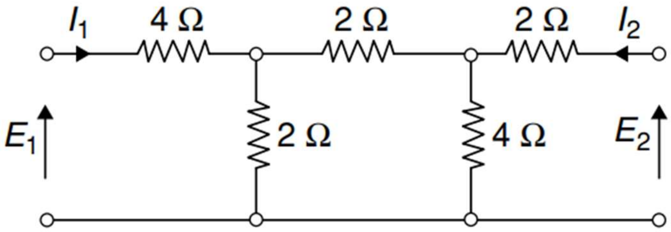
Tutorial 6

1. The h-parameters for a 2- port network are defined by -

$$\begin{bmatrix} E_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ E_2 \end{bmatrix}.$$

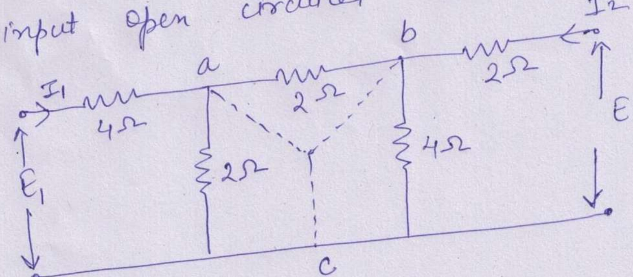
For the 2-port network shown in the figure below, the value of h_{12} is given by:



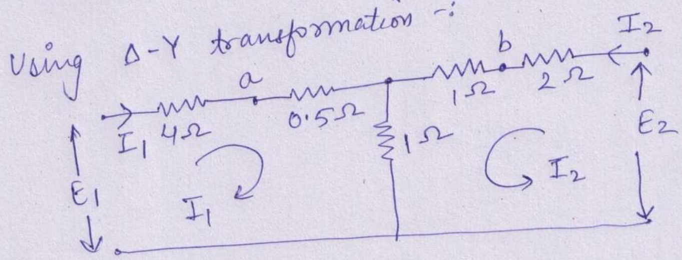
The h-parameter is

$$h_{12} = \left. \frac{E_1}{E_2} \right|_{I_1 = 0}$$

where, h_{12} is ratio of E_1 and E_2 for the input open circuited condition.



Using Δ-Y transformation :-



$$E_1 = (4+0.5)I_1 + 1(I_1 + I_2) = 5.5 I_1 + I_2 \quad -(1)$$

$$E_2 = (2+1)I_2 + 1(I_1 + I_2) = I_1 + 4I_2 \quad -(2)$$

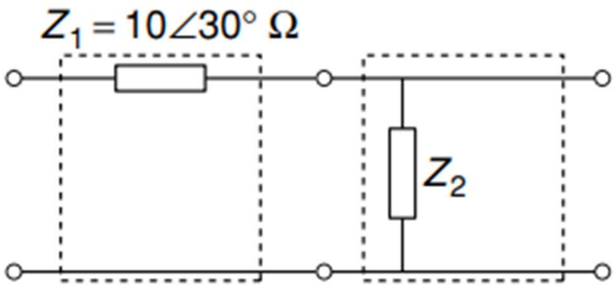
Substituting $I_1 = 0$ in eq^{ns} (1) and (2), we get,

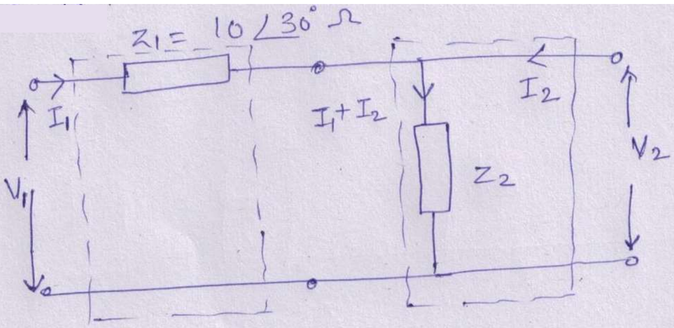
$$E_1 = I_2$$

$$E_2 = 4I_2$$

$$h_{12} = \left. \frac{E_1}{E_2} \right|_{I_1 = 0} = \underline{\underline{0.25}}$$

2. Two networks are connected in cascade as shown in the figure. With the usual notations, the equivalent A, B, C, and D constants are obtained. Given that, $C = 0.025\angle 45°$, the value of Z_2 is -





$$V_1 = AV_2 + BI_2$$

$$I_1 = CV_2 + DI_2$$

$$V_2 = Z_2(I_1 + I_2) \quad \text{—— (1)}$$

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

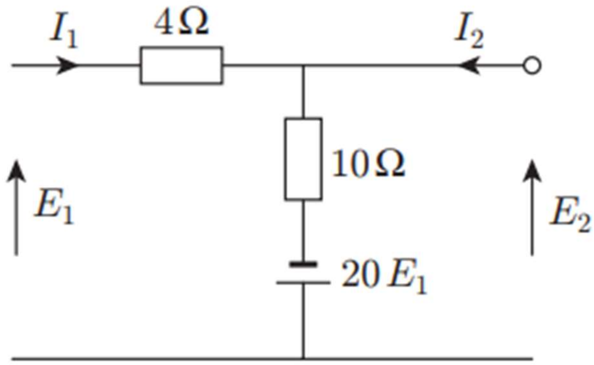
substituting $I_2 = 0$, in eq^n (1), we get,

$$V_2 = I_1 Z_2$$

$$\Rightarrow Z_2 = \left.\frac{V_2}{I_1}\right|_{I_2=0} = \frac{1}{C} = \frac{1}{0.025\angle 45°}$$

$$\boxed{Z_2 = 40\angle -45°\ \Omega}$$

3. Consider a 2-port network given in the figure below. The voltage source in the middle is a dependent voltage source having value $20E_1$. The Z parameters, Z_{11} and Z_{21}, for the network are -



From the given N/W,

$$E_1 = 4I_1 + 10(I_1 + I_2) - 20E_1$$

$$21E_1 = 14I_1 + 10I_2 \quad \text{— (1)}$$

$$E_2 = 10(I_1 + I_2) - 20E_1$$

$$E_2 + 20E_1 = 10I_1 + 10I_2 \quad \text{— (2)}$$

from (1),

$$Z_{11} = \frac{E_1}{I_1} = \frac{14}{21}\Bigg|_{I_2=0}$$

from (2),

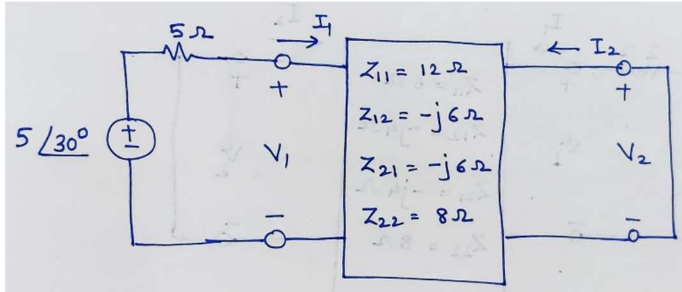
$$E_2 = 10I_1 - \frac{14}{21} \times 20I_1 \Bigg|_{I_2=0}$$

$$= \frac{210\,I_1 - 280\,I_1}{21} = \frac{-70}{21}\,I_1 \Big/_{I_2=0}$$

$$\frac{E_2}{I_1} = Z_{21} = \frac{-70}{21}$$

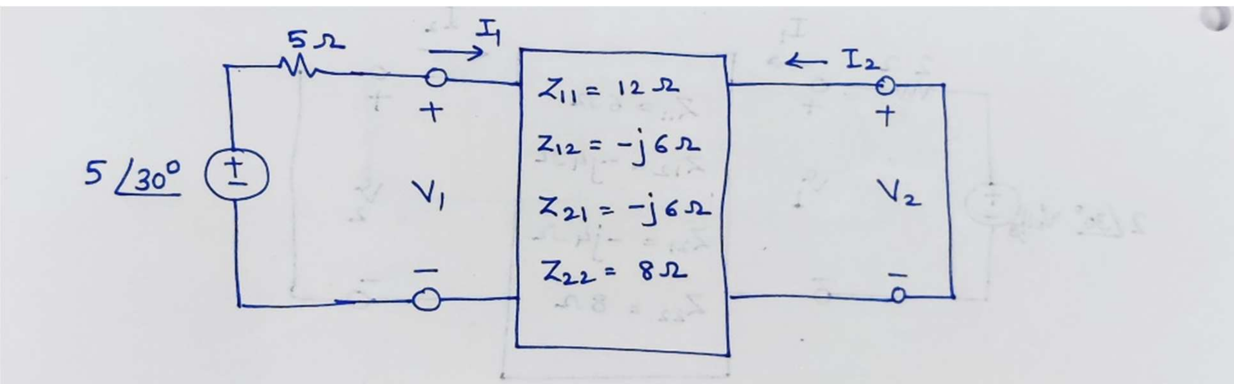
$$\boxed{Z_{11} = \frac{14}{21}, \quad Z_{21} = \frac{-70}{21}}$$

4. For the circuit shown in the figure below, the possible combinations of currents I_1 and I_2 in mA are given below-



I. 232.55 ∠30°, 116.27 ∠120°
II. 232.55 ∠30°, 174.42 ∠120°
III. 398.66 ∠60°, 116.27 ∠150°
IV. 398.66 ∠60°, 174.42 ∠150°

Out of the above possible combinations, the correct option is -



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

$0 = Z_{21} I_1 + Z_{22} I_2$

$I_2 = -\dfrac{Z_{21}}{Z_{22}} I_1$

$I_2 = \dfrac{-(-j6)}{8} I_1 = j\,0.75\, I_1$

$5\angle 30^\circ - 5 I_1 = 12 I_1 + Z_{12} \cdot j \cdot 0.75 I_1$

$5\angle 30^\circ = 17 I_1 + (-j6)(j0.75) I_1$

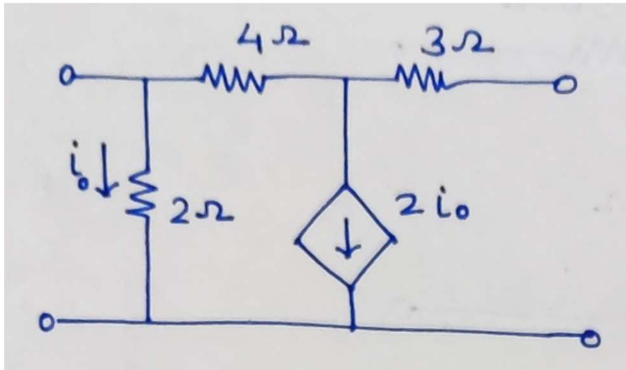
$5\angle 30^\circ = 17 I_1 + 4.5 I_1$

$5\angle 30^\circ = 21.5 I_1$

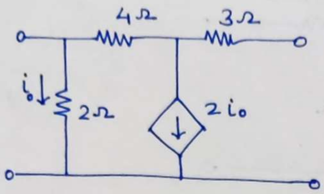
$\boxed{I_1 = 232.55\angle 30^\circ \text{ mA}}$

$\boxed{\& \quad I_2 = 174.42\angle 120^\circ \text{ mA}}$

5. For the circuit shown below, find the short circuit input and output admittances, respectively, in S.



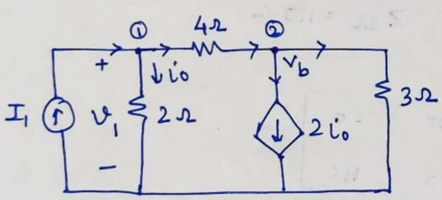
Solution -



Short circuit input admittance, $y_{11} = \frac{I_1}{V_1}$

Short circuit output admittance, $y_{22} = \frac{I_2}{V_2}$

for $y_{11} \Rightarrow$ short circuit port 2, $V_2 = 0$



$$i_o = \frac{V_1}{2}$$

At node 1

$$I_1 = i_o + \frac{V_1 - V_b}{4}$$

$$I_1 = \frac{V_1}{2} + \frac{V_1}{4} - \frac{V_b}{4}$$

$$I_1 = \frac{3V_1}{4} - \frac{V_b}{4}$$

$$I_1 = \frac{3V_1}{4} + \frac{9V_1}{4 \times 7}$$

$$I_1 = \frac{15}{14} V_1$$

$$\boxed{\therefore y_{11} = \frac{I_1}{V_1} = \frac{15}{14} \text{ ℧}}$$

At node 2

$$\frac{V_1 - V_b}{4} = 2i_o + \frac{V_b}{3}$$

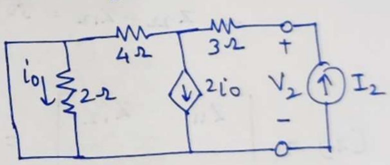
$$\frac{V_1}{4} - \frac{V_b}{4} = 2 \times \frac{V_1}{2} + \frac{V_b}{3}$$

$$-\frac{V_b}{4} - \frac{V_b}{3} = \frac{3V_1}{4}$$

$$\frac{7V_b}{12} = -\frac{3V_1}{4}$$

$$V_b = -\frac{9V_1}{7}$$

for $y_{22} \rightarrow V_1 = 0$

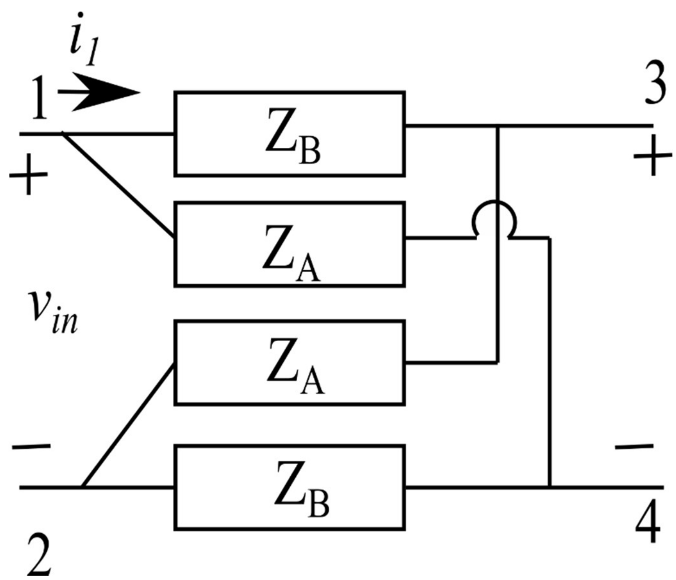


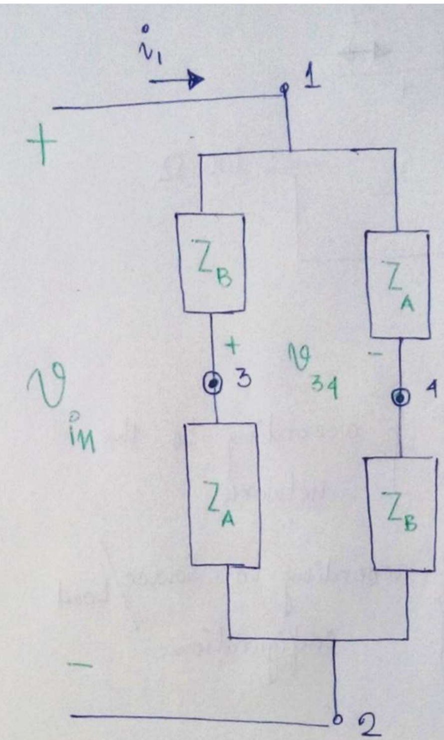
$i_o = 0, \therefore 2i_o = 0$

$\therefore V_2 = 7 I_2$

$$\boxed{\therefore y_{22} = \frac{I_2}{V_2} = \frac{1}{7} \text{ ℧}}$$

6. For the lattice network shown in the figure below, $Z_A = j2\Omega$ and $Z_B = 2\Omega$, find out the transfer impedance $\frac{v_{34}}{i_1}$





$$v_{34} = v_3 - v_4$$

$$= v_{in} \cdot \frac{Z_A}{Z_A + Z_B} - v_{in} \frac{Z_B}{Z_A + Z_B}$$

$$= v_{in} \left[\frac{Z_A - Z_B}{Z_A + Z_B} \right]$$

$$i_1 = \frac{v_{in}}{(Z_A + Z_B)/2}$$

$$\therefore \frac{v_{34}}{i_1} = \frac{(Z_A - Z_B)}{2} = \frac{j2 - 2}{2} = (-1 + j)\ \Omega \quad \text{(Ans)}$$