Classroom

ESE Mains Achiever's Study Plan

Electronics & Communication Engineering

Networks Part-3

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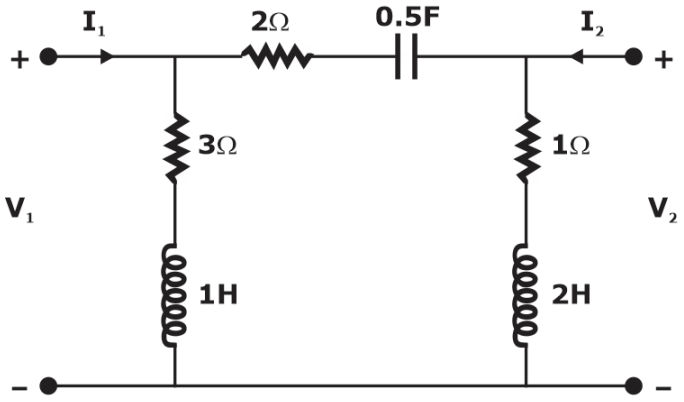
1. Find the Y parameter of the circuit shown below:



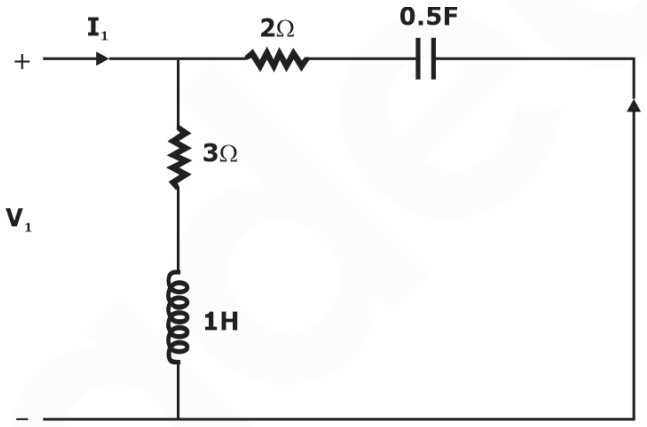
Sol. The Y parameter or short circuit parameter

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

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

To calculate Y_{11} and Y_{21}, $V_2 = 0$ or short circuit

So, the circuit will be



1Ω and 2H inductors can be removed as they are redundant.

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

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

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

$$V_1 = I_1\left[\frac{2\left(s^2+4s+3\right)}{s^2+3s+2s+2}\right] \quad \ldots\ldots(i)$$

$$Y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0} = \frac{s^2+5s+2}{2\left(s^2+4s+2\right)} \ldots(A)$$

From circuit of figure – 1

$$I_2 = -I_1\left[\frac{3+s}{3+s+2+\frac{2}{s}}\right] \qquad \text{(by current division rule)}$$

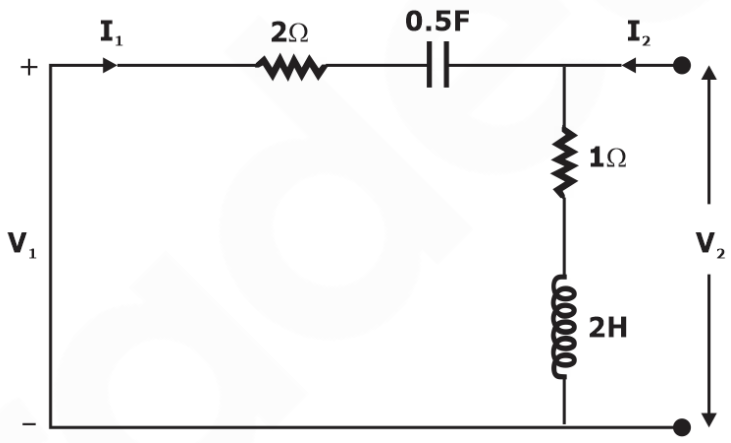
$$I_2 = -I_2\left[\frac{s(s+3)}{s^2+5s+2}\right].....(ii)$$

$$Y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0} = \frac{\frac{-I_2 s(s+3)}{s^2+5s+2}}{I_1 \times \frac{2(s^2+4s+3)}{s^2+5s+2}}$$

$$Y_{21} = \frac{-s(s+3)}{2(s^2+4s+3)}$$

$$Y_{21} = -\frac{s}{2(s+1)} \quad .....(B)$$

For Y_{12} and Y_{22} we have $V_1 = 0$ or short circuited.



For $Y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1=0}$, for $Y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1=0}$

$$V_2 = I_2\left[(1+2s)\,||\left(\frac{2s+2}{s}\right)\right] = I_2\left[\frac{(1+2s)\times\left(\frac{2s+2}{s}\right)}{(1+2s)+\left(\frac{2s+2}{s}\right)}\right] = I_2\left[\frac{2(1+2s)(s+1)}{2s^2+s+2s+2}\right]$$

$$V_2 = I_2\left[\frac{2(1+2s)(s+1)}{2s^2+3s+2}\right].....(iii)$$

$$Y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1=0} = \left[\frac{2s^2+3s+2}{4s^2+6s+2}\right].....(C)$$

$$I_1 = -I_2 \frac{(1+2s)}{1+2s+2+\frac{2}{s}} = -I_2 \frac{(2s+1)s}{2s^2+3s+2}$$

$$I_1 = -I_2 \frac{s(2s+1)}{(2s^2+3s+2)} \quad \text{.....(iv)}$$

$$Y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1=0} = \frac{-\frac{s(2s+1)}{(2s^2+3s+2)}}{\frac{2(2s+1)(s+1)}{(2s^2+3s+2)}} = -\frac{s}{2(s+1)}$$

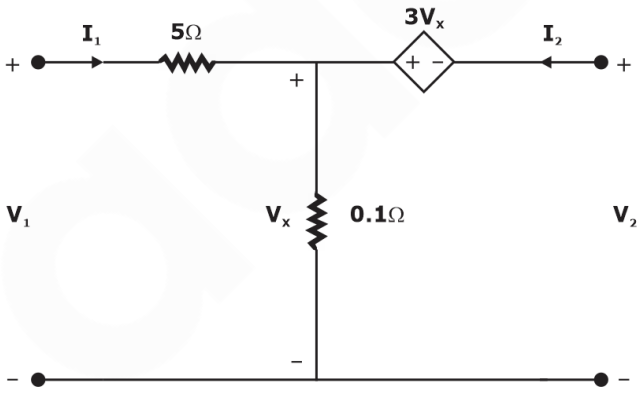
$$Y_{12} = -\frac{s}{2(s+1)}$$

So the Y parameter matrix will be

$$[Y] = \begin{bmatrix} \frac{s^2+5s+2}{2(s^2+4s+2)} & -\frac{s}{2(s+1)} \\ -\frac{s}{2(s+1)} & \frac{2s^2+3s+2}{4s^2+6s+2} \end{bmatrix}$$

$Y_{12} = Y_{21}$ therefore network is symmetrical

2. Determine h-parameter of the network shown below:



Sol. Applying KVL in loops

$-V_1 + 5I_1 + V_x = 0$ ...(i)

$-V_2 - 3V_x + V_x = 0$

or $-V_2 = 2V_x$ ...(ii)

$$V_x = \frac{(I_1+I_2)}{0.1} = 10(I_1+I_2) \quad \text{.....(iii)}$$

By (i) and (iii)

$-V_1 + 5I_1 + 10\ I_1 + 10I_2 = 0$

$15I_1 + 10I_2 = V_1$ .....(iv)

By (ii) and (iii)

$-V_2 = 2 \times 10 (I_1 + I_2)$

$20I_1 + 20I_2 = -V_2$ .....(v)

$I_2 = \frac{-V_2 - 20I_1}{20}$ .....(vi)

The h parameter is given as

$V_1 = h_{11}I_1 + h_{12}V_2$ .....(A)

$I_2 = h_{21}I_1 + h_{22}V_2$....(B)

By (iv) and (vi)

$$V_1 = 15I_1 + 10 \times \frac{(-V_2 - 20I_1)}{20} = 15I_1 - 0.5V_2 - 10I_1$$

$V_1 = 5I_1 - 0.5V_2$ .....(C)

Rewriting equation (vi)

$$I_2 = \frac{-20I_1 - V_2}{20}$$

$I_2 = -I_1 - 0.05V_2$ .....(D)

Comparing A, B, C and D

$h_{11} = 5$, $h_{12} = -0.5$, $h_{21} = -1$ $h_{22} = -0.05$

$\because h_{21} \neq -h_{12}$ so the above h parameter is not reciprocal.

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