obtain $[Z]^{-1}$

Find Y Parameters ...

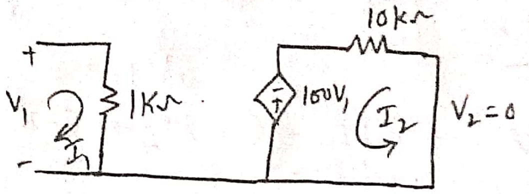
Find Y parameters for the network shown in the figure



Sol: $V_2 = 0$



$= 0$ (open)



KVL eqs to two essential meshes: $-V_1 + 1\times10^3 I_1 = 0$

$$I_1 = \frac{V_1}{10^3} = 0.001 V_1$$

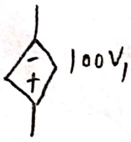
$$+10\times10^3 I_2 - 100V_1 = 0$$

$$I_2 = \frac{100V_1}{10\times10^3} = 0.01V_1$$

$$Y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0} = \frac{0.001V_1}{V_1} = 0.001\ \mho$$

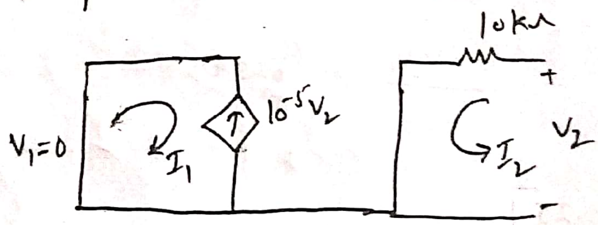
$$Y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0} = \frac{0.01V_1}{V_1} = 0.01\ \mho$$

$V_1 = 0$



$= 0$ (short)

Also due to short across 1KΩ when V_1...
1KΩ can be ...



KCL: $I_1 = -10^{-5}V_2$

KVL: $-V_2 + 10\times10^3 I_2 = 0$.

Caution: I_1 should always be clockwise
I_2 should always be anticlockwise

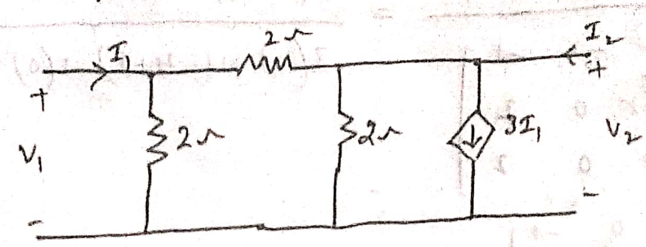
$$I_2 = \frac{V_2}{10\times10^3} = 10^{-4}V_2$$

$$Y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1=0} = \frac{-10^{-5}V_2}{V_2} = -10^{-5}\ \mho = -0.00001\ \mho$$

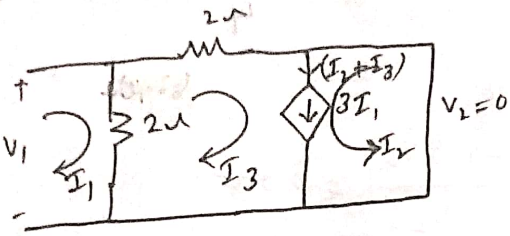
$$Y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1=0} = \frac{10^{-4}V_2}{V_2} = 10^{-4}\ \mho = 0.0001\ \mho$$

$$Y = \begin{bmatrix} 0.001 & -0.00001 \\ 0.01 & 0.0001 \end{bmatrix} \mho$$

Prob 8: Determine y parameters of the two port network shown in the figure.



Sol: $V_2 = 0$. A short is across 2Ω. It can be neglected.



KCL equation to supermesh: $I_2 + I_3 = 3I_1 \Rightarrow (3)I_1 + (-1)I_2 + (-1)I_3 = 0$ — ①

KVL equation to supermesh: $2(I_3 - I_1) + 2I_3 = 0 \Rightarrow (-2)I_1 + (0)I_2 + (+4)I_3 = 0$ — ②

KVL equation to essential mesh: $V_1 + 2(I_1 - I_3) = 0 \Rightarrow (+2)I_1 + (0)I_2 + (-2)I_3 = +V_1$ — ③

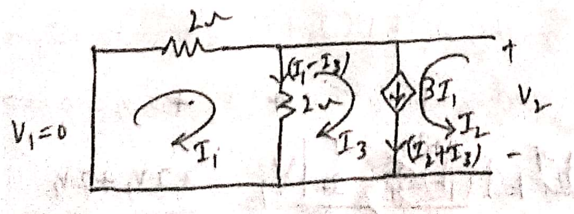
Solving,

$$I_1 = 1V_1$$
$$I_2 = 2.5V_1$$
$$I_3 = 0.5V_1$$

$$y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0} = \frac{V_1}{V_1} = 1\,\mho$$

$$y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0} = \frac{2.5V_1}{V_1} = 2.5\,\mho$$

$V_1 = 0$. A short is across 2Ω. It can be neglected.



KCL eq. to supermesh: $I_2 + I_3 = 3I_1 \Rightarrow (3)I_1 + (-1)I_2 + (-1)I_3 = 0$ — ①

KVL eq to supermesh: $-V_2 + 2(I_1 - I_3) = 0 \Rightarrow (+2)I_1 + (0)I_2 + (-2)I_3 = +V_2$ — ②

KVL eq to essential mesh: $+2I_1 + 2(I_1 - I_3) \Rightarrow (+4)I_1 + (0)I_2 + (-2)I_3 = 0$ — ③

Solving,

$I_1 = -0.5V_2$

$I_2 = -0.5V_2$

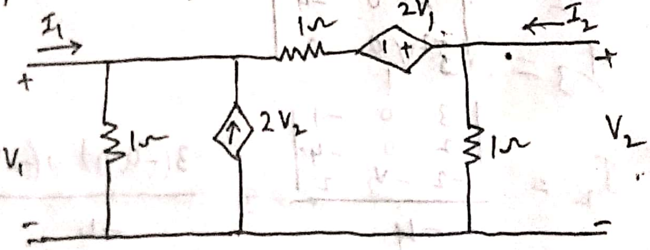
$I_3 = -1V_2$

$$Y_{12} = \frac{I_1}{V_2}\bigg|_{V_1=0} = \frac{-0.5V_2}{V_2} = -0.5\,℧$$

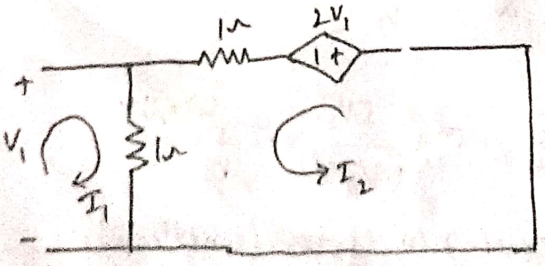
$$Y_{22} = \frac{I_2}{V_2}\bigg|_{V_1=0} = \frac{-0.5V_2}{V_2} = -0.5\,℧$$

$$Y = \begin{bmatrix} 1 & -0.5 \\ 2.5 & -0.5 \end{bmatrix} ℧$$

Prob 9: Find the Y parameters for the network shown in the figure.



Sol: $V_2 = 0$ $\quad 2V_2 = 0$ (open) . 1Ω Connected across short can be eliminated.



KVL to essential mesh : $-V_1 + 1(I_1 + I_2) = 0 \Rightarrow I_1 + I_2 = +V_1$ — ①

KVL to essential mesh : $-1(I_1+I_2) - 1I_2 - 2V_1 = 0 \Rightarrow -I_1 - 2I_2 = +2V_1$ — ②

Solving ① & ②

$(1)I_1 + (1)I_2 = V_1$

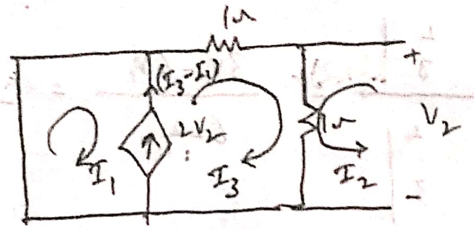
$(-1)I_1 + (-2)I_2 = 2V_1$

$$I_1 = 4V_1$$
$$I_2 = -3V_1$$

$$y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0} = \frac{4V_1}{V_1} = 4\,℧$$

$$y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0} = \frac{-3V_1}{V_1} = -3\,℧$$

$\underline{V_1 = 0}$ $2V_1$ = 0 (short). 1Ω can be neglected since short is across it.



KCL to super mesh : $I_3 - I_1 = 2V_2 \Rightarrow (-1)I_1 + (0)I_2 + (1)I_3 = 2V_2$ - ①

KVL to supermesh : $+1I_3 + 1(I_2 + I_3) = 0 \Rightarrow (0)I_1 + (1)I_2 + (2)I_3 = 0$ - ②

KVL to essential mesh : $-V_2 + 1(I_2 + I_3) = 0 \Rightarrow (0)I_1 + (+1)I_2 + (+1)I_3 = +V_2$ - ③

Solving,

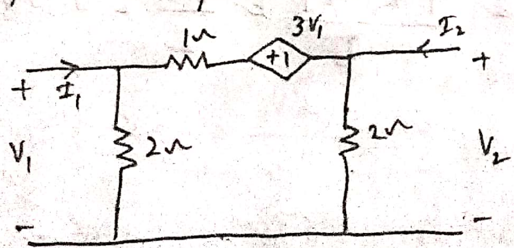
$$I_1 = -3V_2$$
$$I_2 = 2V_2$$
$$I_3 = -1V_2$$

$$y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1=0} = \frac{-3V_2}{V_2} = -3\,℧$$

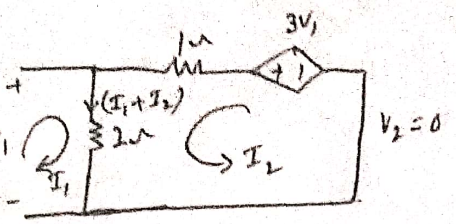
$$y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1=0} = \frac{2V_2}{V_2} = 2\,℧$$

$$y = \begin{bmatrix} 4 & -3 \\ -3 & 2 \end{bmatrix} ℧$$

$\underline{\text{Prob 10}}$: Find the y parameters for the circuit shown in the figure.



$\underline{V_2 = 0}$. 2Ω across short can be eliminated.



KVL to essential mesh : $-V_1 + 2(I_1+I_2) = 0 \implies (+2)I_1 + (+2)I_2 = +V_1$ — ①

KVL to essential mesh : $-3V_1 + 1I_2 + 2(I_1+I_2) \implies (+2)I_1 + (+3)I_2 = +3V_1$ — ②

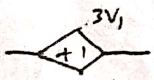
Solving, $I_1 = -1.5V_1$

$I_2 = 2V_1$

$$Y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0} = \frac{-1.5V_1}{V_1} = -1.5\,\mho$$

$$Y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0} = \frac{2V_1}{V_1} = 2\,\mho$$

$\underline{V_1 = 0}$



$= 0$ (short). 2Ω across short can be neglected.

KVL equations to two essential meshes : $(3)I_1 + (+2)I_2 = 0$

(By inspection) $(+2)I_1 + (2)I_2 = +V_2$

Solving,

$I_1 = -1V_2$

$I_2 = 1.5V_2$

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

$$Y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1=0} = \frac{1.5V_2}{V_2} = 1.5\,\mho$$

$$Y = \begin{bmatrix} -1.5 & -1 \\ 2 & 1.5 \end{bmatrix}$$