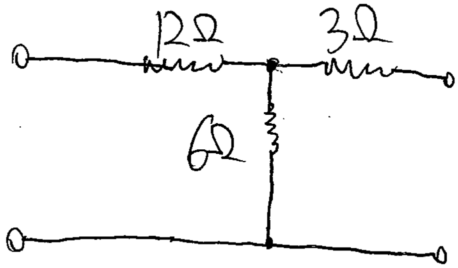
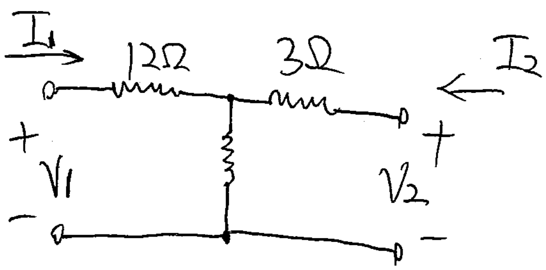
Q1. Find the Y parameters for the two-port network shown below.



Solution:



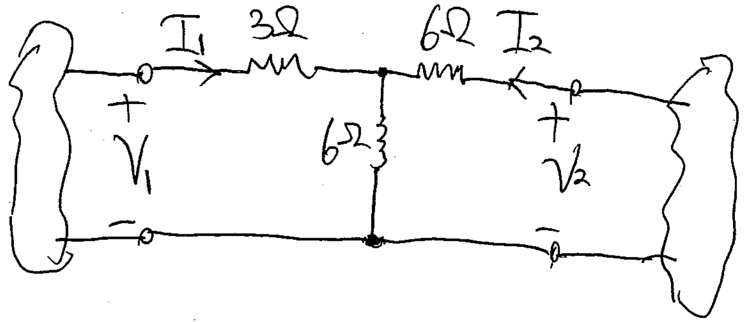
$$Y_{11} = I_1/V_1 \Big|_{V_2=0} = \frac{1}{12+(6\|3)} = \frac{1}{14}\,S.$$

$$Y_{22} = \frac{I_2}{V_2} \Big|_{V_1=0} = \frac{1}{3+(12\|6)} = \frac{1}{7}\,S$$

$$Y_{12} = \frac{I_1}{V_2} \Big|_{V_1=0} = \left[\frac{12\|6}{(12\|6)+3}\right]\left(-\frac{1}{12}\right) = -\frac{1}{21}\,S$$

$$Y_{21} = \frac{I_2}{V_1} \Big|_{V_2=0} = \left[\frac{3\|6}{(3\|6)+12}\right]\left(-\frac{1}{3}\right) = -\frac{1}{21}\,S$$

Q2. Determine the Y parameters for the network.



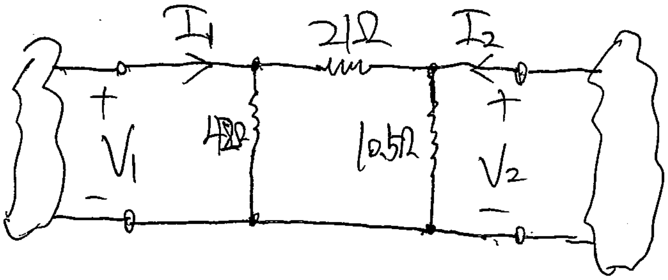
Solution: $Y_{11} = \dfrac{I_1}{V_1}\Big|_{V_2=0} = \dfrac{1}{3+(6\|6)} = \dfrac{1}{6}\,S.$

$$Y_{22} = \frac{I_2}{V_2}\Big|_{V_1=0} = \frac{1}{6+(6\|3)} = \frac{1}{8}\,S$$

$$Y_{21} = \frac{I_2}{V_1}\Big|_{V_2=0} = \frac{6\|6}{(6\|6)+3}\left(-\frac{1}{6}\right) = -\frac{1}{12}\,S.$$

$$Y_{12} = \frac{I_1}{V_2}\Big|_{V_1=0} = \frac{3\|6}{(3\|6)+6}\left(-\frac{1}{3}\right) = -\frac{1}{12}\,S.$$

Q3. Find the Z parameters for the two-port network.



Solution:

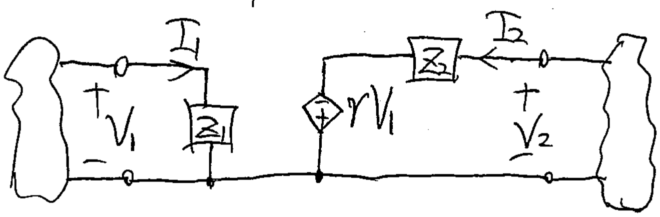
$$Z_{11} = \frac{V_1}{I_1}\Big|_{I_2=0} = 42 \,\|\, (21+10.5) = 18\Omega$$

$$Z_{22} = \frac{V_2}{I_2}\Big|_{I_1=0} = 10.5 \,\|\, (21+42) = 9\Omega$$

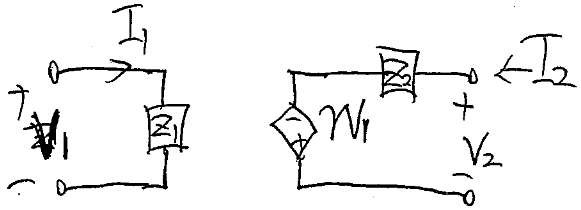
$$Z_{21} = \frac{V_2}{I_1}\Big|_{I_2=0} = \frac{42}{42+21+10.5}(10.5) = 6\Omega$$

$$Z_{12} = \frac{V_1}{I_2}\Big|_{I_1=0} = \frac{10.5}{10.5+21+42}(42) = 6\Omega$$

Q4. Find the Z parameters for the network.



Solution:



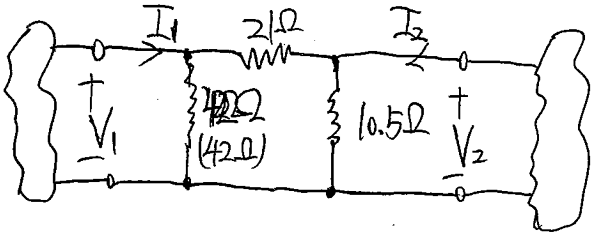
$$Z_{11} = \frac{V_1}{I_1}\bigg|_{I_2=0} = Z_1$$

$$Z_{22} = \frac{V_2}{I_2}\bigg|_{I_1=0} = Z_2$$

$$Z_{21} = \frac{V_2}{I_1}\bigg|_{I_2=0} = \frac{-rV_1}{V_1/Z_1} = -rZ_1$$

$$Z_{12} = \frac{V_1}{I_2}\bigg|_{I_1=0} = 0$$

Q5. Compute the hybrid parameters for the network.



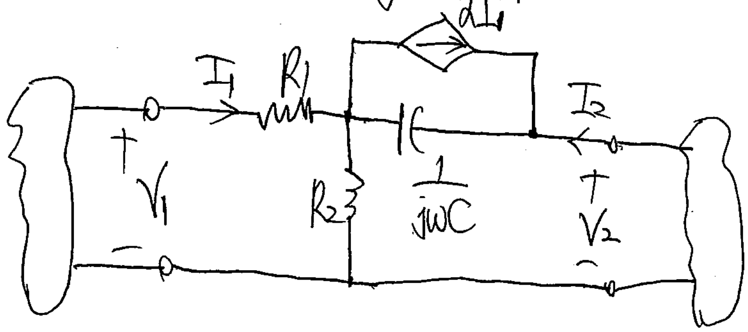
Solution: $h_{11} = \left.\dfrac{V_1}{I_1}\right|_{V_2=0} = R_1 // R_2 = 14\Omega$

$$h_{21} = \left.\frac{I_2}{I_1}\right|_{V_2=0} = -\frac{R_1}{R_1+R_2} = -\frac{2}{3}$$

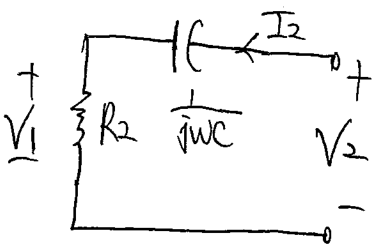
$$h_{12} = \left.\frac{V_1}{V_2}\right|_{I_1=0} = \frac{R_1}{R_1+R_2} = \frac{2}{3}$$

$$h_{22} = \left.\frac{I_2}{V_2}\right|_{I_1=0} = \frac{1}{R_3 // (R_1+R_2)} = \frac{1}{9}S.$$

Q6. Determine the hybrid parameters for the network.



Solution: For $I_1=0$



$\Rightarrow$

$$h_{12}=\frac{V_1}{V_2}\Big|_{I_1=0}=\frac{j\omega C R_2}{1+j\omega C R_2} \quad (*)$$

$$h_{22}=\frac{I_2}{V_2}\Big|_{I_1=0}=\frac{j\omega C}{1+j\omega C R_2} \quad (*)$$

For $V_2=0$, use loop analysis.

$$(I_2+\alpha I_1)/j\omega C+(I_1+I_2)R_2=0$$

yields $I_1(\alpha+j\omega C R_2)+I_2(1+j\omega C R_2)=0$

$$h_{21}=\frac{I_2}{I_1}=-\frac{\alpha+j\omega C R_2}{1+j\omega C R_2} \quad (*)$$

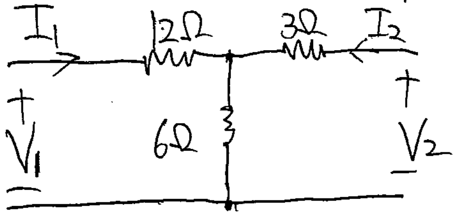
and

$$V_1=I_1(R_1+R_2)+I_2R_2=I_1\left\{R_1+R_2-R_2\left(\frac{\alpha+j\omega C R_2}{1+j\omega C R_2}\right)\right\}$$

$$V_1=I_1\left\{\frac{R_1+R_2(1-\alpha)+j\omega R_1R_2C}{1+j\omega R_2 C}\right\}$$

$$h_{11}=\frac{V_1}{I_1}=\frac{R_1+R_2(1-\alpha)+j\omega R_1R_2C}{1+j\omega R_2C} \quad (*)$$

Q7. Find the transmission parameters for the network.



Solution:

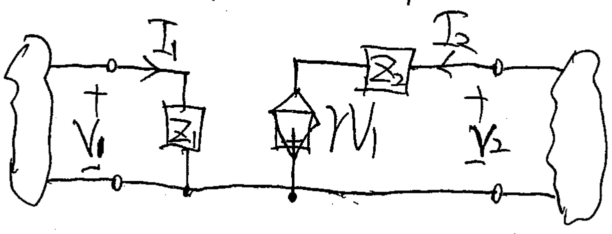
$$A = \frac{V_1}{V_2}\bigg|_{I_2=0} \Rightarrow V_2 = \frac{6}{18}V_1 \Rightarrow A = 3$$

$$B = \frac{V_1}{-I_2}\bigg|_{V_2=0} \Rightarrow -I_2 = \frac{(3\|6)V_1}{12+(3\|6)}\left(\frac{1}{3}\right) \Rightarrow B = 21\Omega$$

$$C = \frac{I_1}{V_2}\bigg|_{I_2=0} = \frac{1}{6}S.$$

$$D = \frac{I_1}{-I_2}\bigg|_{V_2=0} \Rightarrow -I_2 = I_1\left(\frac{6}{6+3}\right) \Rightarrow D = \frac{3}{2}$$

Q8. Find the ABCD parameters for the circuit.



Solution: $A = \frac{V_1}{V_2}\Big|_{I_2=0} \Rightarrow V_2 = -rV_1 \Rightarrow A = -\frac{1}{r}$

$$B = \frac{V_1}{-I_2}\Big|_{V_2=0} \Rightarrow I_2 = \frac{rV_1}{Z_2} \Rightarrow B = -\frac{Z_2}{r}$$

$$C = \frac{I_1}{V_2}\Big|_{I_2=0} \Rightarrow V_2 = -rV_1,\ V_1 = I_1 Z_1 \Rightarrow C = -\frac{1}{rZ_1}$$

$$D = \frac{I_1}{-I_2}\Big|_{V_2=0} \Rightarrow I_2 = \frac{rV_1}{Z_2},\ I_1 = \frac{V_1}{Z_1} \Rightarrow D = -\frac{Z_2}{rZ_1}$$

Q9. Following are the hybrid parameters for a network.

$$\begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} = \begin{bmatrix} \frac{11}{5} & \frac{2}{5} \\ -\frac{2}{5} & \frac{1}{5} \end{bmatrix}$$

Determine the Y parameters for the network.

Solution: $* \; y_{11} = \frac{1}{h_{11}} = \frac{5}{11} S.$

$* \; y_{12} = -\frac{h_{12}}{h_{11}} = -\frac{2}{11} S.$

$* \; y_{21} = \frac{h_{21}}{h_{11}} = -\frac{2}{11} S.$

$y_{22} = \frac{\Delta_4}{h_{11}}, \quad \Delta_4 = \frac{11}{5}\left(\frac{1}{5}\right) - \left(-\frac{2}{5}\right)\left(\frac{2}{5}\right) = \frac{11}{25} + \frac{4}{25} = \frac{15}{25} = \frac{3}{5}$

$\Rightarrow * \; y_{22} = \frac{3}{11} S.$

Q10. If the Y parameters for a network are known to be

$$\begin{bmatrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{bmatrix} = \begin{bmatrix} \frac{5}{11} & -\frac{2}{11} \\ -\frac{2}{11} & \frac{3}{11} \end{bmatrix}$$

Find the z parameters.

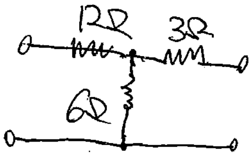
Solution: $\Delta_Y = \frac{5}{11}\left(\frac{3}{11}\right) - \left(-\frac{2}{11}\right)^2 = \frac{15}{121} - \frac{4}{121} = \frac{11}{121} = \frac{1}{11}$

$$z_{11} = \frac{y_{22}}{\Delta_Y} = 3\Omega$$

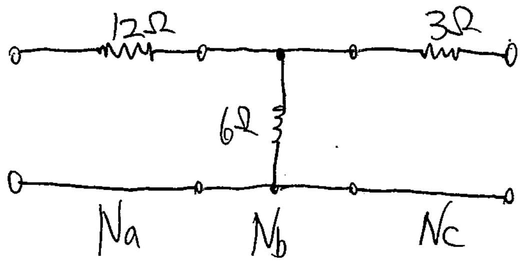
$$z_{12} = -\frac{y_{12}}{\Delta_Y} = 2\Omega$$

$$z_{21} = -\frac{y_{21}}{\Delta_Y} = 2\Omega$$

$$z_{22} = \frac{y_{11}}{\Delta_Y} = 5\Omega$$

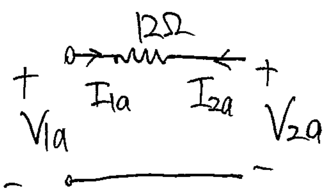
Q11. Find the transmission parameters of the network in 

by considering the circuit to be a cascade interconnection of three two-port networks as shown below:



Solution: Network consists of 3 two-ports.

Circuit A



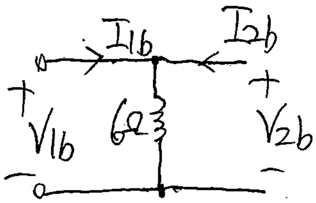
$$A_a = \frac{V_1}{V_2}\Big|_{I_2=0} = 1$$

$$B_a = \frac{V_1}{-I_2}\Big|_{V_2=0} = 12\Omega$$

$$C_a = \frac{I_1}{V_2}\Big|_{I_2=0} = 0$$

$$D_a = \frac{I_1}{-I_2}\Big|_{V_2=0} = 1$$

Circuit B



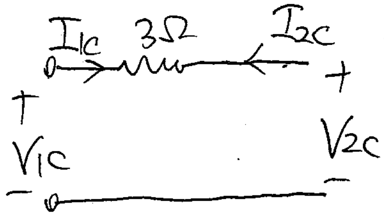
$A_b = 1$

$B_b = 0 \quad (I_{2b} = \infty)$

$C_b = \frac{1}{6}\ S$

$D_b = 1$

Circuit C



$A_c = 1$

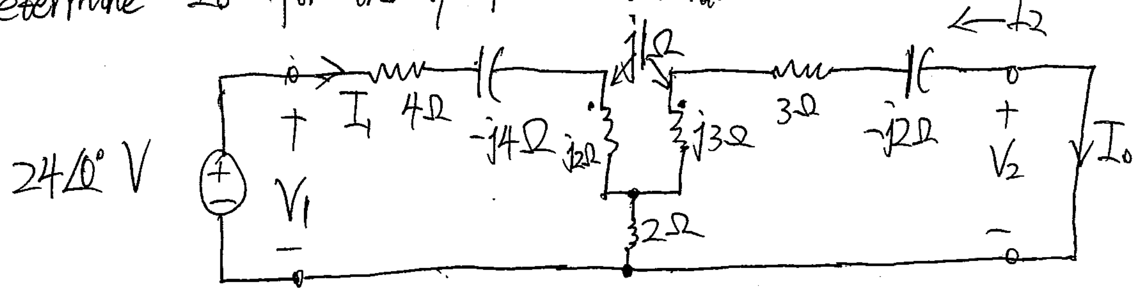
$B_c = 3\Omega$

$C_c = 0$

$D_c = 1$

$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} 1 & 12 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ \frac{1}{6} & 1 \end{bmatrix} \begin{bmatrix} 1 & 3 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 3 & 21 \\ \frac{1}{6} & \frac{3}{2} \end{bmatrix}$$

Q12. Find the Z parameters for the two-port network below and then determine I_o for the specified terminal conditions.



Solution:

$V_1 = I_1(6-j2) + I_2(2+j1)$ $\qquad$ $V_2 = I_1(2+j1) + I_2(5+j1)$

$$\boxed{\begin{array}{ll} Z_{11} = 6-j2\,\Omega & Z_{12} = 2+j1\,\Omega \\ Z_{21} = 2+j1\,\Omega & Z_{22} = 5+j1\,\Omega \end{array}}$$

$V_1 = 24\angle 0^\circ$ V

$V_2 = 0$ $\qquad$ $I_2 = -I_o$

$$\begin{bmatrix} 6-j2 & 2+j1 \\ 2+j1 & 5+j1 \end{bmatrix}\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 24\angle 0^\circ \\ 0 \end{bmatrix} \Rightarrow I_2 = 1.78\angle -138^\circ \text{ A}$$

$$\Rightarrow I_o = 1.78\angle 42^\circ \text{ A.}$$