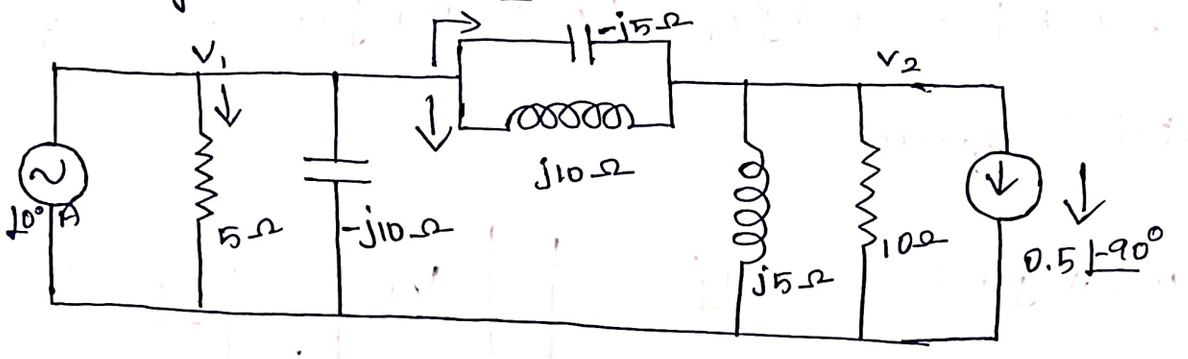
Node Analysis: for AC circuit:



Apply KCL at Node 1

$$1\angle 0^\circ = \frac{V_1 - 0}{5} + \frac{V_1 - 0}{-j10} + \frac{V_1 - V_2}{-j5\Omega} + \frac{V_1 - V_2}{j10\Omega}$$

$$= \frac{V_1}{5} + \frac{V_1}{-j10} + \frac{V_1}{-j5\Omega} - \frac{V_2}{-j5\Omega} + \frac{V_1}{j10\Omega} - \frac{V_2}{j10\Omega}$$

$$= V_1\left[\frac{1}{5} - \frac{1}{j10} - \frac{1}{j5} + \frac{1}{10j}\right] + V_2\left[\frac{1}{j5} - \frac{1}{j10}\right]$$

$$= V_1\left[\frac{1}{5} + \frac{j}{10} + \frac{j}{5} - \frac{j}{10}\right] + V_2\left[\frac{-j}{5} + \frac{j}{10}\right]$$

$$= V_1[0.2 + j0.2] + V_2[j(-0.2+0.1)]$$

$$1 = V_1[0.2 + j0.2] + V_2(-0.1)j \quad \text{——} \ (1)$$

Apply KCL at node 2

$$0.5\angle -90^\circ + \frac{V_2}{10} + \frac{V_2}{j5\Omega} + \frac{V_2 - V_1}{-j5\Omega} + \frac{V_2 - V_1}{j10\Omega}$$

$$0.5\angle -90^\circ + \frac{V_2}{10} + \frac{V_2}{j5} - \frac{V_2}{j5\Omega} + \frac{V_1}{j5\Omega} + \frac{V_2}{j10} - \frac{V_1}{j10}$$

$$-0.5j = 0.1V_2 - j0.2V_1 - j0.1V_2 + j0.1V_1$$

$$-0.5j = +0.1jV_1 + V_2[0.1 - j0.1)$$

$$-0.5j = 0.1jV_1 + (0.1 - 0.1j)V_2$$

(40) $-0.5j = 0.1jV_1 - (0.1 - 0.1j)V_2$ —— (2)

Matrix form:

$$\begin{vmatrix} 0.2 + j0.2 & -0.1j \\ 0.1j & -(0.1 - j0.1) \end{vmatrix} \begin{vmatrix} V_1 \\ V_2 \end{vmatrix} = \begin{vmatrix} 1 \\ -0.5 \end{vmatrix}$$

$$\Delta = \begin{vmatrix} 0.2 + j0.2 & -0.1j \\ 0.1j & -(0.1 - j0.1 \end{vmatrix}$$

$$= (0.2 + j0.2)(-0.1 + j0.1) - (0.1j)(-0.1)j$$

$$= 0.05 - j0.1$$

$$\Delta_1 = \begin{vmatrix} 1 & -j0.1 \\ -0.5j & -(0.1 - j0.1) \end{vmatrix}$$

$$= -0.05 - j0.1$$

$$V_1 = \frac{\Delta V_1}{\Delta} = 1 - j2$$

$$= 2.23 \angle -63.4$$

$$\Delta V_2 = \begin{vmatrix} 0.2 + j0.2 & 1 \\ 0.1j & -j0.5 \end{vmatrix}$$

$$= -0.1 + 0.2j$$

$$V_2 = \frac{\Delta V_2}{\Delta}$$