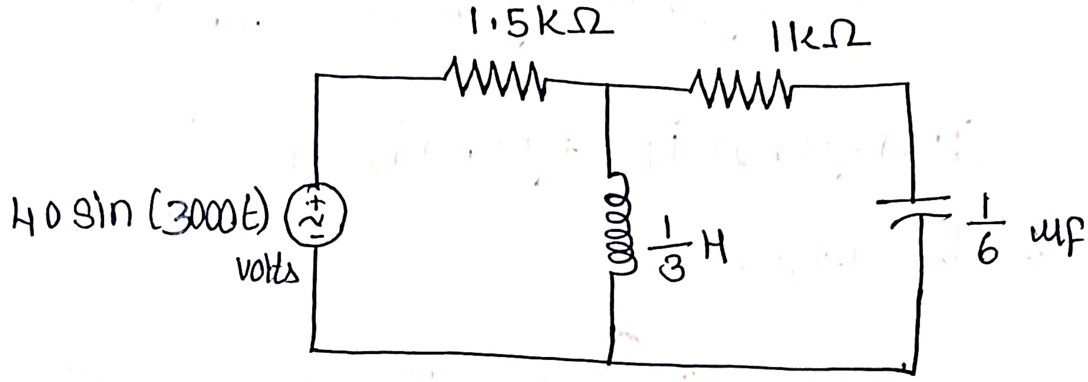
Determine the mesh current for the following circuit using mesh current analysis



1) All the passive elements should be represented in terms of impedance.

2) Represent time domain current and voltage source in terms of ~~imped~~ polar form.

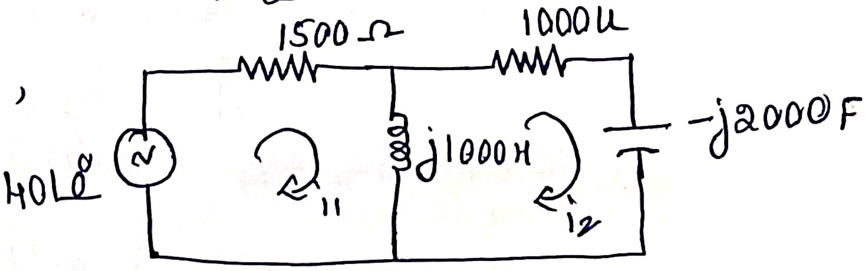
$$V_m \sin(\omega t) = V_m \angle 0^\circ$$

$$40 \sin(3000t) = 40 \angle 0^\circ \quad [\omega = 3000]$$

$$X_L = j\omega L = j \times 3000 \times \frac{1}{3} = 1000j$$

$$X_C = \frac{1}{j\omega C} = \frac{1}{j \times \cancel{3000}^{1000} \times \frac{1}{\cancel{6}_{2}} \mu F} = -j \frac{\times 10^6}{500} = -j2000$$

The ckt is drawn as,



(34) Apply KVL to loop 1,

$$+40\angle 0 - 1500 i_1 - j1000(i_1 - i_2) = 0$$

$$1500 i_1 - j1000 i_1 + j1000 i_2 = 40\angle 0^\circ$$

$$(1500 - j1000) i_1 + j1000 i_2 = 40\angle 0^\circ \quad \text{——— (1)}$$

Apply KVL to loop 2.

$$-1000j(I_2 - I_1) - 1000 I_2 + j2000 I_2 = 0.$$

$$-1000j I_2 + 1000j I_1 - 1000 I_2 + j2000 I_2 = 0.$$

$$1000j I_1 + (1000j - 1000) I_2 = 0 \quad \text{——— (2)}.$$

$$IZ = V.$$

$$\begin{bmatrix} 1500 - j1000 & 1000j \\ 1000j & -1000 + 1000j \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 40\angle 0^\circ \\ 0 \end{bmatrix}$$

$$\Delta = (1500 - j1000)(-1000 + j1000) - j^2(1000)^2$$

$$= -1500000 + j1500000 + j1000000\ 3500000 - j50,0000$$

$$+1000000$$

$$= \quad +j$$

$$\Delta_2 = j40,000$$

$$\Delta_1 = 40,000 - j40,000$$

$$I_2 = \frac{\Delta_2}{\Delta} = -0.0016 - j0.0112$$

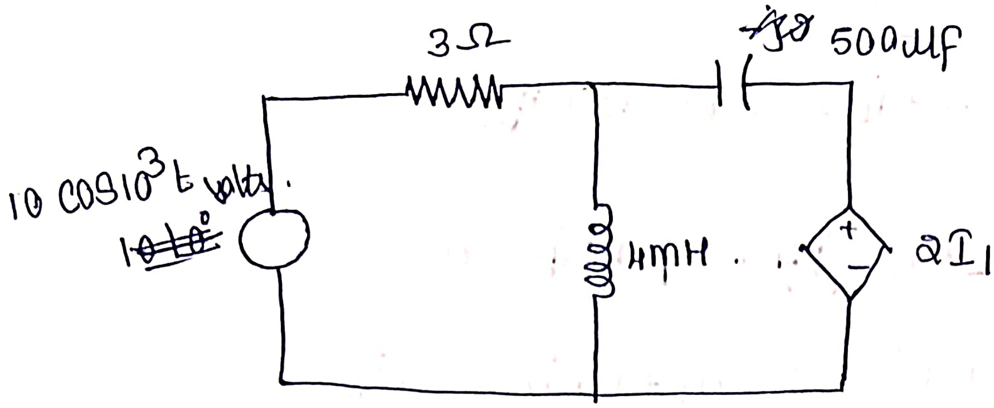
$$0.0113\angle 98.13 A.$$

$$I_1 = 0.0128 - j0.0096$$

$$= 0.0113\angle 98.13$$

mesh analysis

(35)



soln

$V_m \cos(\omega t) = 10 \cos(10^3 t)$ in polar form

$V_m = 10 \quad \omega \cancel{t} = 10^3 \cancel{t} \Rightarrow \omega = 10^3$

$V_m \angle 0^\circ$

$10 \angle 0^\circ$.

$X_L = j\omega L$

$= j\, 10^3 \times 4 \times 10^{-3}$

$\boxed{X_L = j4\ \Omega}$

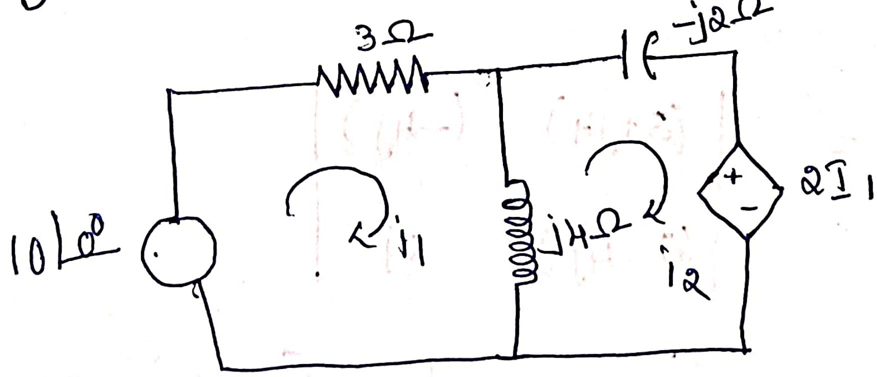
$X_C = \frac{1}{j\omega C}$

$= \frac{1}{j 10^3 \times 500 \times 10^{-6}}$

$= -j \frac{1}{.500}$

$\boxed{X_C = -j2\ \Omega}$

Redrawing the circuit in time domain



(36)

$$10\angle 0^\circ - 3i_1 - (i_1 - i_2)\,4j = 0$$

$$10\angle 0^\circ - 3i_1 - j4\,i_1 + 4j\,i_2 = 0$$

$$10\angle 0^\circ = 3i_1 + j4\,i_1 - j4\,i_2$$

$$= (3+j4)\,i_1 - j4\,i_2 \quad \text{——— (1)}$$

$$-j4\,(i_2 - i_1) - (-j2) - 2I_1 = 0$$

$$-j4\,i_2 + j4\,i_1 + j2i_2 - 2I_1 = 0$$

$$(-2+4j)\,i_1 - 2j\,i_2 = 0 \quad \text{——— (2)}$$

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$$(2-4j)\,i_1 + 2j\,i_2 = 0 \quad \text{——— (3)}$$

$$\begin{vmatrix} (3+j4) & (-4j) \\ (2-4j) & 2j \end{vmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 10\angle 0^\circ \\ 0 \end{bmatrix}$$

$$\Delta = \begin{vmatrix} (3+j4) & (-4j) \\ (2-4j) & 2j \end{vmatrix}$$

$$= [6j - 8] - [-8j - 16]$$

$$\boxed{\Delta = 14j + 8}$$

$$\Delta_2 = \begin{bmatrix} 3+j4 & 10 \\ 2-4j & 0 \end{bmatrix}$$

$$= -(2-4j)\,10$$

$$\boxed{\Delta_1 = -20+40j}$$

$$\Delta_1 = \begin{vmatrix} 10 & -4j \\ 0 & 2j \end{vmatrix}$$

$$= 20j$$

$$I_1 = \frac{\Delta_1}{\Delta} = \frac{20j}{8+14j} = 1.076 + 0.615j$$

$$I_1 = 1.24 \angle 29.7$$

$$\boxed{I_1 = 1.24 \cos 10^3 t + 29.7^{\circ}}$$

$$I_2 = \frac{\Delta_2}{\Delta} = \frac{-20+40j}{8+14j} = 1.53 + 2.30j$$

$$I_2 = 2.77 \angle 56.3$$

$$I_2 = 2.77 \cos (10^3 t + 56.3^{\circ}$$

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$\Delta = -500000 + 2500{,}0001 + 1000000$

$= -500000 + 3500{,}0001$