Q.1 $v = 100\cos(240\pi t + 45^\circ)$ mV.

a) $\omega = 240\pi = 754$ rad/sec.

$f = \frac{\omega}{2\pi} = 120$ Hz

$T = 8.33$ msec.

b) $T = 8.33$ m sec. ($T = 1/f$)

3) $v_m = 100$ volts.

4) $v(0) = 100\cos(240\pi \times 0 + 45^\circ)$

$= 100 \cos 45^\circ$

$v(0) = 50\sqrt{2}$ mV.

5) $\phi = 45^\circ$

$\phi = 45 \times \frac{\pi}{180} = \pi/4$ radian.

6) Smallest positive value of t at which $v = 0$

$0 = 100\cos(240\pi t + 45^\circ)$

$\cos^{-1} 0 = 240\pi t + 45^\circ$

$90^\circ = 240\pi t + 45^\circ$

$t = \frac{45^\circ}{240\pi}$

$t = \frac{45 \times \cancel{\pi}}{240\cancel{\pi}\ 180} = 1.041$ msec.

7) Smallest positive value of t at which $dv/dt = 0$

$\frac{dv}{dt} = -100\sin(240\pi t + 45^\circ)\ 240\pi$

$0 = -100\sin(240\pi t + 45^\circ)\ 240\pi$

$\sin^{-1} 0 = 240\pi t + 45^\circ$

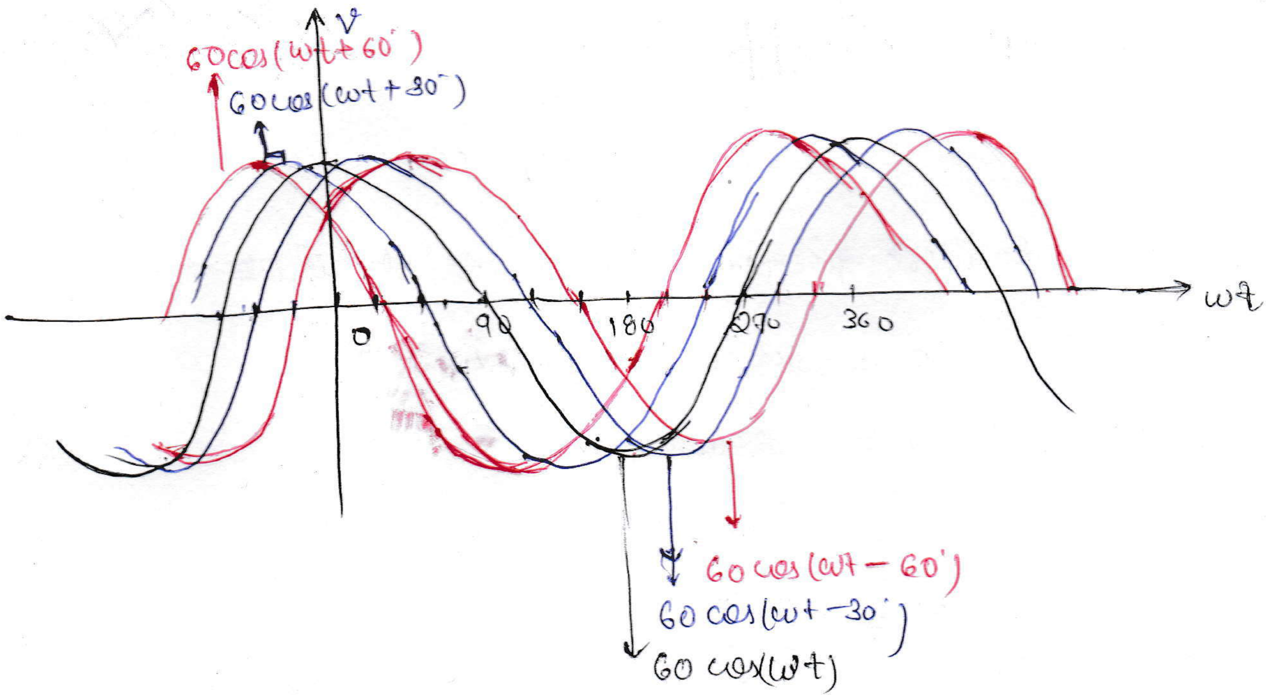
$0 = 240\pi t + 45^\circ$

$t = \frac{45 \times \frac{\pi}{180}}{240\pi}$

$t = -1.04$ msec

Ans.

Q.2.



a) Voltage function is shifting to the left as ϕ becomes more +ve.

b) Direction of shift will towards right if ϕ changes from 0 to −30°.

Q.3 $\quad v(t) = 170\cos(120\pi t - 60^\circ)$ V

1) $v_m = 170$

2) frequency in Hz →

$\omega = 120\pi$

$f = \frac{\omega}{2\pi}$

$= \frac{120\pi}{2\pi} = 60$ Hz.

3) frequency in radian per sec.

$\omega = 120\pi = 377$ rad/sec.

4) Phase angle in radians

$\phi = 60^\circ \Rightarrow \frac{60 \times \pi}{180}$

$= \pi/3$ radian.

5) Phase angle in degree

$\phi = 60^\circ$

6) Period $T = 1/f = 16.67$ msec.

7) The first time after $t=0$ that $v = 170$V.

$\Rightarrow$ after 16.67 m sec.

8) Senusoidal function is shifted right by 125/18 ms.

$\phi/\omega = \frac{125}{18} \times 10^{-3}$

$\phi = \frac{125}{18} \times 10^{-3} \times 120\pi \times \frac{180^\circ}{\pi}$

$= 150^\circ$

Expression for $v = 170\cos(120\pi t - 60 - 150^\circ)$

$v = 170\cos(120\pi t - 210^\circ)$ V.

9) $v(t) = 170\sin(120\pi t)$

$= 170\cos(120\pi t - 90^\circ)$

Means $+30^\circ$ shift is require.

$t = \frac{30^\circ \times \pi}{120\pi \times 180^\circ} = 1.388$ msec.

10) $v(t) = 170\cos 120\pi t$

-60° shift is require

$t = \frac{60^\circ \times \pi}{120\pi \times 180^\circ} = 2.77$ msec.

Q.4 a) $y = 10\cos(300t + 45^\circ) + 500\cos(300t - 60^\circ)$

$y = 10\angle 45^\circ + 500\angle -60^\circ$ → Phasor form.

$y = 483.85\angle -48.48$

$y = 483.85\cos[300t - 48.48]$

b) $y = 250\cos(377t + 30^\circ) - 150\sin(377t + 140^\circ)$

$= 250\cos(377t + 30) - 150\cos[377t + 140^\circ - 90^\circ]$

$= 250\angle 30^\circ - 150^\circ\angle 50^\circ$

$= 120.5\angle 4.804$

$= 120.5\cos[377t + 4.804]$

c) $y = 60\cos(100t + 60^\circ) - 120^\circ\sin(100t - 125^\circ) + 100\cos(100t + 90$

$= 60\cos(100t + 60^\circ) - 120^\circ\cos[100t - 125^\circ - 90^\circ]$
$+ 100\cos(100t + 90^\circ)$

$= 60\angle 60^\circ - 120\angle -215 + 100\angle 90^\circ$

$= 152.87\angle 32.98$

$= 152.87\cos(100t + 32.94)$

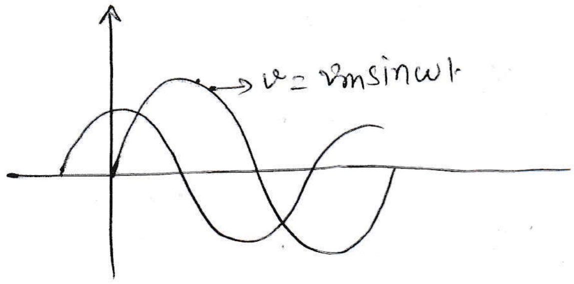
d) $y = 100\cos(\omega t + 40^\circ) + 100\cos(\omega t + 160^\circ) + 100\cos(\omega t - 80^\circ)$

$= 100\angle 40^\circ + 100\angle 160^\circ + 100\angle -80^\circ$

$= 0\angle 0^\circ$

$y = 0\cos(\omega t + 0^\circ)$

Q.5 Given



$v = 2.5 \sin\omega t$ mV. $\quad f = 40\text{ kHz}$. $\quad \omega = 80\pi\,\cancel{k}\text{rad/sec}$.

$i_m = 125.67\ \mu A$.

$$i = C\frac{dv}{dt}$$

$$i = C\frac{d\,2.5\sin\omega t}{dt}$$

~~or~~ $$i = C\,2.5\,\omega\cos\omega t$$

$$i = \underset{\times 10^3}{200\pi}\cdot C\cos 80\pi K t = \underset{\times 10^3}{200\pi}\cdot C\sin(80000\pi t + 90)$$

1) frequency of current $\quad \omega = 80\pi K$ rad/sec. — (1)

2) Phase angle $\phi = 90°$ Leading.

3) Capacitive Reactance. $\quad X_c = \frac{V}{I} = \frac{2.5\times10^{-3}}{125.67\times10^{-6}}$

$$= 19.89 \approx 20\,\Omega.$$

4) Capacitor $\quad C = \frac{1}{X_c \times \omega}$

$$= \frac{1}{20\times 80\pi\times10^{3}}$$

$$\approx 0.200\ \mu f.$$

OR. compare eq^n (1) with i_m

$$125.67 = 200\pi\times10^3\times C$$

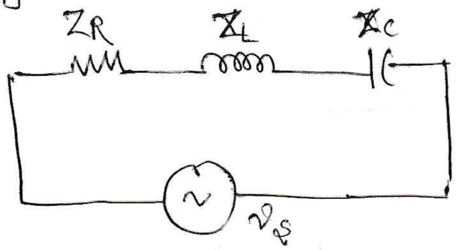
$$\boxed{C = 0.200}\ \mu F$$

5) Impedence of capacitor

$$Z = -jX_c$$

$$= -j20\ \Omega.$$

Q.6 1) frequency domen equivalent ckt-



Here $\omega = 8000$

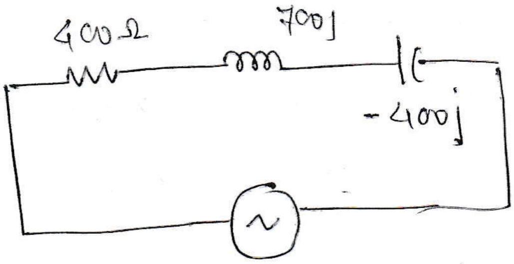
$Z_R = 400\,\Omega$

$Z_L = j\omega L = j \times 8000 \times 87.5 \times 10^{-3}$

$= 700j$

$Z_C = \frac{1}{j\omega C} = \frac{1}{j \times 8000 \times 312.5 \times 10^{-9}}$

$= -400j$



$v_s = 500\cos(8000t + 60^\circ)$

2) Phasor current

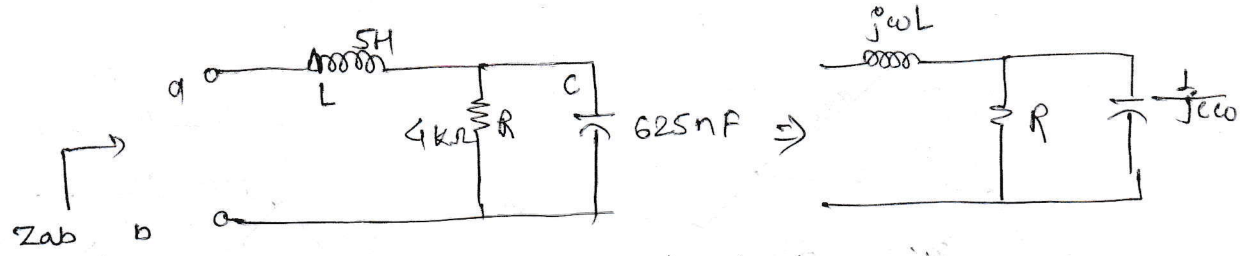
$$i^{\circ} = \frac{500\angle 60^\circ}{400 + j700 - 400j}$$

$i^{\circ} = 1\angle 23.13$ A. Ans.

$i^{\circ} = \cos(8000t + 23.13)$ A.

3)

Q 7



1. frequency at which Zab is purely resistive.

$$Z_{ab} = j\omega L + R \parallel 1/j\omega c$$

$$= j\omega L + \frac{R \times \frac{1}{j\omega c}}{R + 1/j\omega c} = j\omega L + \frac{R}{jR\omega c + 1} \times \frac{1 - j\omega R}{1 - j\omega c R}$$

$$= j\omega L + \frac{R - j\omega c R^2}{1 + \omega^2 R^2 c^2}$$

Compare Img part and equal zero. [Zab will Real if Img part will zero

$$0 = j\omega L - \frac{j\omega c R^2}{1 + \omega^2 R^2 c^2}$$

$$L = \frac{cR^2}{1 + \omega^2 R^2 c^2}$$

$$1 + \omega^2 R^2 c^2 = \frac{cR^2}{L}$$ [Put values of R, L, C

$$\omega^2 \, 4000^2 \times (625 \times 10^{-9})^2 = \frac{(625 \times 10^{-9}) \times (4000)^2}{5} - 1$$

$$= 2 - 1$$

$$\omega^2 = 160000$$

$$\boxed{\omega = 400} \text{ rad/sec.}$$

2). $$Z_{ab} = j\omega L + \left(R \parallel \frac{1}{j\omega c}\right]$$

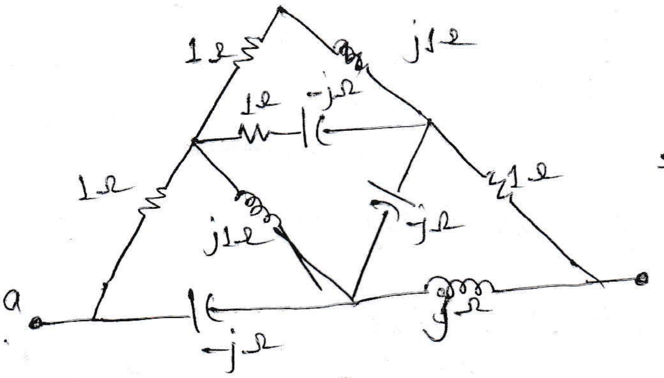
$$= j400 \times 5 + \left[4000 \parallel \frac{1}{j \times 400 \times 625 \times 10^{-9}}\right]$$

$$= 2000j + 2000 - 2000j$$

$$Z_{ab} = 2000\ \Omega$$

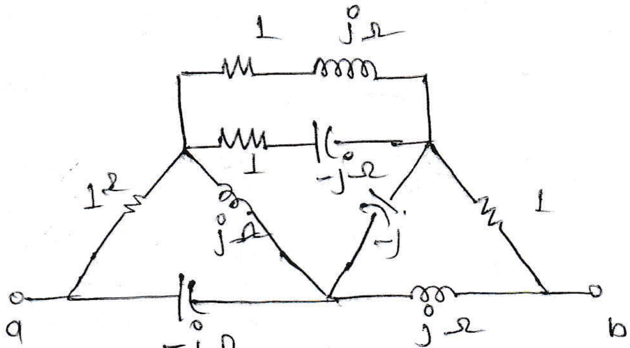
$$\boxed{Z_{ab} = 2k}\ \Omega$$

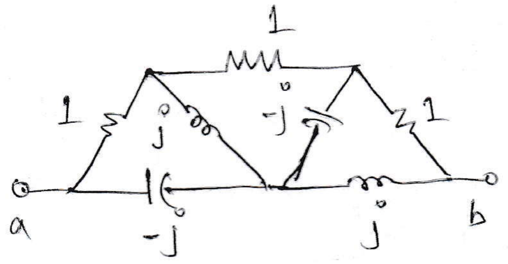
Q.8.

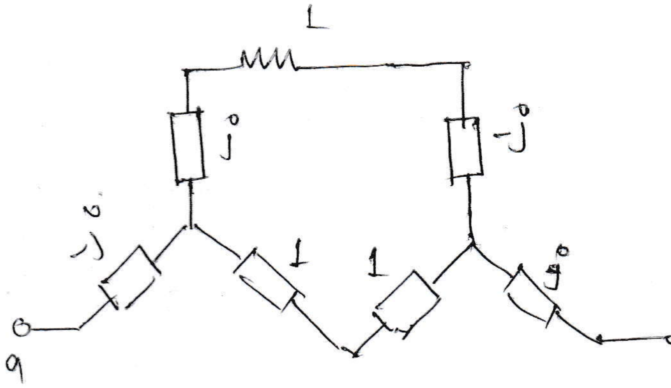


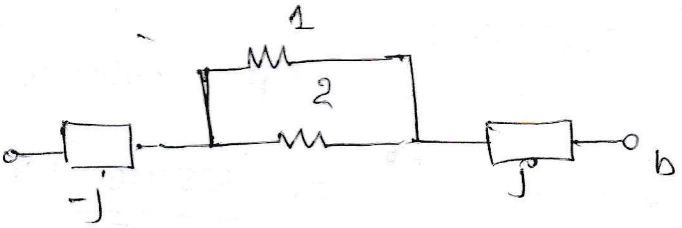
⇑
Z_{ab}

⇒







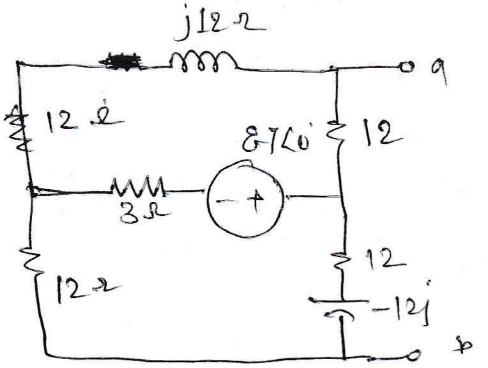


⇓

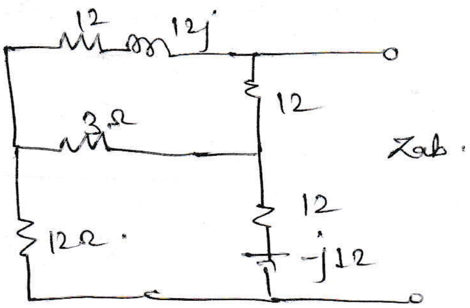
$$Z_{ab} = -j + (1 \| 2) + j$$

$$\boxed{Z_{ab} = 2/3}\ \Omega.$$

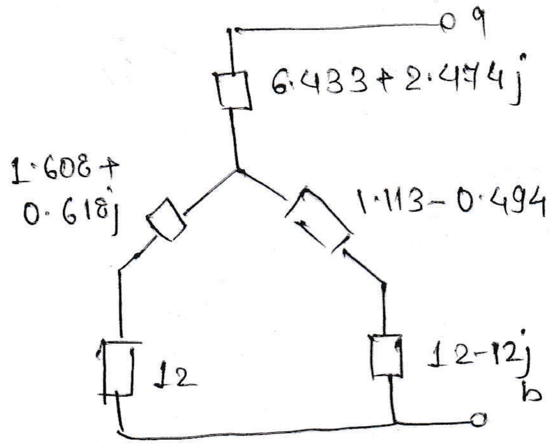
Q.9.

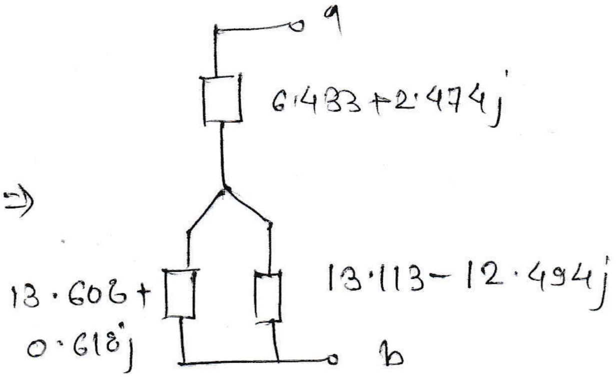


Remove the source.



Thevenin Equivalent Z_{th}.

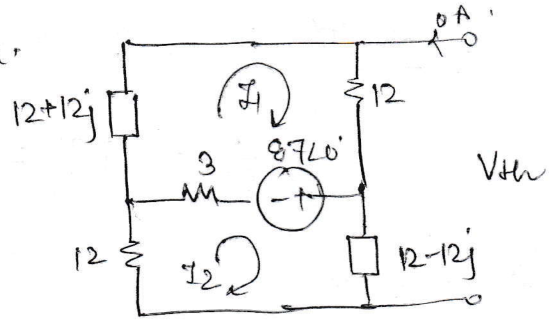




$$Z_{th} = 14.5 - 2.91\times10^{-4}j$$

$$\boxed{Z_{th} = 14.5 \angle -1.15\times10^{-3}}\ \Omega.$$

V_{th}.



$$(12+12j)\,I_1 + 12 I_1 + 87 + 3(I_1 - I_2) = 0$$

$$(27 + 12j)I_1 - 3I_2 = -87 \quad -(1)$$

$$(27-12j)\,I_2 - 3I_1 = 87 \quad -(2)$$

$$I_1 = \frac{3I_2 - 87}{27+12j}$$

Put value of I_1 on eq^n(2)

$$(27-12j)I_2 + \left(\frac{3I_2 - 87}{27+12j}\right)\times(-3I_1) = 87$$

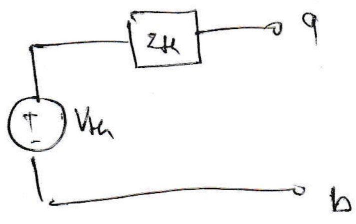
$$\boxed{I_2 = 2.618 + 1.208j}\ A.$$

$$\boxed{I_1 = -2.39 + 1.2j}\ A.$$

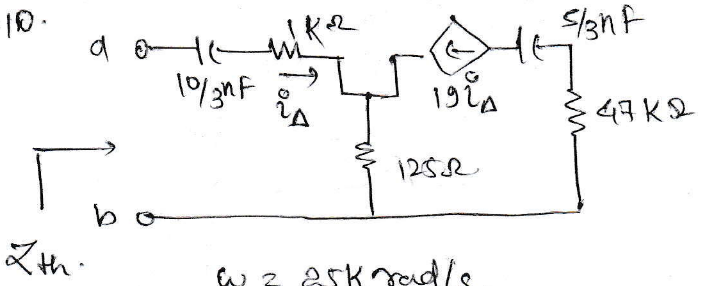
$$V_{th} = 12 I_1 + I_2(12-12j)$$

$$V_{th} = 17.112 - 2.52j$$

$$\boxed{V_{th} = 17.3 \angle -8.38}\ V$$

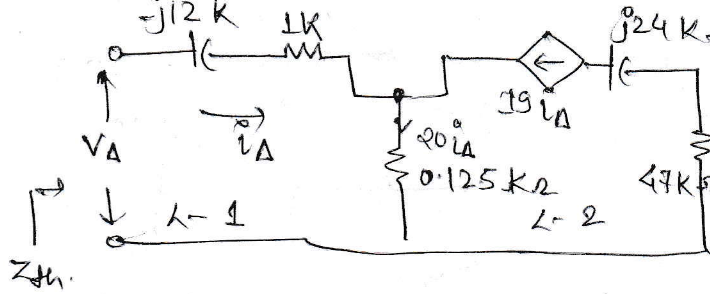


Q.10.



$\omega = 25K$ rad/s.

⇒



for thevenin equivalent $Z_{th} = \dfrac{V_\Delta}{i_\Delta}$

Apply KVL at loop 1

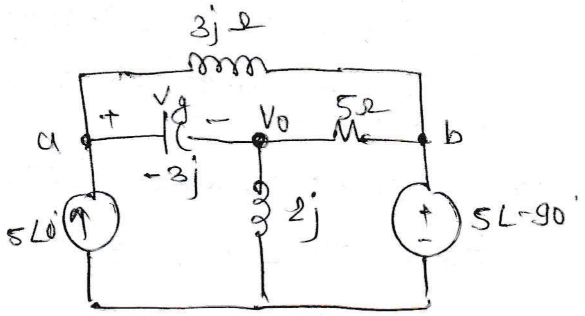
$$V_\Delta = (1 - j12)\, i_\Delta + 0.125 \times 20\, i_\Delta$$

$$V_\Delta = (3.5 - 12j)\, i_\Delta$$

$$\frac{V_\Delta}{i_\Delta} = 3.5 - 12j \ \text{K}\Omega$$

$$\boxed{Z_{th} = 3.5 - 12j}\ \text{K}\Omega.$$

Q.11.



Apply KCL → at node V_o.

$$\frac{V_o - V_a}{-3j} + \frac{V_o - 5\angle{-90}}{5} + \frac{V_o}{2j} = 0$$

$$V_o\left[\frac{1}{5} - \frac{1}{6}j\right] = \frac{V_a}{-3j} + 1\angle \quad \text{—(1)}$$

KCL at node a

$$\frac{V_a - V_o}{-3j} + \frac{V_a - 5\angle{-90}}{3j} = 5$$

$$\frac{V_o}{3j} = 5 + \frac{5\angle{-90}}{3j}$$

$$\boxed{V_o = 10j} \quad \text{—(2)}$$

put value of V_o in eq^n (1) -

$$V_a = 9 - 5j$$

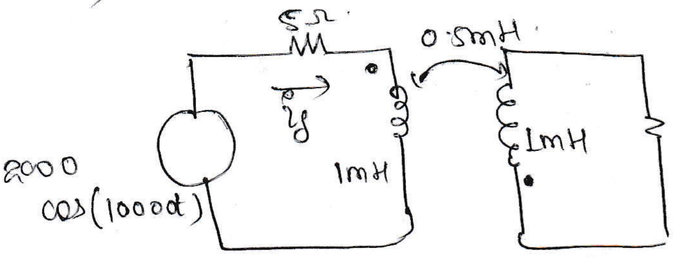
So $V_g = V_a - V_o$

$$= 9 - 5j - 10j$$

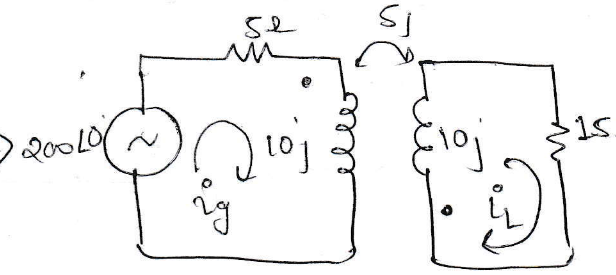
$$= 9 - 15j$$

$$\boxed{V_g = 17.5\angle{-59}}\ \text{V}.$$

Q.12. 1) Steady state expression for current i_g & i_L.



$\Rightarrow$



$\omega = 10000$ rad/sec.

Apply KVL at both loop.

$$200\angle 0^\circ = (5+j10)\, i_g + j5\, i_L \quad -(1)$$

$$0 = (15+10j)\, i_L + 5j\, i_g$$

$$i_L = \frac{j5 i_g}{15+10j} \quad -(2)$$

by solving eq^n (1) & (2) we get.

$$i_g = 5.88 - 16.47j = 17.5\angle -70.34$$

$$i_g = 17.5\cos(10000t - 70.34)\ A.$$

$$i_L = 4.70 - 1.176j$$

$$i_L = 4.85\angle -14^\circ$$

$$i_L = 4.85\cos[10000t - 14^\circ]$$

2) Coefficient of coupling.

$$K = \frac{M}{\sqrt{L_1 L_2}} = \frac{0.5}{\sqrt{1\times 1}} \Rightarrow \boxed{K = 0.5}.$$

3) Energy stored in the magnetically coupled coil

at $t = 50\pi\ \mu s$.

$$i_g = 17.50\cos[10000\times 50\pi\times 10^{-6} - 70.34]$$

$$= 17.50\cos(90 - 70.34) = 16.48\ A.$$

$$i_L = 4.85\cos(90^\circ - 14) = 1.1733\ A.$$

Total Energy in coupled coil

$$W = \tfrac{1}{2}L_1 i_g^2 + \tfrac{1}{2} i_L^2 L_2 + M i_g i_L.$$

$$\boxed{W = 146.15}\ mJ$$

at $t = 100\pi$

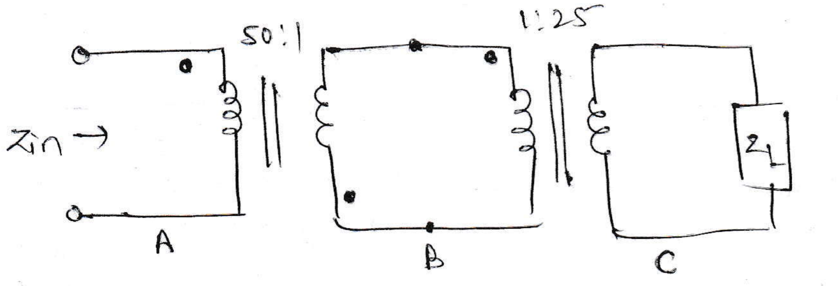
$$i_g = 17.50\cos(180^\circ - 70.34) = -5.887\ A.$$

$$i_L = 4.85\cos(180^\circ - 14^\circ) = -4.7\ A.$$

Total energy -

$$W = \tfrac{1}{2}L_1 i_g^2 + \tfrac{1}{2} i_L^2 L_2 + M i_g i_L \Rightarrow \boxed{W = 42.20}\ mJ$$

Q.13.



$Z_L = 200 + j\,150\ \Omega$.

$n = \frac{N_2}{N_1}$

$Z_B = \frac{Z_L}{n^2}$ $\left[\ Z_B = \left(\frac{N_1}{N_2}\right)^2 \times Z_L\right.$

$= \frac{200 + j\,150}{(25)^2}$

$Z_B = 0.32 + 0.24j$

$Z_A = \frac{Z_B}{n^2}$

$= \frac{0.32 + 0.24j}{(1/50)^2}$

$Z_A = 800 + 600j\ \Omega$.

$\boxed{Z_{in} = 800 + 600j}\ \Omega$.