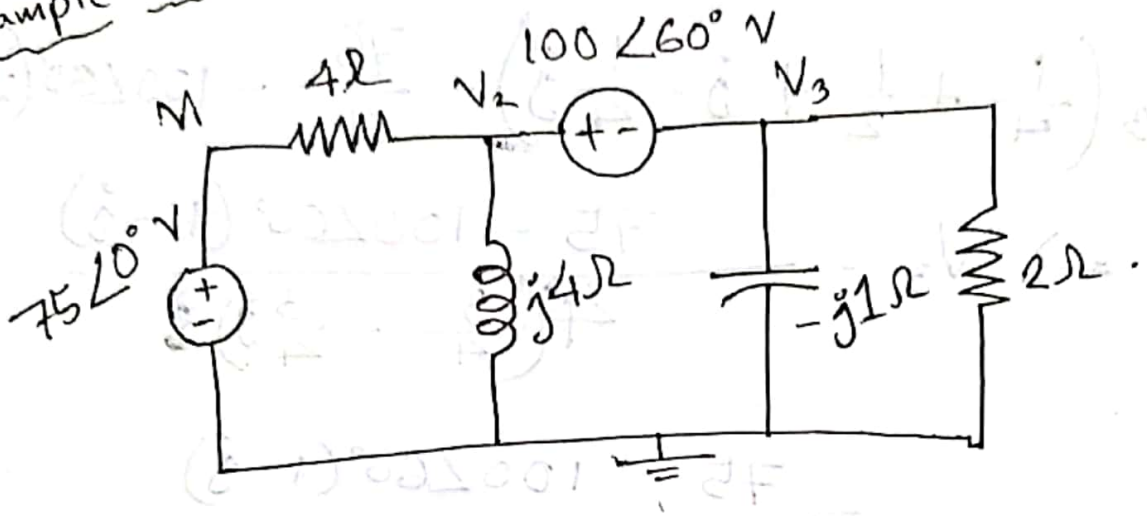
Lecture 14 (Continued)

Nodal & Mesh Analysis on AC Circuits

Example 2 (Nodal)



Node 1

$$V_1 = 75\angle 0^\circ \quad \text{---} \quad (i)$$

Supernode

$$V_2 - V_3 = 100\angle 60^\circ \quad \text{---} \quad (ii)$$

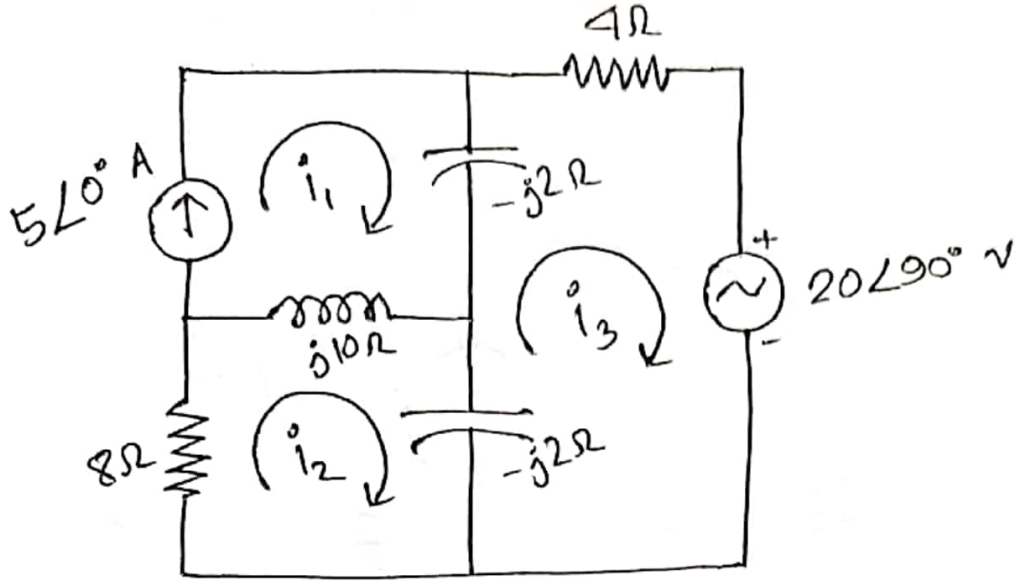
$$V_2\left(\frac{1}{4} + \frac{1}{j4}\right) - \frac{V_1}{4} + V_3\left(\frac{1}{-j} + \frac{1}{2}\right) = 0$$

$$\text{---} \quad (iii)$$

Substituting, $V_1 = 75$ in (iii),

$$V_2\left(\frac{1}{4} + \frac{1}{j4}\right) + V_3\left(\frac{1}{2} - \frac{1}{j}\right) = \frac{75}{4} \quad \text{---} \quad (iv)$$

Example 3 (Mesh)



Mesh 1

$$i_1 = 5\angle 0^\circ \quad \text{—} \quad (i)$$

Mesh 2

$$8 i_2 + j10(i_2 - i_1) - j2(i_2 - i_3) = 0$$

$$\Rightarrow i_2(8 + j8) - j10 i_1 + j2 i_3 = 0$$

— (ii)

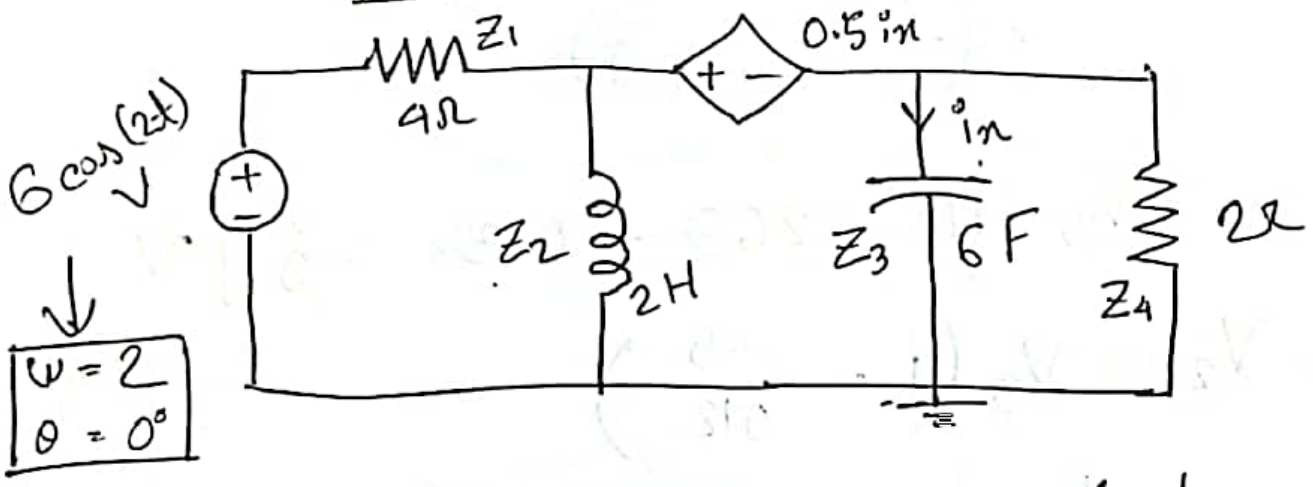
Mesh 3

$$-j2(i_3 - i_1) + 4 i_3 + 20\angle 90^\circ - j2(i_3 - i_2) = 0$$

$$\Rightarrow i_3(4 - j4) + i_1 j2 + i_2 j2 = -20\angle 90^\circ$$

— (iii)

II AC Nodal Analysis



$Z_1 = 4\Omega$

$Z_2 = j\omega L$

$= j \times 2 \times 2$

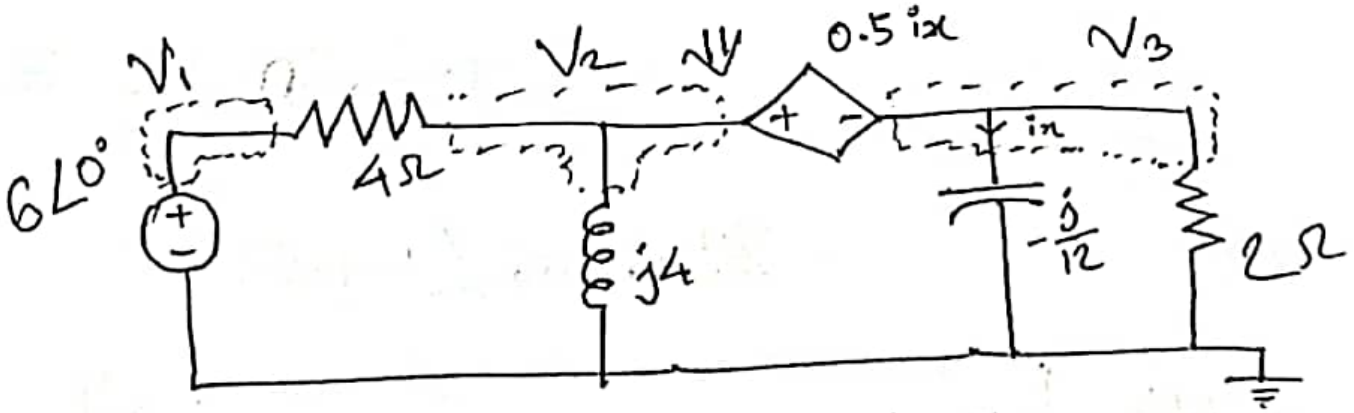
$= j4\ \Omega$

$Z_3 = \frac{1}{j\omega C}$

$= \frac{1}{j \times 2 \times 6}$

$= \frac{-j}{12}\ \Omega$

$Z_4 = 2\ \Omega$



Here, $i_x = \frac{V_3}{Z_3} = \frac{12V_3}{-j} = j12V_3$

Node -1

$$V_1 = 6\angle 0^\circ \quad \text{---} \quad (i)$$

Node - 2,3 [Supernode]

$$V_2 - V_3 = 0.5\, ix$$

$$= 0.5 \times (j12 V_3) = j6 V_3$$

$$\Rightarrow V_2 = V_3 (1 + j6) \quad \text{---} \quad (ii)$$

Applying KCL at Node 2 & 3,

$$\frac{V_2 - V_1}{4} + \frac{V_2}{j4} + j12 V_3 + \frac{V_3}{2} = 0 \quad \text{---} \quad (iii)$$

Solving Equation

$$V_1 = 6\ V \qquad [\text{from (i)}]$$

$$V_2\left(\frac{1}{4} + \frac{1}{j4}\right) + V_3\left(\frac{1}{2} + j12\right) = \frac{6}{4}$$

from (ii), replacing V_2 by $V_3(1 + j6)$,

$$\Rightarrow V_3(1 + j6)\left(\frac{1}{4} + \frac{1}{j4}\right) + V_3\left(\frac{1}{2} + j12\right) = \frac{3}{2}$$

$$\Rightarrow V_3\left\{\left(\frac{7}{4} + \frac{5}{4}j\right) + \left(\frac{1}{2} + j12\right)\right\} = \frac{3}{2}$$

$$\Rightarrow V_3\left(\frac{9}{4} + \frac{53}{4}j\right) = \frac{3}{2}$$

$$\Rightarrow V_3 = \frac{3}{2} \times \frac{1}{\frac{9}{4} + \frac{53}{4}j}$$

$$\therefore V_3 = \boxed{0.0187 - 0.11j} \quad \text{(Ans.)}$$

$$= 0.1116 \angle -80.36^\circ$$

$$\therefore V_2 = V_3(1 + j6)$$

$$= \boxed{0.6789 + 0.00207j} \quad \text{(Ans.)}$$

$$= 0.6786 \angle 0.175^\circ$$

$i_x(t)$

$$i_x = j12V_3 = 1.32 + 0.224j$$

$$= 1.339 \angle 9.637^\circ$$

$$\therefore i_x(t) = \boxed{1.339 \cos(2t + 9.637^\circ)}$$

(Ans.)