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BATCH : B10

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Date
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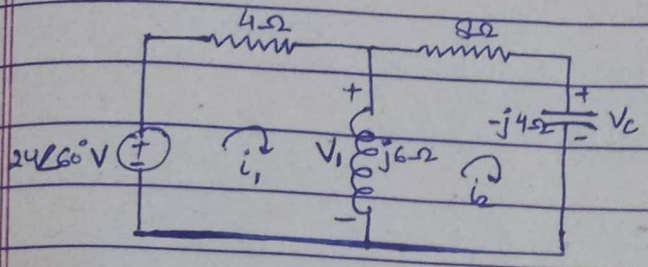
Electrical Science - I (15B11EC111)

Tutorial - 8

Q.1.



Applying KVL in mesh ① :

$$24\angle 60 - 4i_1 - j6(i_1 - i_2) = 0$$

$$(4+j6)i_1 - j6 i_2 = 24\angle 60^\circ \quad -①$$

Applying KVL in mesh ② :

$$-8i_2 + j4 i_2 + j6(i_1 - i_2) = 0$$

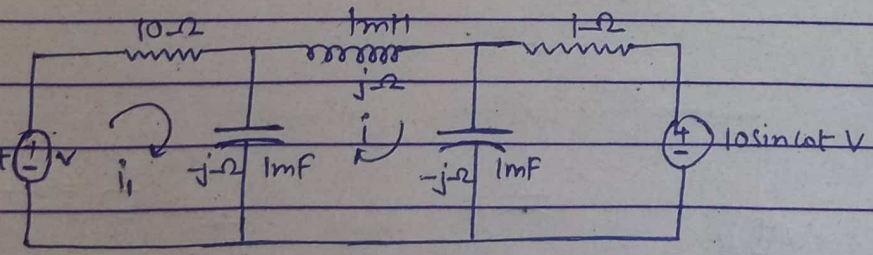
$$j6 i_1 - (8+j2) i_2 = 0 \quad -②$$

$$\begin{bmatrix} 4+j6 & -j6 \\ j6 & -(8+j2) \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} 24\angle 60^\circ \\ 0 \end{bmatrix}$$

$$i_1 = \frac{\Delta_1}{\Delta} = \frac{\begin{vmatrix} 24\angle 60 & -j6 \\ 0 & -(8+j2) \end{vmatrix}}{\begin{vmatrix} 4+j6 & -j6 \\ j6 & -(8+j2) \end{vmatrix}} = 2.184 + j1.213 \text{ A}$$

$$i_2 = \frac{\Delta_2}{\Delta} = \frac{\begin{vmatrix} 4+j6 & 24\angle 60 \\ j6 & 0 \end{vmatrix}}{\begin{vmatrix} 4+j6 & -j6 \\ j6 & -(8+j2) \end{vmatrix}} = -0.4706 + j1.756 \text{ A}$$

Q.2.



Applying KVL in loop ① ,

$$18\angle 0 = 10i_1 - j(i_1 - i)$$

$$10\angle 0 = (10-j)i_1 - ji \quad -①$$

Applying KVL in loop ②

$-ji + j(i - i_2) - j(i_1 - i) = 0$

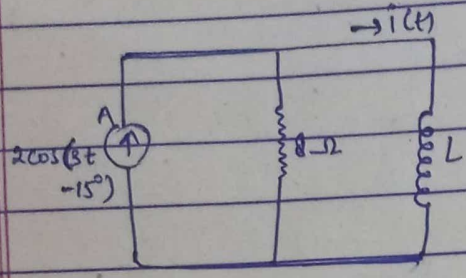
$ji - ji_1 - ji_2 = 0$ — ②

Applying KVL in loop ③

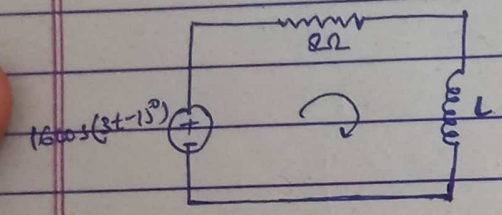
$-i_2 \cdot 10\angle -90 - j(i - i_2) = 0$

$-ji + (1+j)i_2 = 10\angle -90°$ — ③

Q.3.



$i(t) = B\cos(3t - 51.87°)$



The current through the inductor is,

$i(t) = B\cos(3t - 57.87°)$

$\frac{V}{R+j\omega L} = B\cos(3t - 51.87°)$

$\frac{16\cos(3t-15°)}{8+j\omega L} = B\cos(3t - 57.87°)$

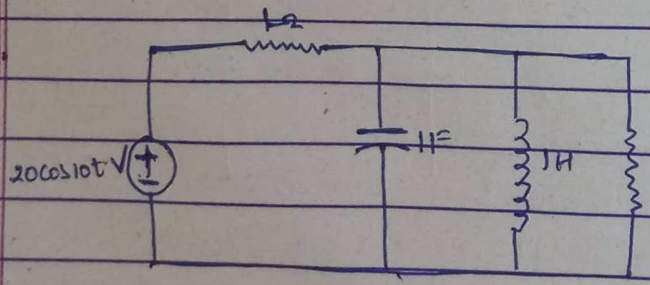
$\frac{16}{8+j\omega L} \angle -15° = B\angle -57.87°$

$-57.87 = -15 - \tan^{-1}\left(\frac{3L}{8}\right)$

$L = 2H$ //

$B = \frac{16}{\sqrt{64+9L^2}} = \frac{16}{10} = 1.6$ A //

Q.4.



$\frac{1}{Z_1} = \frac{1}{R_1} + \frac{1}{X_L} + \frac{1}{X_C}$

$Y_1 = 1 + \frac{1}{j10} + j10$

$Z_1 = \frac{j10}{j10 - 99}$

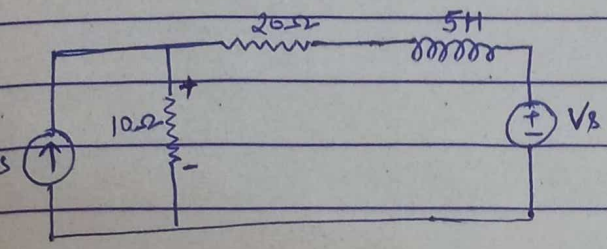
$= \frac{j10 - 99}{j10}$

$$Z_{eq} = 1 + \frac{j10}{j10 - 99} = \frac{j20 - 99}{j10 - 99}$$

$$i = \frac{20\cos 10t}{\left(\frac{j20 - 99}{j10 - 99}\right)} = \frac{20\angle 0}{1.01 - 0.99j} = 19.703\angle 5.653^\circ$$

$$= 19.703\cos(10t + 5.653^\circ) \text{ A}$$

Q.6.

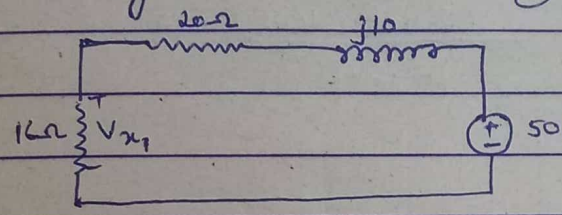


$V_s = 50\sin 2t = 50\angle -90^\circ$

$i_s = 12\cos(6t + 10^\circ)$ A

$i_s = 12\angle 10^\circ$

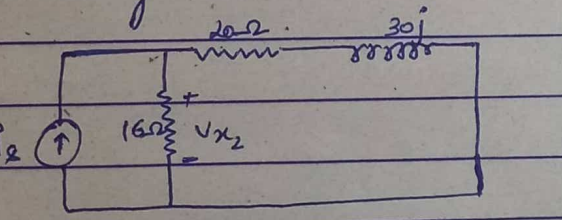
Considering $V_s = 50\angle -90^\circ$ voltage source & $\omega = 2$



$$V_{x_1} = \frac{50\angle -90^\circ \times 16}{36 + j10}$$

$$V_{x_1} = 21.411\angle -105.524$$

Considering $i_s = 12\angle 10^\circ$ & $\omega = 6$



Applying Nodal Analysis

$$12\angle 10^\circ = \frac{V_x}{16} + \frac{V_x}{20 + j30}$$

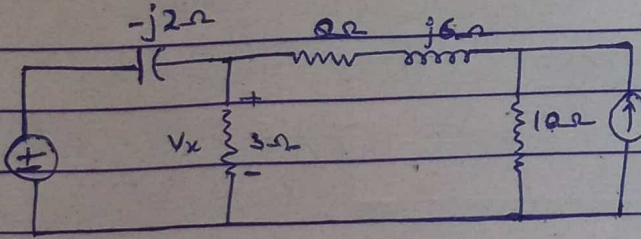
$$6922.65\angle 66.30^\circ = (20 + j30)V_{x_2} + 16V_{x_2}$$

$$6922.65\angle 66.30 = (36 + 30j)V_{x_2}$$

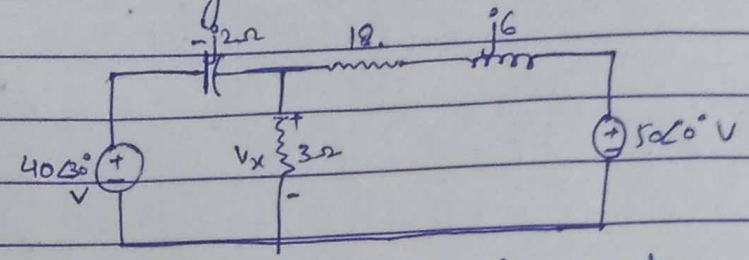
$$V_{x_2} = 147.72\angle 26.504^\circ$$

$$V_x = V_{x_1} + V_{x_2} = 21.411\cos(2t - 105.524^\circ) + 147.72\cos(6t + 26.504^\circ)$$

Q.5.



Nodal Analysis + Source transformation.



Applying Nodal Analysis into Node

$$\frac{V_x - 40\angle 30^\circ}{-j2} + \frac{V_x}{3} + \frac{V_x - 50\angle 0^\circ}{18+j6} = 0$$

$$\frac{V_x}{-j2} + \frac{V_x}{3} + \frac{V_x}{18+j6} = \frac{40\angle 30^\circ}{-j2} + \frac{50\angle 0}{18+j6}$$

$$\frac{(54+j18)V_x + (12-36j)V_x - j6V_x}{-6j(18+j6)} = 20\angle 120^\circ + 2.635\angle -18.43^\circ$$

$$V_x = \frac{2062.908\angle 42.89}{66-24j} = 29.36\angle 62.87^\circ \text{ Volt}$$