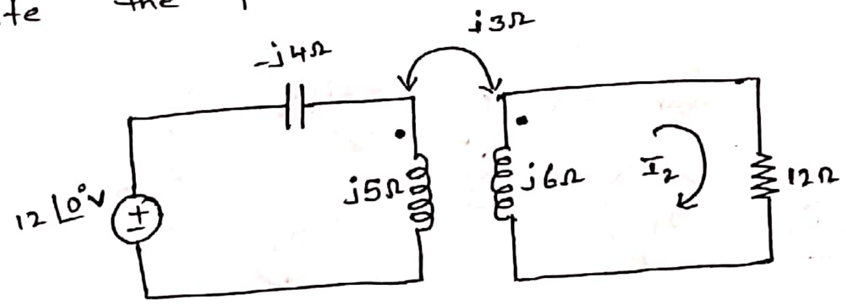
(1) calculate the phasor currents I_1 and I_2 in the circuit.



Ans : for coil 1, KVL gives

$$-12 + (-j4 + j5) I_1 - j3 I_2 = 0$$

$$j I_1 - j3 I_2 = 12 \quad \text{— (1)}$$

for coil 2, KVL gives

$$-j3 I_1 + (12 + j6) I_2 = 0$$

$$I_1 = \frac{(12 + j6) I_2}{j3} = (2 - j4) I_2 \quad \text{— (2)}$$

substituting this equ ("1"), we get

$$(j2 + 4 - j3) I_2 = (4 - j) I_2 = 12$$

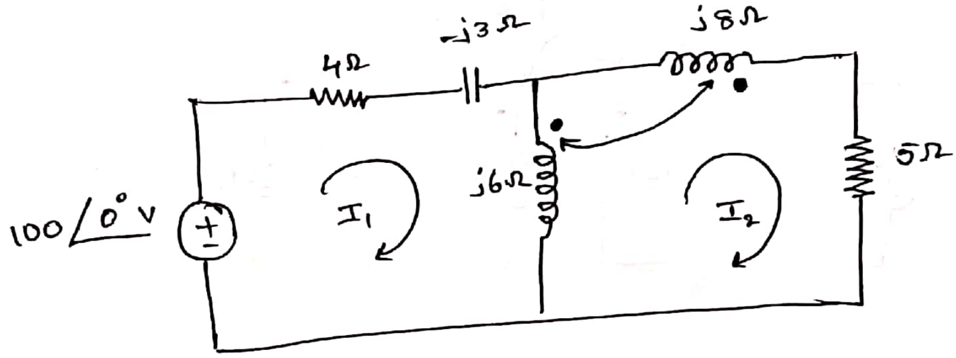
$$I_2 = \frac{12}{4 - j} = 2.91\angle 14.04^\circ A. \quad \text{— (3)}$$

from ~~[illegible]~~ eqs. '2' and '3'

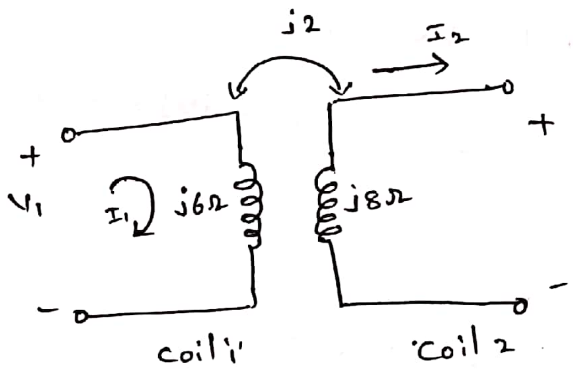
$$I_1 = (2 - j4) I_2 = (4.472\angle -63.43^\circ)(2.91\angle 14.04^\circ)$$

$$= 13.01\angle -49.39^\circ A.$$

② Calculate the Mesh current in circuit of fig



Ans :

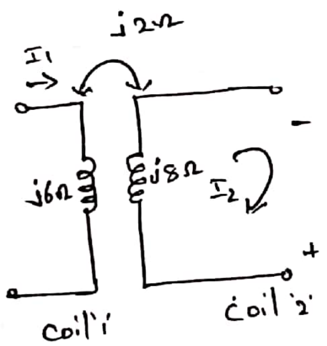


(a) $V_1 = -2jI_2$

for mesh '1' in fig. KVL gives

$$-100 + I_1(4-j3+j6) - j6I_2 = 0$$

$$100 = (4+j3)I_1 - j8I_2 \quad \text{—— ①}$$



for mesh '2' in fig KVL gives.

$$0 = -2jI_1 - j6I_1 + (j6+j8+j2\times 2+5)I_2$$

$$0 = -j8I_1 + (5+j18)I_2 \quad \text{—— ②}$$

putting eqs. (1) and (2) we get

$$\begin{bmatrix} 100 \\ 0 \end{bmatrix} = \begin{bmatrix} 4+j3 & -j8 \\ -j8 & 5+j18 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

the determinants are

$$\Delta = \begin{vmatrix} 4+j3 & -j8 \\ -j8 & 5+j18 \end{vmatrix} = 30 + j87$$

$$\Delta_1 = \begin{vmatrix} 100 & -j8 \\ 0 & 5+j18 \end{vmatrix} = 100(5+j18)$$

$$\Delta_2 = \begin{vmatrix} 4+j3 & 100 \\ -j8 & 0 \end{vmatrix} = j800$$

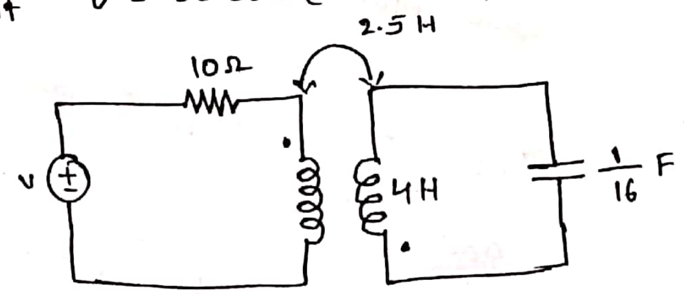
we obtain the mesh currents as

$$I_1 = \frac{\Delta_1}{\Delta} = \frac{100(5+j18)}{30+j87} = \frac{1868.2\angle 74.5^\circ}{92.03\angle 71^\circ} =$$

$$I_1 = 20.3\angle 3.5^\circ \text{ A}$$

$$I_2 = \frac{\Delta_2}{\Delta} = \frac{j800}{30+j87} = \frac{800\angle 90^\circ}{92.03\angle 71^\circ} = 8.693\angle 19^\circ \text{A.}$$

(3) Determine the coupling coefficient. Calculate the energy the energy stored in the coupled inductors at time $t = 1s$ if $v = 60\cos(4t + 30^\circ)$ V.



Ans: the coupling coefficient is

$$k = \frac{M}{\sqrt{L_1 L_2}} = \frac{2.5}{\sqrt{20}} = 0.56$$

frequency - domain equivalent of the circit.

$$60\cos(4t + 30^\circ) \Rightarrow 60\angle 30^\circ, \quad \omega = 4\ \text{rad/s}$$

$$5H \Rightarrow j\omega L_1 = j20\,\Omega$$

$$2.5H \Rightarrow j\omega M = j10\,\Omega$$

$$4H \Rightarrow j\omega L_2 = j16\,\Omega$$

$$\frac{1}{16}F \Rightarrow \frac{1}{j\omega c} = -j4\,\Omega$$

for Mesh '1'

$$(10 + j20)I_1 + j10 I_2 = 60\angle 30^\circ \quad \text{—— (1)}$$

for mesh '2'

$$j10 I_1 + (j16 - j4) I_2 = 0$$

$$I_1 = -1.2 I_2 \quad \text{—— (2)}$$

(4)

substituting this into eq (1)

$$I_2(-12 - j14) = 60\angle 30^\circ \Rightarrow I_2 = 3.254\angle 160.6^\circ A$$

and

$$I_1 = -1.2 I_2 = 3.905\angle -19.4^\circ A$$

In the time domain

$i_1 = 3.905 \cos(4t - 19.4°)$, $i_2 = 3.254 \cos(4t + 160.6°)$

At time. $t = 1s$, $4t = 4\,rad = 229.2°$, and

$i_1 = 3.905 \cos(229.2° - 19.4°) = -3.389\,A.$

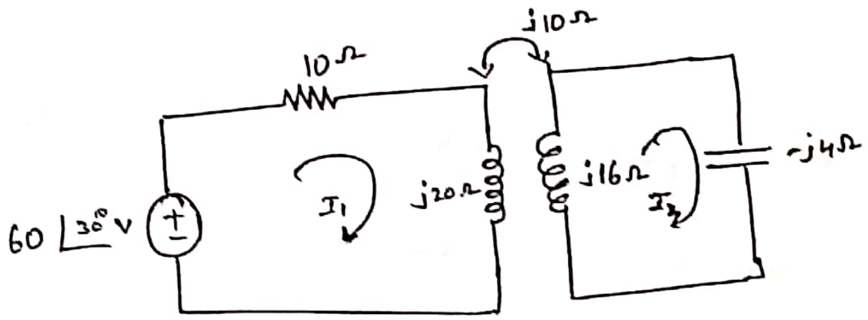
$i_2 = 3.254 \cos(229.2° + 160.6°) = 2.824\,A.$

total energy stored in the coupled inductors is

$w = \frac{1}{2} L_1 i_1^2 + \frac{1}{2} L_2 i_2^2 + M i_1 i_2$

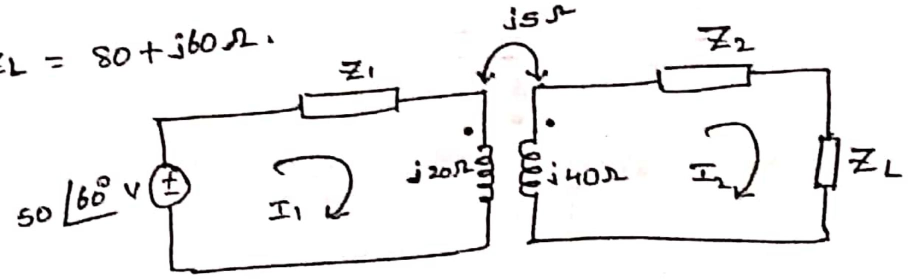
$= \frac{1}{2}(5)(-3.389)^2 + \frac{1}{2}(4)(2.824)^2 + 2.5(-3.389)(2.824)$

$\underline{w = 20.73J}$



* frequency - domain equivalent.

(4) In the circuit of fig, calculate the input impedance and current I_1. Take $Z_1 = 60 - j100\,\Omega$, $Z_2 = 30 + j40\,\Omega$, and $Z_L = 80 + j60\,\Omega$.



Ans:

$$Z_{in} = Z_1 + j20 + \frac{(5)^2}{j40 + Z_2 + Z_L}$$

$$= 60 - j100 + j20 + \frac{25}{110 + j140}$$

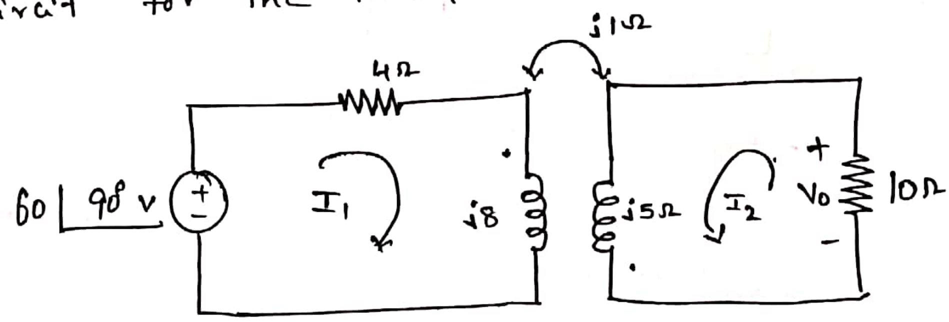
$$= 60 - j80 + 0.14\angle -51.84^\circ$$

$$= 60.09 - j80.11 = 100.14\angle -53.1^\circ\ \Omega$$

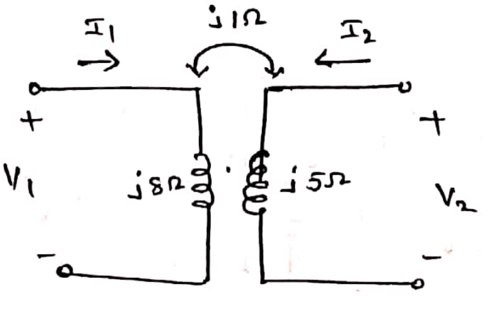
$$I_1 = \frac{V}{Z_{in}} = \frac{50\angle 60^\circ}{100.14\angle -53.1^\circ}$$

$$I_1 = 0.5\angle 113.1^\circ A$$

(5) Solve for I_1, I_2, and V_0 in fig using T-equivalent circuit for the linear transformer.

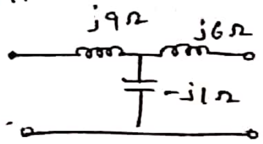


Ans:



$$L_a = L_1 - (-M) = 8+1 = 9\,H$$

$$L_b = L_2 - (-M) = 5+1 = 6\,H, \qquad L_c = -M = -1\,H.$$



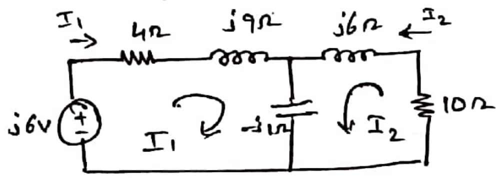
(b)

Mesh analysis.

$$j6 = I_1(4 + j9 - j1) + I_2(-j1) \quad \text{—— (1)}$$

$$0 = I_1(-j1) + I_2(10 + j6 - j1). \quad \text{—— (2)}$$

"equivalent circuit"



from eq. (2)

$$I_1 = \frac{(10 + j5)}{j} I_2 = (5 - j10)\, I_2 \quad \text{—— (3)}$$

substituting eq (3) into (1)

$$j6 = (4 + j8)(5 - j10)\, I_2 - jI_2 = (100 - j)\, I_2 \simeq 100 I_2$$

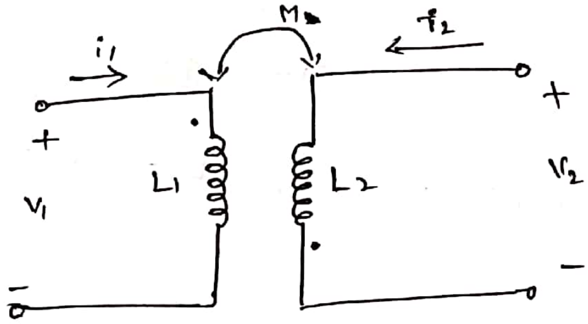
$$I_2 = \frac{j6}{100} = j0.06 = 0.06\angle 90^\circ\,A.$$

from eq (3)

$$I_1 = (5 - j10)\, j0.06 = 0.6 + j0.3\,A$$

$$V_o = -10 I_2 = -j0.6 = 0.6\angle -90^\circ V$$

(6) the coils in fig have $L_1 = 40mH$, $L_2 = 5mH$, and coupling coefficient $k = 0.6$. find $i_1(t)$ and $V_2(t)$, given that ~~$V_1(t) = 10$~~ $V_1(t) = 10\cos\omega t$ and $i_2(t) = 2\sin\omega t$, $\omega = 2000$ rad/s

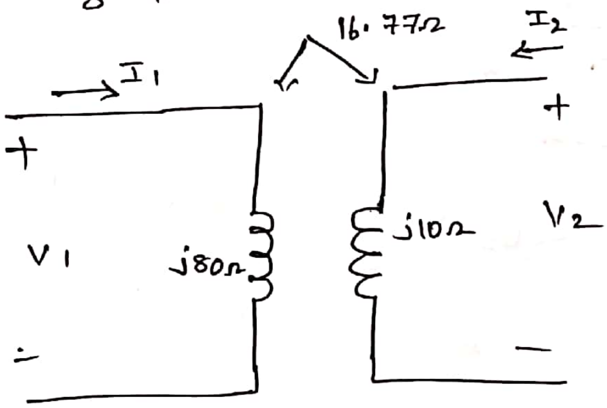


$M = K\sqrt{L_1 L_2} = 0.6\sqrt{40 \times 5} = 8.4853 \text{ mH}$

$40\text{mH} \longrightarrow j\omega L = j2000 \times 40 \times 10^{-3} = j80$

$5\text{ mH} \longrightarrow j\omega L = j2000 \times 5 \times 10^{-3} = j10$

$8.4853\text{mH} \longrightarrow j\omega M = j2000 \times 8.4853 \times 10^{-3} = j16.97$



$V_1 = j80 I_1 - j16.97\, I_2$ ——— (1)

$V_2 = -16.97 I_1 + j10 I_2$ ——— (2)

$V_1 = 10\angle 0^\circ$. and $I_2 = 2\angle -90^\circ = -j2$ substituting eq (1)

$$I_1 = \frac{V_i + j16.97\, I_1}{j80} = \frac{10 + j16.97 \times (-j2)}{j80}$$

$$= 0.5493 \angle -90^\circ$$

$i_1(t) = 0.5493 \sin\omega t$ A.

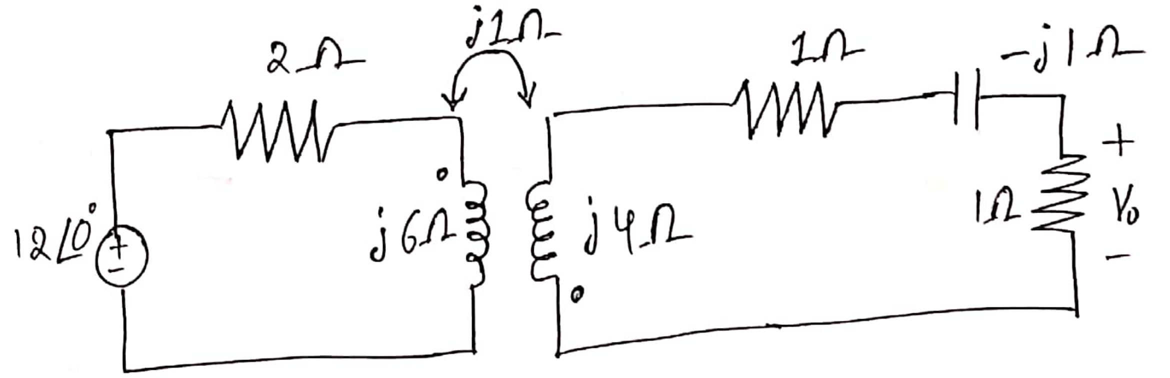
from (2).

$$V_2 = -16.97 \times (-0.j5493) + j10 \times (-j2)$$

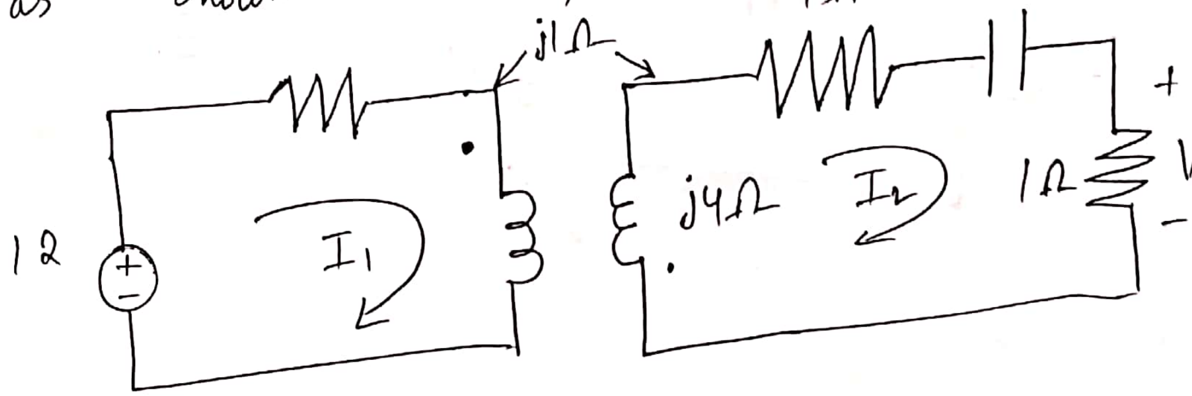
$$= 20 + j9.3216 = 22.0656 \angle 24.99^\circ$$

$$V_2(t) = 22.065 \cos(\omega t + 25^\circ) \, \underline{\underline{V}}$$

7 For the circuit given below, find V_o



Sol: We apply Mesh Analysis to the circuit as shown below;



For Mesh 1;

$$12 = I_1(2+j6) + jI_2 \quad \text{--- (1)}$$

for Mesh 2,

$$0 = jI_1 + (2 - j1 + j4)\, I_2$$

(or)

$$0 = jI_1 + (2+j3)\, I_2 \quad \text{---- (2)}$$

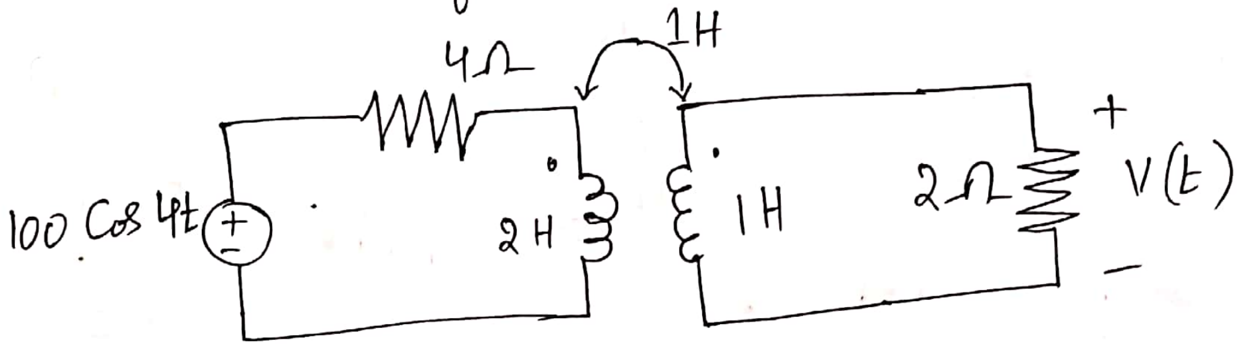
In matrix form,

$$\begin{bmatrix} 12 \\ 0 \end{bmatrix} = \begin{bmatrix} 2+j6 & j \\ j & 2+j3 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

$I_2 = -0.4381 + j0.3164$

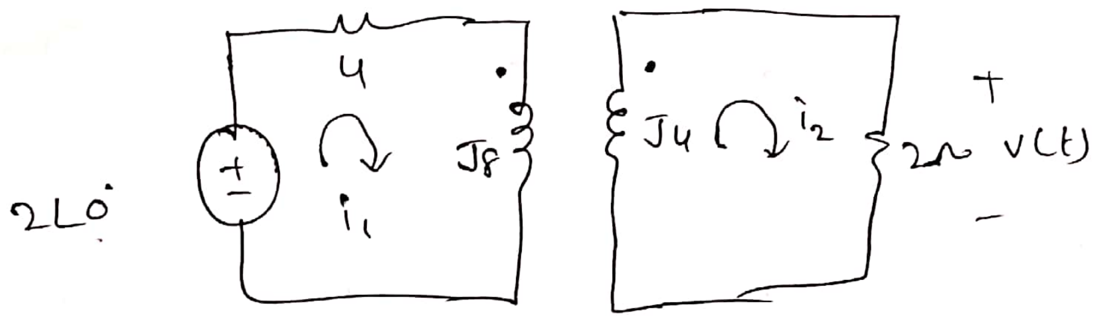
$V_o = I_2 \times 1 = 540.5 \angle 144.16^\circ \, mV$

Q find $v(t)$ for the below circuit



$2H \rightarrow j\omega L = j4 \times 2 = j8$

$1H \rightarrow j\omega L = j4 \times 1 = j4$



$2 = (4+j8)I_1 - 4jI_2 \rightarrow ①$

$0 = -4jI_1 + (2+j4)I_2 \rightarrow ②$

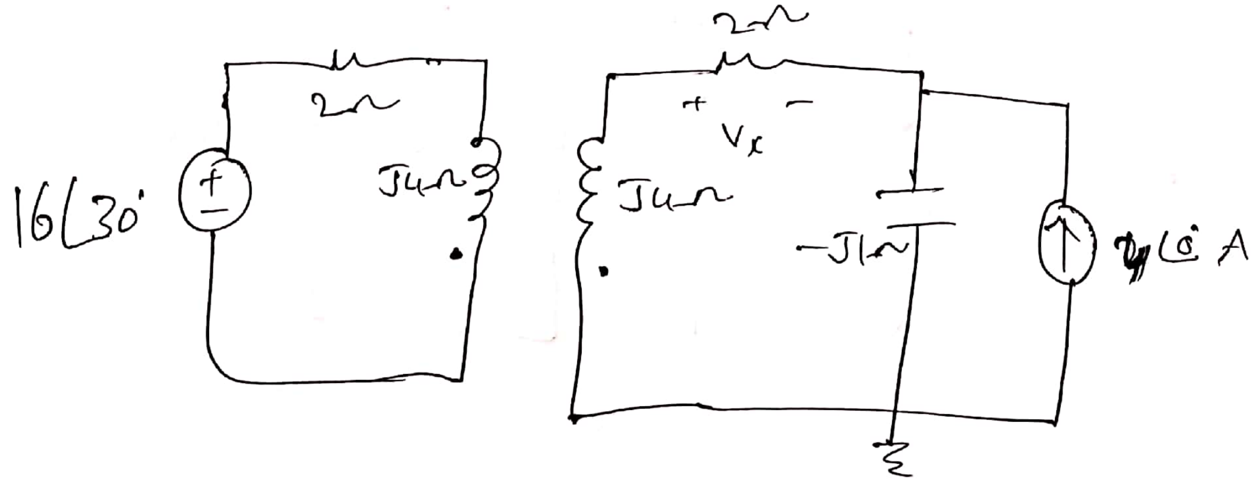
$$\begin{bmatrix} 2 \\ 0 \end{bmatrix} = \begin{bmatrix} 4+j8 & -j4 \\ -j4 & 2+j4 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

$\boxed{I_2 = 0.2353 - j0.0588}$

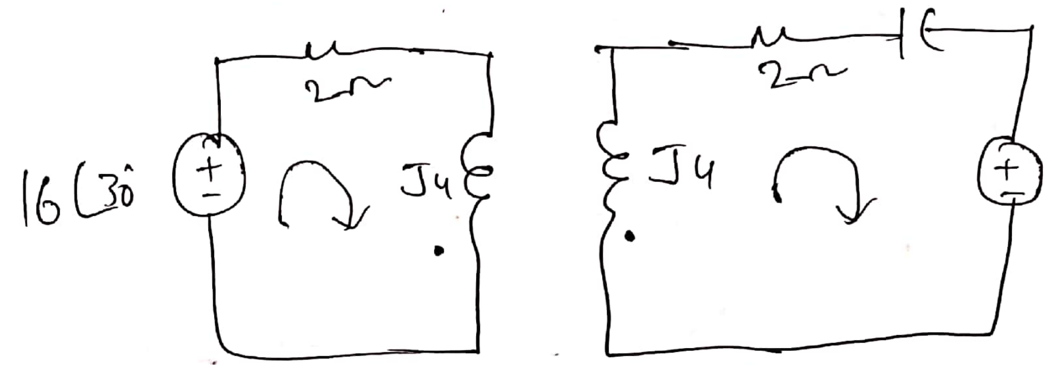
$V = 2I_2 = 0.4851 \angle -14.04^\circ$

$v(t) = 0.4851 \cos(4t - 14.04^\circ) \, V$

9. Find 'Vx' for the circuit shown in below figure 9.



A) consider the circuit below



For loop1, $8\angle 30^\circ = (2+J4)I_1 - JI_2$

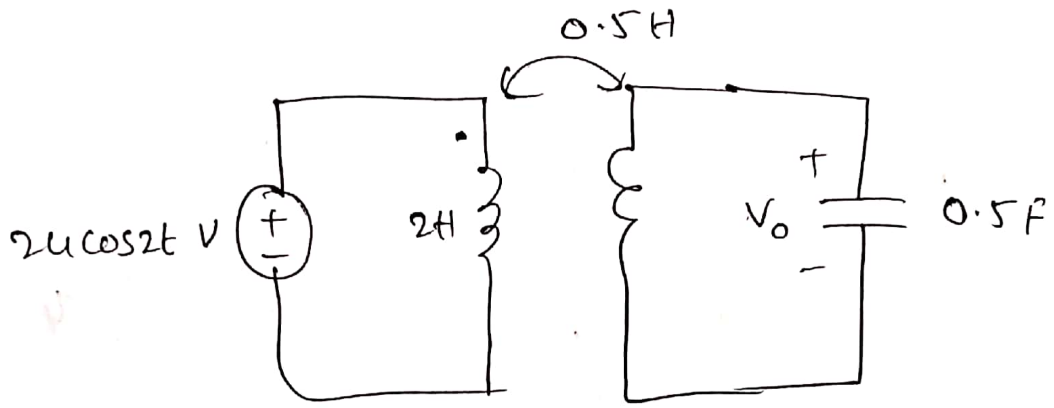
$I_1 = (3-J2)I_2 - 2$

$I_2 = (10.928 + J12) / (14 + J7)$

$= 1.037\angle 21.12^\circ$

$\boxed{V_x = 2I_2 = 2.074\angle 21.12^\circ}$

10. Find the 'V_o' in the circuit in Figure 10.

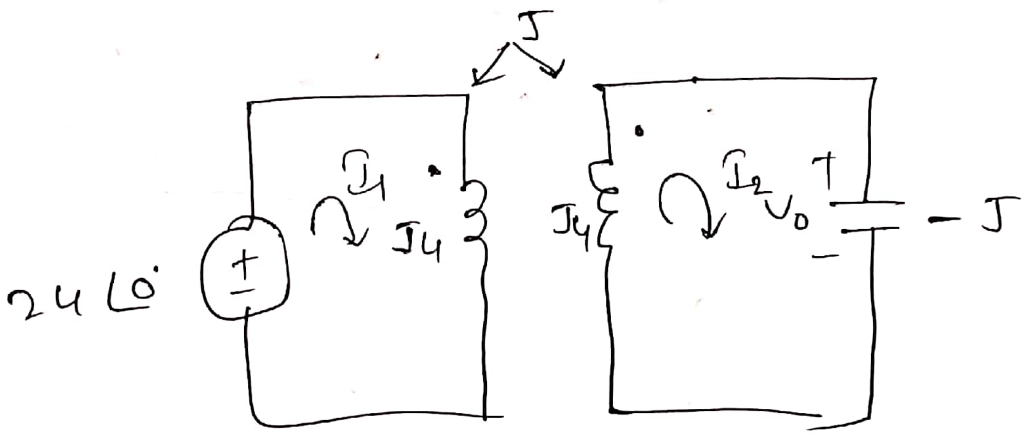


$2H \rightarrow j\omega L = j4$

$0.5H \rightarrow j\omega L = j$

$\frac{1}{2} F \rightarrow \frac{1}{j\omega C} = \frac{1}{j2 \times 1/2} = -j$

consider the ckt below,



$24 = j4I_1 - jI_2$

$0 = -jI_1 + (j4 - j)I_2 \Rightarrow 0 = -I_1 + 3I_2$

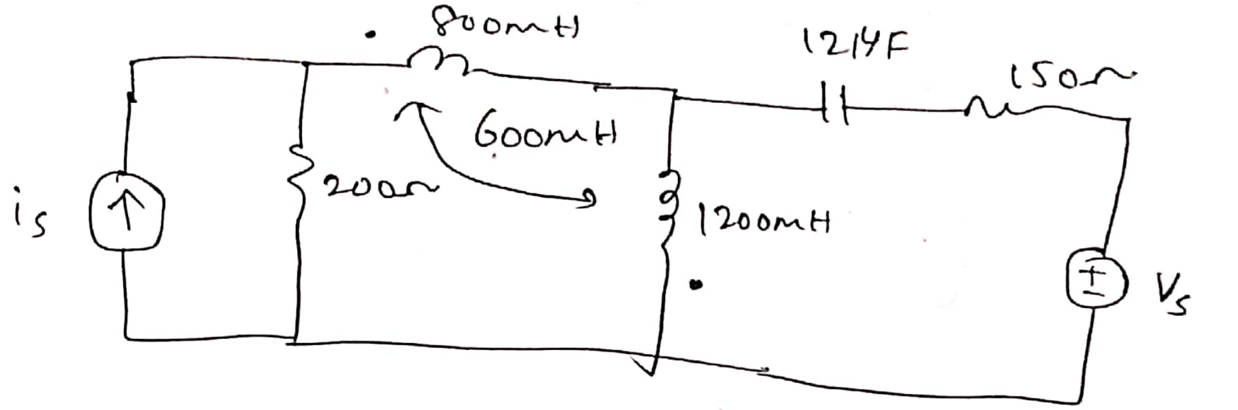
$$\begin{bmatrix} 24 \\ 0 \end{bmatrix} = \begin{bmatrix} j4 & -j \\ -1 & 3 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

$\boxed{I_2 = -j2.1818}$, $V_o = -jI_2$

$\boxed{V_o = -2.1818}$

$\boxed{V_o = -2.1818\cos 2t \text{ V}}$

11. use mesh analysis to find i_x, where $i_s = 4\cos(600t)$ A & $V_s = 110\cos(600t + 30^\circ)$.



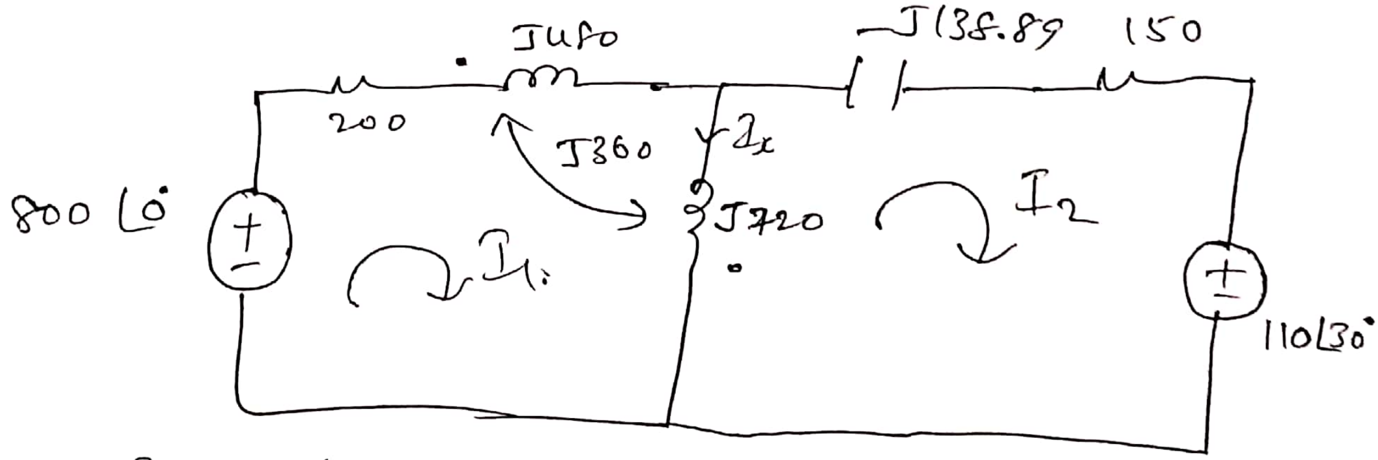
A)

800mH → $J\omega L = J480$

600mH → $J\omega L = J360$

1200mH → $J\omega L = J720$

12μF → $\dfrac{1}{J\omega C} = -J138.89$



Fr mesh 1,

$$800 = (200 + J480 + J720) I_1 + J360 I_2 - J720 I_2$$

or, $$800 = (200 + J1200) I_1 - J360 I_2$$

Fr mesh 2,

$$(110\angle 30^\circ \;\#\; 150 - J138.89 + J720) I_2 + J360 I_1 = 0$$

$$-95.2628 - J55 = -J360 I_1 + (150 + J581) I_2$$

In matrix form

$$\begin{bmatrix} 800 \\ -95.2628 - J55 \end{bmatrix} = \begin{bmatrix} 200 + J1200 & -J360 \\ -J360 & 150 + J581.4 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

$$I_x = I_1 - I_2$$

$$\boxed{I_x = 0.781 - J\,0.4552 = 0.4619\angle -80.26}$$

$$\boxed{I_x = 461.9 \cos(600t - 80.26^\circ)\ mA}$$

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