CIRCUITS AND ELECTRONICS

CSE250

summer 22

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sec : 19

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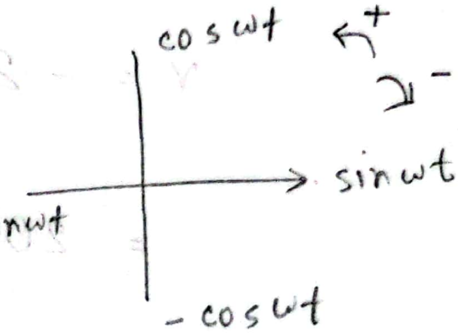
Ans to Q no 1

(1) $I = 2\cos(\omega t + 10^\circ)$

$v = 3\sin(\omega t - 10^\circ)$

$= 3\cos(\omega t - 10^\circ - 90^\circ)$ $-\sin\omega t$



$= 3\cos(\omega t - 100^\circ)$

$\therefore$ phase diffrence $= 10^\circ - (-100^\circ) = 110^\circ$

$\therefore$ I is leading v by 110°

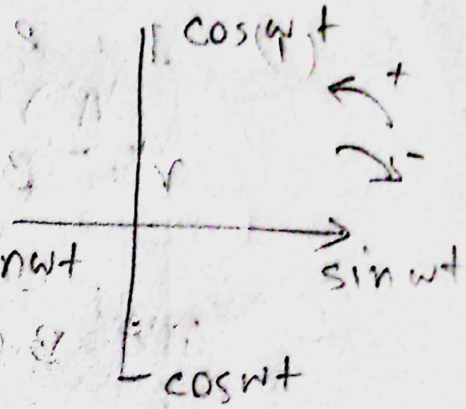
phasor form:

a) $I = 2\cos(\omega t + 10^\circ) = 2\angle 10^\circ$

b) $v = 3\cos(\omega t - 100^\circ) = 3\angle -100^\circ$

(II) $I = 16\cos(\omega t + 10^\circ)$

$v = -20\sin(\omega t - 10^\circ)$



$= 20\cos(\omega t - 10^\circ + 90^\circ)$

$= 20\cos(\omega t + 80^\circ)$

$\therefore$ phase diffrence $= (80^\circ - 10^\circ) = 90^\circ$

$\therefore$ v is leading I by 90°

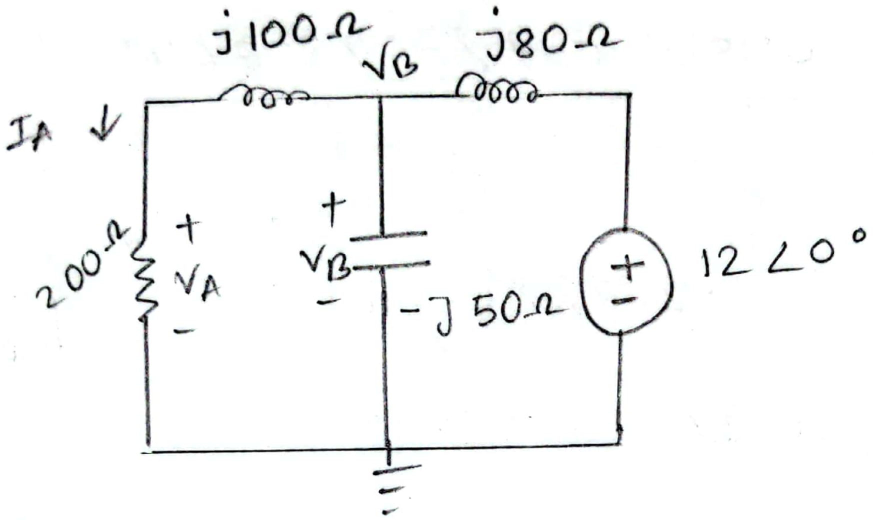
Phasor form:

$I = 16\cos(\omega t + 10^\circ) = 16\angle 10^\circ$

$v = 20\cos(\omega t + 80^\circ) = 20\angle 80^\circ$

Ans to the Q 2

4×10^{-3} -



KCL at V_B,

$$\frac{V_B}{-j50} + \frac{V_B - 12\angle 0^\circ}{j80} + \frac{V_B}{j100+200} = 0$$

$$\Rightarrow V_B(0.2j) - 0.0125jV_B + 0.15j + (4\times10^{-3} - 2\times10^{-3}j)V_B = 0$$

$$\Rightarrow V_B(0.2j - 0.0125j - 2\times10^{-3}j + 4\times10^{-3}) = -0.15j$$

$$\Rightarrow V_B = -\frac{0.15j}{4\times10^{-3} + 0.1855j}$$

$$= -0.80824 - 0.17428j$$

$$= \boxed{0.808437 \angle -178.764 V}$$

Now, $I_A = \dfrac{V_B}{Z_{eq}}$

$$= \frac{0.808437 \angle -178.7647}{(200 + 100j)}$$

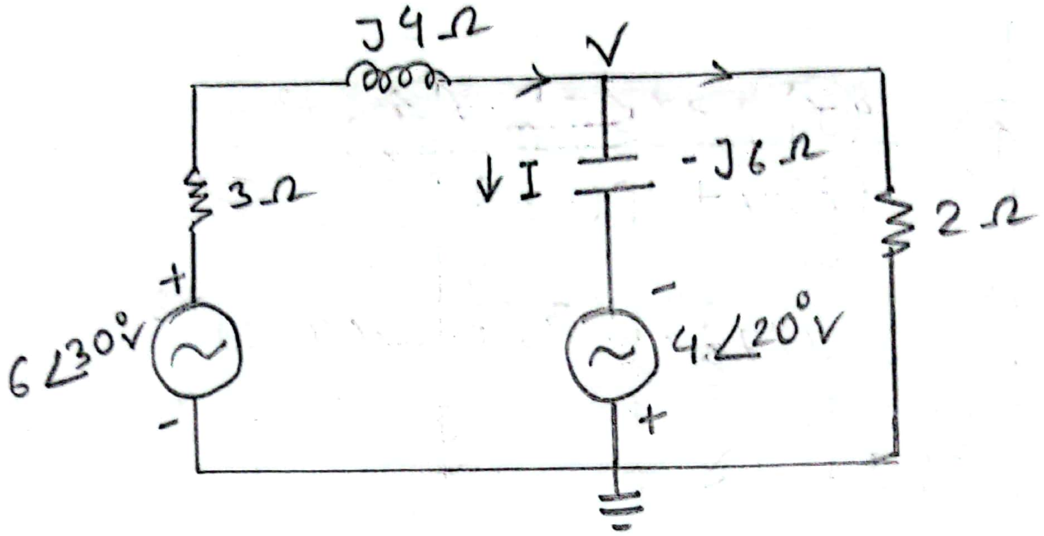
$$= -3.2678 \times 10^{-3} + 1.5467 \times 10^{-3} j$$

$\therefore V_A = 200 I_A$

$$= -0.6535 + 0.3093 j$$

$$= \boxed{0.723 \angle 154.67 \text{ V}}$$

Ans to Q 3



KCL at V,

$$\frac{V + 4\angle 20^\circ}{-j6} + \frac{V - 6\angle 30^\circ}{j4 + 3} + \frac{V}{2} = 0$$

$$\Rightarrow 0.167\,jV + 0.667\angle 110^\circ + V(0.12 - 0.16j) + 1.2\angle 156.86^\circ + 0.5V = 0$$

$$\Rightarrow V(0.167j + 0.12 - 0.16j + 0.5) = -1.726\angle 140.48^\circ$$

$$\Rightarrow V = 2.127 - 1.795j = \boxed{2.78\angle -40.16^\circ\,V}$$

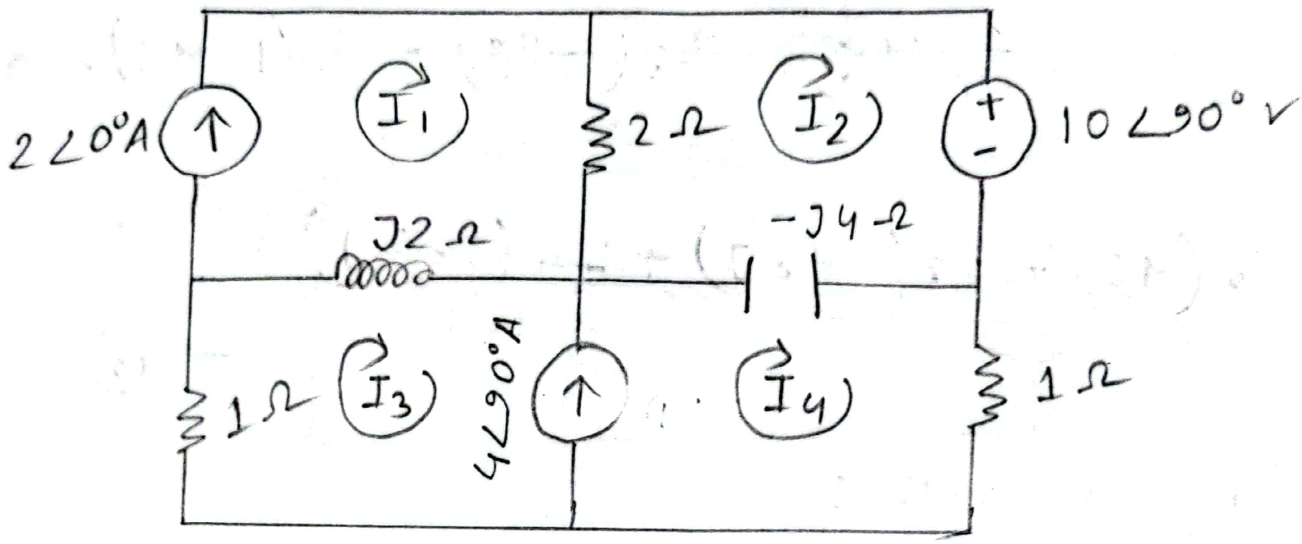
$$\therefore I = \frac{V + 4\angle 20^\circ}{-j6} = \frac{2.78\angle -40.16^\circ + 4\angle 20^\circ}{-j6}$$

$$= 0.0712 + 0.981j$$

$$= \boxed{0.9836\angle 85.84^\circ\,A}$$

Ans to Q 4

$10.77\angle 111.80$



(i) At loop 1 :

$$I_1 = 2\angle 0° A \quad — (1)$$

(ii) At loop 2 : (KVL)

$$10\angle 90° + (-j4)(I_2 - I_4) + 2(I_2 - I_1) = 0$$

$$\Rightarrow 10\angle 90° - I_2(j4) + I_4(j4) + 2I_2 - 2(2\angle 0°) = 0$$

$$\Rightarrow I_2(2 - 4j) + I_4(4j) = -10.77\angle 111.8 \quad — (2)$$

(iii) At supermesh :

$$I_3 + j2(I_3 - I_1) + (-j4)(I_4 - I_2) + I_4 = 0$$

$$\Rightarrow I_3(1 + 2j) - I_1(j2) - (j4)I_4 + I_2(j4) + I_4 = 0$$

$[I_1 = 2\angle 0°]$

$$\Rightarrow -2\angle 0°(j2) + I_3(1+2j) + I_2(j4) + I_4(1-4j) = 0$$

$$\Rightarrow -4j + I_2(4j) + I_3(1+2j) + I_4(1-4j) = 0$$

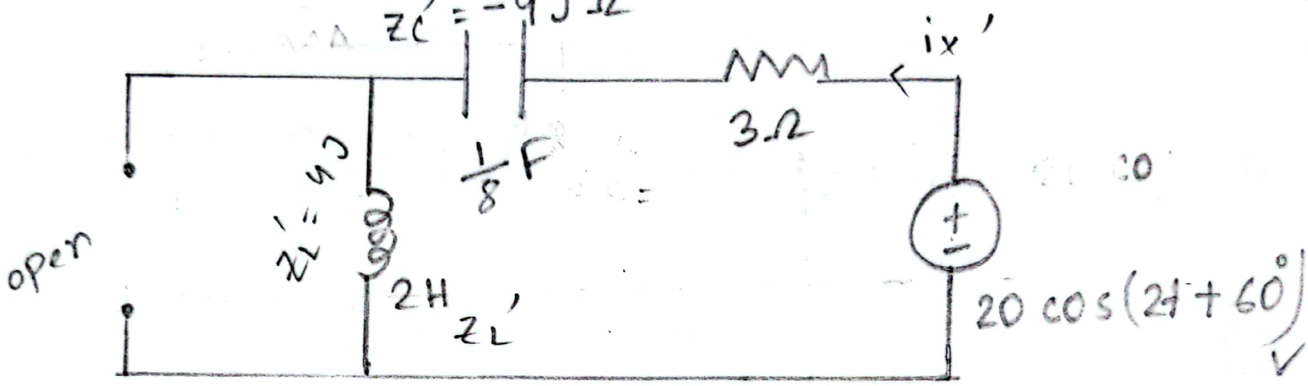
$$\Rightarrow I_2(4j) + I_3(1+2j) + I_3(1-4j) = 4j \quad — (3)$$

(iv)
from supermesh ;

$$I_4 - I_3 = 4\angle 90° \quad — (4)$$

Ans to Q 5

circuit after turning off current source :



$= 20\angle 60^\circ$

For $\omega = 2$;

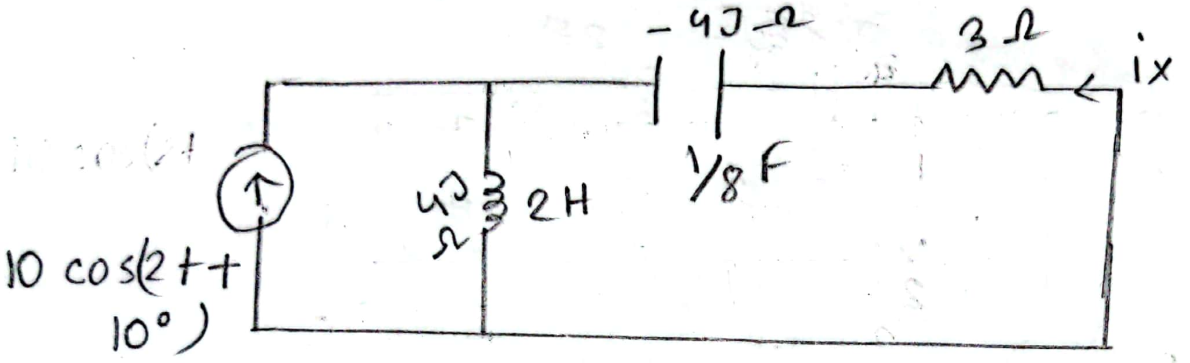
$$Z_C' = \frac{1}{j\omega C} = \frac{1}{j\times 2\times \frac{1}{8}} = -4j$$

$$Z_L' = j\omega L = j\times 2\times 2 = 4j$$

$$i_x' = \frac{V}{Z_{eq}} = \frac{20\angle 60^\circ}{3-4j+4j}$$

$$= 6.667\angle 60^\circ \text{ A}$$

Circuit after turning off voltage source:



$= 10\angle 10°$

Since $\omega = 2$, $Z_C'' = -4j$

$Z_L'' = 4j$

Current Division:

$$V'' = \frac{I}{Z_{eq}} = \frac{10\angle 10°}{(-4j+3) \parallel 4j} = \frac{10\angle 10°}{5.33+4j}$$

$$= 1.338 - 0.678j$$

$$I_x'' = -\left(\frac{V''}{3-4j}\right) = \frac{1.338-0.678j}{3-4j}$$

$$= -0.2691 - 0.132j$$

$$= 0.30012\angle -153.75° \text{ A}$$

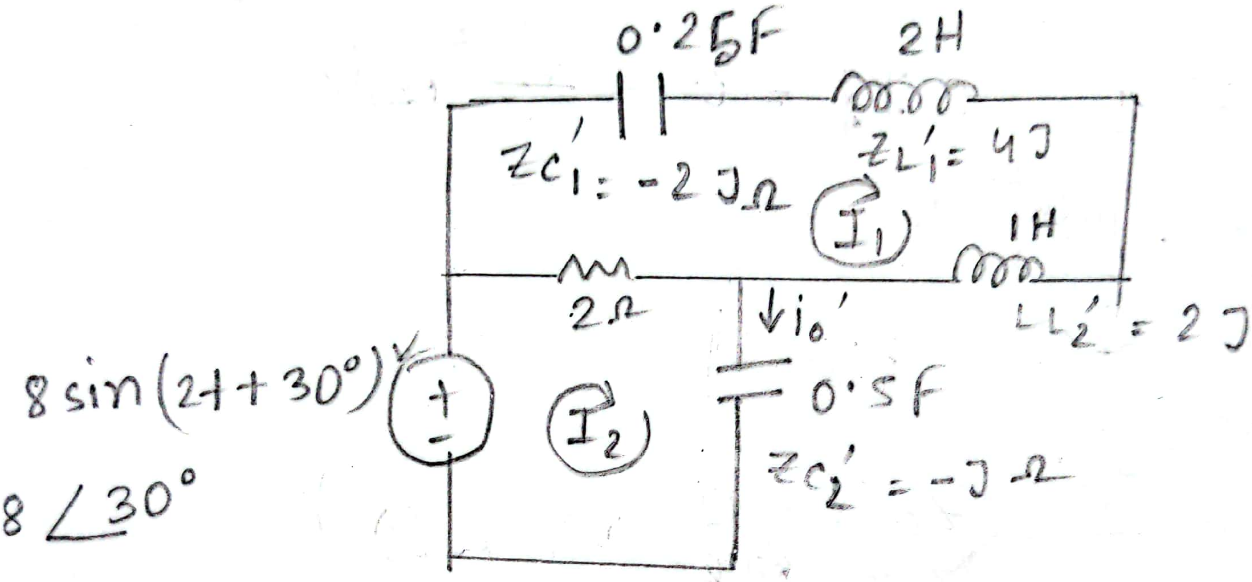
$$I_x = I_x' + I_x'' = 6.667\angle 60° + 0.30012\angle -153.75°$$

$$= 6.919\angle 61.488°$$

$$= \boxed{6.919\cos(2t + 61.488°)} \text{ A}$$

Ans to Q 6

Circuit after turning off current source:



For $\omega = 2$:

$$Zc_1' = \frac{1}{J\omega C_1} = \frac{1}{J \times 0{\cdot}25 \times 2} = -2J$$

$$Zc_2' = \frac{1}{J\omega C_2} = \frac{1}{J \times 0{\cdot}5 \times 2} = -J$$

$$Z_{L_1}' = J\omega L_1 = J \times 2 \times 2 = 4J$$

$$Z_{L_2}' = J\omega L_2 = J \times 2 \times 1 = 2J$$

Now, KVL at loop 2,

$$-8\angle 30° + 2I_2 - 2I_1 - JI_2 = 0$$

$$\Rightarrow -2I_1 + I_2(2-J) = 8\angle 30° \quad \text{——} \quad (1)$$

Now, KVL at loop 1 :

$$2I_1 - 2I_2 - (2j)I_1 + (4j)I_1 + (2j)I_1 = 0$$

$$\Rightarrow (4j+2)I_1 - 2I_2 = 0 \quad \text{—— } (2)$$

Cramer's rule :

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

$$= -2 \times -2 - \{(2-j)(4j+2)\}$$

$$= 4 - (8j + 4 + 4 - 2j)$$

$$= 4 - 6j - 8$$

$$= -6j - 4 = 7 \cdot 21 \angle -123 \cdot 69^\circ$$

$$\Delta_1 = \begin{bmatrix} 8\angle 30^\circ & (2-j) \\ 0 & -2 \end{bmatrix}$$

$$= 8\angle 30^\circ \times (-2) = -8\sqrt{3} - 8j$$

$$= 16 \angle -150^\circ$$

$$\Delta_2 = \begin{bmatrix} -2 & 8\angle 30^\circ \\ (4j+2) & 0 \end{bmatrix}$$

$$= -\left(8\angle 30 \times 4j + 8\angle 30 \times 2 \right)$$

$$= 2.143 - 35.71j$$

$$= 35.77\angle -86.56^\circ$$

$$\therefore I_2 = \frac{\Delta_2}{\Delta} = \frac{35.77\angle -86.56^\circ}{7.21\angle -123.69^\circ}$$

$$= 3.95 + 2.99j$$

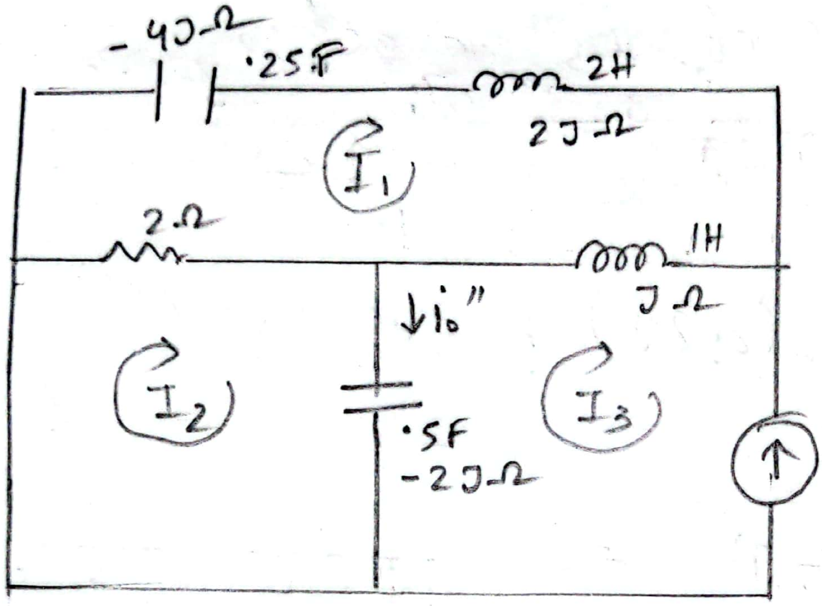
$$= 4.96\angle 37.12^\circ$$

$$\therefore i_o' = 4.96\angle 37.12^\circ \text{ A}$$

PTO

(Part II) $\quad \omega = (1+0) = 1$

After turning off voltage source :



cos(t) $= 1\angle 0$

for $w = 1$,

$Zc_1'' = \frac{1}{J \cdot 1 \cdot 0{\cdot}25} = -4J$ | $Zc_2'' = \frac{1}{J \times 1 \times 0{\cdot}5} = -2J$

$ZL_1'' = J \times 1 \times 2 = 2J$ $\quad ZL_2'' = J \times 1 \times 1 = J$

① KVL at loop 1,

$(-4J)I_1 + (2J)I_1 + (J)(I_1 - I_3) + 2I_1 - 2I_2 = 0$

$\Rightarrow I_1(2-J) - 2I_2 - (J)I_3 = 0$ —— ①

② KVL at loop 2,

$2I_2 - 2I_1 + (-2J)(I_2 - I_3) = 0$

$\Rightarrow 2I_2 - 2I_1 - (2J)I_2 + (2J)I_3 = 0$

$\Rightarrow -2I_1 + I_2(2-2J) + I_3(2J) = 0$ —— ②

③ KVL at loop 3 :

$$I_3 = -\cos(t) = -1\angle 0° \quad — ③$$

using value of I_3 we get,

① $I_1(2-j) - 2I_2 = -1\angle 0° \times j = -j \quad — ④$

② $-2I_1 + I_2(2-2j) = 2j \times -(-1\angle 0°)$

$= 2j \quad —— ⑤$

From 4, 5 :

$$\Delta = \begin{bmatrix} (2-j) & -2 \\ -2 & (2-2j) \end{bmatrix}$$

$= (4-2j-4j+2) - 4$

$= -6j - 2$

$$\Delta_2 = \begin{bmatrix} (2-j) & -j \\ -2 & 2j \end{bmatrix}$$

$= 4j+2-2j = 2j+2$

$$I_2 = \frac{\Delta_2}{\Delta} = \frac{2j+2}{-6j-2} = -0.4+0.2j$$

$= 0.447\angle 153.434°$

∴

$\therefore\ i_0'' = I_2 - I_3$

$= 0.447\angle 153.43^\circ + 1\angle 0^\circ$

$= 0.6 + 0.2J$

$= 0.632\angle 18.434^\circ$

$i_0 = i_0' + i_0''$

$= 4.96\angle 37.12^\circ + 0.632\angle 18.434^\circ$

$$\boxed{= 4.96\sin(2t + 37.12^\circ) + 0.632\cos(t + 18.434^\circ)}$$

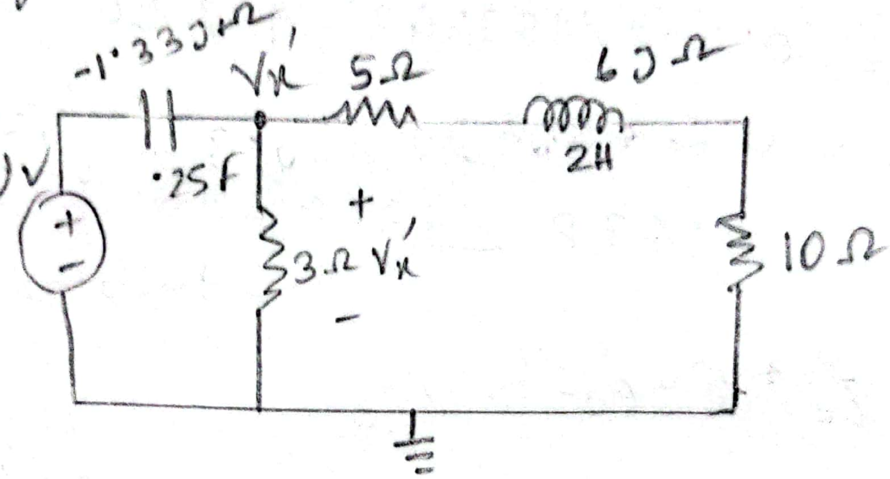
Ans to Q 7

Turning of the current source :

$w_1 = (2+1) = 3$

$10\cos(3t - 60^\circ)\,V$

$= 10\angle -60^\circ\ V$



for $w = 3$:

$$Z_c' = \frac{1}{j\times 3\times 0{\cdot}25} = -1{\cdot}33j$$

$$Z_L' = j\times 3\times 2 = 6j$$

KCL at V_x' :

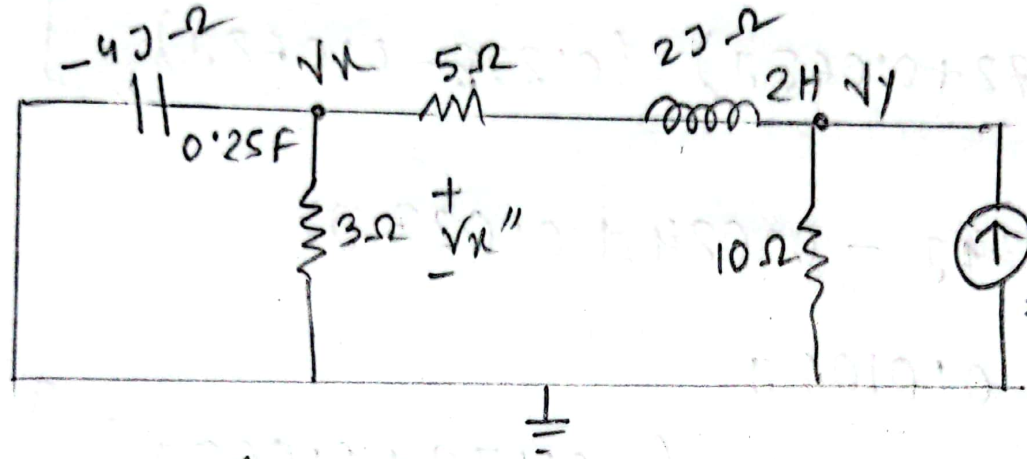
$$\frac{V_x' - 10\angle -60^\circ}{-1{\cdot}33j} + \frac{V_x'}{3} + \frac{V_x'}{(15+6j)} = 0$$

$$\Rightarrow (0{\cdot}751j)V_x' + 7{\cdot}518\angle -150^\circ + 0{\cdot}33V_x' + V_x'(0{\cdot}057 - 0{\cdot}022j) = 0$$

$$\Rightarrow V_x'(0{\cdot}729j + 0{\cdot}387) = -7{\cdot}518\angle -150^\circ$$

$$\Rightarrow V_x' = 7{\cdot}72 - 4{\cdot}83j = 9{\cdot}108\angle -32{\cdot}037^\circ$$

After turning off voltage : $\omega_2 = (1+0) = 1$



$-4\sin(t+55^\circ)$
$= 4\cos(t+55^\circ+90^\circ)$
$= 4\angle 145^\circ$ A

for $\omega = 1$,

$$Z_C'' = \frac{1}{J\times 1\times 0.25} = -4J$$

$$Z_L'' = J\times 1\times 2 = 2J$$

KCL at V_x'',

$$\frac{V_x''}{-4J} + \frac{V_x''}{3} + \frac{V_x'' - V_y}{(5+2J)} = 0$$

$$\Rightarrow (0.25J)V_x'' + 0.33V_x'' + V_x''(0.172 - 0.068J) + V_y(-0.172 + 0.068J) = 0$$

$$\Rightarrow V_x''(0.502 + 0.182J) + V_y(-0.172 + 0.068J) = 0 \quad \text{--- (1)}$$

KCL at V_y :

$$\frac{V_y}{10} + \frac{V_y - V_x''}{(5+2J)} = 4\angle 195^\circ$$

$$\Rightarrow 0.1V_y + V_y(0.172 - 0.068J) + V_x''(-0.172 + 0.068J) = 4\angle 195^\circ$$

$$\Rightarrow V_x''(-0.172 + 0.068J) + V_y(0.272 - 0.068J) = 4\angle 145^\circ \quad \text{--- (2)}$$

$$\Delta = \begin{bmatrix} 0.502 & (-0.172+0.068j) \\ (-0.172+0.068j) & (0.272-0.068j) \end{bmatrix}$$

$$= 0.136 - 0.034j - 0.024 + 0.023j$$

$$= 0.111 - 0.0106j$$

$$\Delta_1 = \begin{bmatrix} 0 & (-0.172+0.068j) \\ 4\angle 145^\circ & (0.272-0.068j) \end{bmatrix}$$

$$= -0.407 + 0.617j$$

$$V_x'' = \frac{\Delta_1}{\Delta} = \frac{-0.407+0.617j}{0.111-0.0106j}$$

$$= -4.16 + 5.16j = 6.63\angle 128.88^\circ$$

$$V_x = V_x' + V_x'' = 9.108\angle -32.037^\circ + 6.63\angle 128.88^\circ$$

$$\Rightarrow V_x = 9.108\cos(3t - 32.037^\circ) + 6.63\cos(t + 128.88^\circ)$$