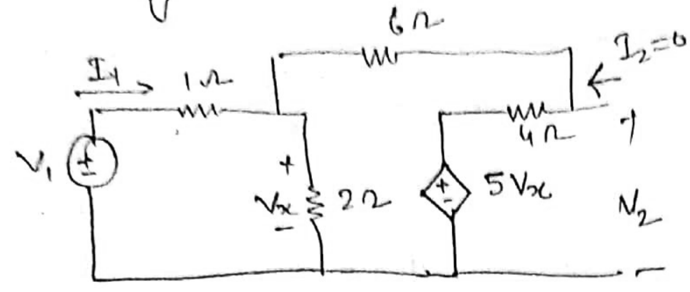
Solution, Tutorial-5

Q1

To get A and C



$$\frac{V_1 - V_x}{1} = \frac{V_x}{2} + \frac{V_x - 5V_x}{10}$$

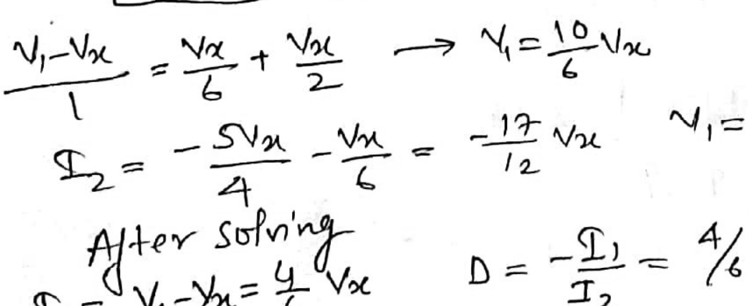
$$V_1 = 1.1 V_x$$

$$V_2 = 4(-0.4 V_x) + 5V_x = 3.4 V_x$$

$$A = \frac{V_1}{V_2} = \frac{1.1}{3.4} = 0.3235$$

$$I_1 = \frac{V_1 - V_x}{1} = 1.1V_x - V_x = 0.1V_x \longrightarrow C = \frac{I_1}{V_2} = \frac{0.1}{3.4} = 0.02941$$

To get B and D



$$\frac{V_1 - V_x}{1} = \frac{V_x}{6} + \frac{V_x}{2} \longrightarrow V_1 = \frac{10}{6} V_x$$

$$I_2 = -\frac{5V_x}{4} - \frac{V_x}{6} = -\frac{17}{12} V_x \qquad V_1 = I_1 + V_x$$

After solving

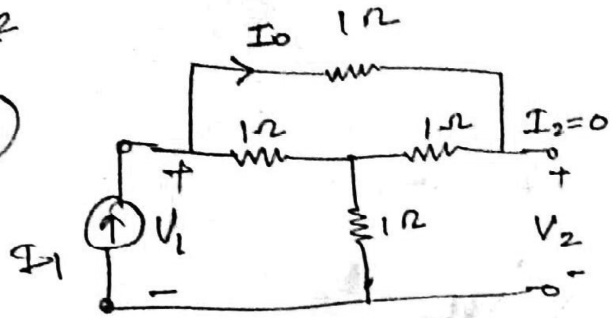
$$I_1 = V_1 - V_x = \frac{4}{6} V_x \qquad D = -\frac{I_1}{I_2} = 4/6 \left(\frac{12}{7}\right) = 0.4706$$

$$B = -\frac{V_1}{I_2} = \frac{10}{6} \times \frac{12}{17} = 1.176$$

$$[T] = \begin{bmatrix} 0.3235 & 1.176 \\ 0.02941 & 0.4706 \end{bmatrix}$$

Q_2

(a)



To obtain Z_{11} and Z_{21}

So that $V_1 = I_1\left[1 + 1 \,||\, (1+1)\right] = I_1\left(1 + \frac{2}{3}\right) = \frac{5}{3} I_1$

$$Z_{11} = \frac{V_1}{I_1} = \frac{5}{3}$$

$$I_0 = \frac{1}{3} I_1 =$$

$-V_2 + I_0 + I_1 = 0 \qquad V_2 = \frac{1}{3} I_1 + I_1 = \frac{4}{3} I_1$

$$Z_{21} = \frac{V_2}{I_1} = \frac{4}{3}$$

To obtain Z_{22} and Z_{12}

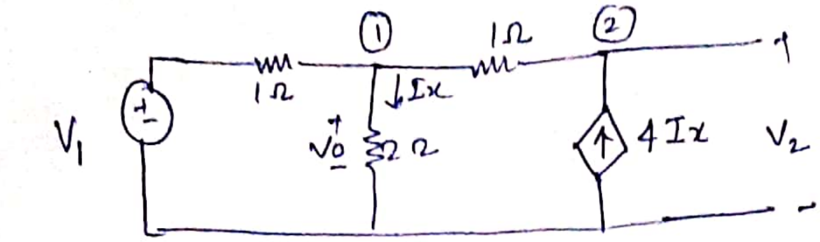
$\left.\begin{array}{l} Z_{22} = Z_{11} = 5/3 \\ Z_{21} = Z_{12} = 4/3 \end{array}\right\}$ Due to symmetry.

$$[Z] = \begin{bmatrix} 5/3 & 4/3 \\ 4/3 & 5/3 \end{bmatrix} \Omega$$

(b) $$[h] = \begin{bmatrix} \frac{\Delta_Z}{Z_{22}} & \frac{Z_{12}}{Z_{22}} \\ -\frac{Z_{21}}{Z_{22}} & \frac{1}{Z_{22}} \end{bmatrix} = \begin{bmatrix} 3/5 & 4/5 \\ -4/5 & 3/5 \end{bmatrix}$$

(c) $$[T] = \begin{bmatrix} \frac{Z_{11}}{Z_{21}} & \frac{\Delta_Z}{Z_{21}} \\ \frac{1}{Z_{21}} & \frac{Z_{22}}{Z_{21}} \end{bmatrix} = \begin{bmatrix} 5/4 & 3/4 \\ 3/4 & 5/4 \end{bmatrix}$$

Q_3 To get A and C



at node 1

$$I_1 = \frac{V_0}{2} + \frac{V_0 - V_2}{1} \rightarrow 2I_1 = 3V_0 - 2V_2$$

at node 2

$$\frac{V_0 - V_2}{1} = -4I_x = -4\frac{V_0}{2} = -2V_0 \Rightarrow V_0 = \frac{V_2}{3}$$

after solving

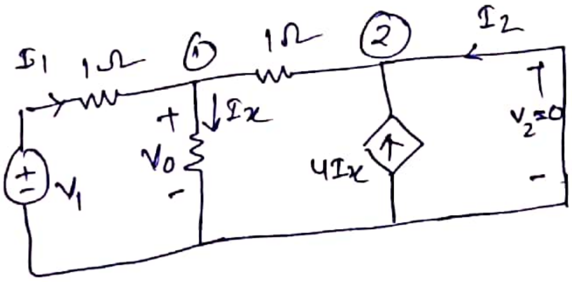
$$2I_1 = -V_2$$

$$\boxed{C = \frac{I_1}{V_2} = \frac{-1}{2} = -0.5}$$

But, $I_1 = \frac{V_1 - V_0}{1} = V_1 - \frac{V_2}{3} \Rightarrow -0.5V_2 = V_1 - \frac{V_2}{3} \Rightarrow V_1 = \frac{-0.5V_2}{3}$

$$\boxed{A = \frac{V_1}{V_2} = \frac{-0.5}{3}}$$

To get B and D



At node 1

$$I_1 = \frac{V_0}{2} + \frac{V_0}{1} \rightarrow 2I_1 = 3V_0$$

at node 2

$$I_2 + 4I_x + \frac{V_0}{1} = 0$$

$$I_2 = -3V_0 \Rightarrow 2I_1 + I_2 = 0 \rightarrow I_1 = -0.5I_2 \rightarrow D = \frac{-I_1}{I_2} = 0.5$$

$$\boxed{D = -0.5}$$

$$I_1 = \frac{V_1 - V_0}{1} \Rightarrow V_1 = I_1 + V_0$$

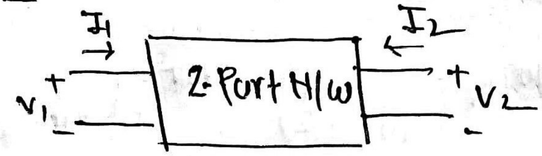
$$V_1 = -\frac{1}{2}I_2 - \frac{1}{3}I_2 = -\frac{5}{6}I_2, \quad \boxed{B = \frac{-V_1}{I_2} = 5/6}$$

$$[T] = \begin{bmatrix} \frac{-0.5}{3} & 5/6 \\ -0.5 & -0.5 \end{bmatrix}$$

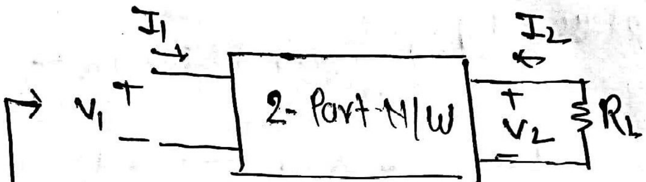
Soln: 04

Given parameters -
$$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} \begin{bmatrix} V_2 \\ -I_2 \end{bmatrix}$$

Two port Network -



According to given condition if port two is terminated by $R_L = 4\Omega$



$$V_2 = (-I_2)R_L$$
$$= -4I_2 \quad \text{---(i)}$$

Input Impedance $= \dfrac{V_1}{I_1}$

Input Impedance seen at port-1 $= \dfrac{V_1}{I_1} = \dfrac{V_2 - 2I_2}{3V_2 - 4I_2}$ --- (ii)

Substitute the value of (i) into (ii) -

$$\frac{V_1}{I_1} = \frac{V_2 - 2I_2}{3V_2 - 4I_2} = \frac{-4I_2 - 2I_2}{-12I_2 - 4I_2} = \frac{-6I_2}{-16I_2} = \frac{3}{8}$$

$$\boxed{\frac{V_1}{I_1} = \frac{3}{8} \text{ ohm}}$$

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Q5

$$[T] = \begin{bmatrix} 3 & 20 \\ 1 & 7 \end{bmatrix}$$

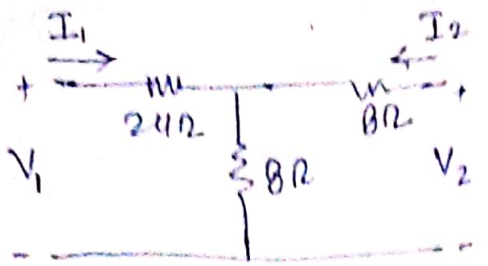
$$\Delta_T = (3)(7) - (20)(1) = 1$$

$$[Z] = \begin{bmatrix} \frac{A}{C} & \frac{\Delta_T}{C} \\ \frac{1}{C} & \frac{D}{C} \end{bmatrix} = \begin{bmatrix} 3 & 1 \\ 1 & 7 \end{bmatrix}$$

$$[Y] = \begin{bmatrix} \frac{D}{B} & -\frac{\Delta_T}{B} \\ \frac{-1}{B} & \frac{A}{B} \end{bmatrix} = \begin{bmatrix} \frac{7}{20} & \frac{-1}{20} \\ \frac{-1}{20} & \frac{3}{20} \end{bmatrix}$$

$$[h] = \begin{bmatrix} \frac{B}{D} & \frac{\Delta_T}{D} \\ \frac{-1}{D} & \frac{C}{D} \end{bmatrix} = \begin{bmatrix} \frac{20}{7} & \frac{1}{7} \\ \frac{-1}{7} & \frac{1}{7} \end{bmatrix}$$

Q6.

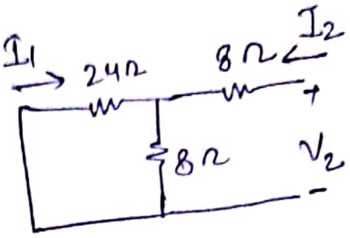


the admittance parameter use the output terminal shorted

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

Then, the two 8-Ω resistors are in parallel and $V_1 = 28 I_1$

$$Y_{11} = \frac{1}{28}\, S$$



for Y_{12}, we have

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

Employing current division, we have

$$-I_1 = I_2\left(\frac{8}{8+24}\right)$$

and $$I_2 = \frac{V_2}{8+\left[\frac{8(24)}{(8+24)}\right]} = \frac{V_2}{14}.$$

$$Y_{12} = \frac{I_1}{V_2} = \frac{-(V_2/14)(1/4)}{V_2} = \frac{-1}{56}\, S$$

$$Y_{21} = Y_{12} = -\frac{1}{56}\, S$$

$$Y_{22} = \frac{I_2}{V_2}\Big|_{V_1=0}, \quad I_2 = \frac{V_2}{8+\left[\frac{8(24)}{8+24}\right]} = \frac{V_2}{14}$$

$$Y_{22} = \frac{1}{14}\, S$$

Thus $I = YV \rightarrow \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} \frac{1}{28} & -\frac{1}{56} \\ -1/56 & \frac{1}{14} \end{bmatrix}\begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$