1) $V_1(t) \Rightarrow 10\cos(\omega t) + 10\sin(\omega t)$

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

$V_1(t) \Rightarrow 10\angle 0^\circ + 10\angle -90^\circ$

$V_1(t) \Rightarrow 10[\cos(0^\circ) + i\sin(0^\circ)] + 10[\cos(-90^\circ) + i\sin(-90^\circ)]$

$\Rightarrow 10[1 + i(0)] + 10[\cos(90^\circ) - i\sin(90^\circ)]$

$\Rightarrow 10[1] + 10[0 - i(1)]$

$V_1(t) \Rightarrow 10 - i(10)$

$V_1(t) \Rightarrow \sqrt{10^2 + 10^2}\ \tan^{-1}\left(\frac{-10}{10}\right)$

$\Rightarrow \sqrt{200}\ \tan^{-1}(-1)$

$V_1(t) \Rightarrow 14.14\angle -45^\circ$

$V_1(t) \Rightarrow 14.14\cos(\omega t - 45)$

$i_1(t) \Rightarrow 10\cos(\omega t + 30^\circ) + 5\sin(\omega t + 30^\circ)$

$i_1(t) \Rightarrow 10\cos(\omega t + 30^\circ) + 5\cos(\omega t + 30^\circ - 90^\circ)$

$\Rightarrow 10\cos(\omega t + 30^\circ) + 5\cos(\omega t - 60^\circ)$

$i_1(t) \Rightarrow 10\angle 30^\circ + 5\angle -60^\circ$

$\Rightarrow 10[\cos(30^\circ) + i\sin(30^\circ)] + 5[\cos(-60^\circ) + i\sin(-60^\circ)]$

$\Rightarrow 10[0.866 + i(0.5)] + 5[\cos(60^\circ) - i\sin(60^\circ)]$

$\Rightarrow 10[0.866 + i(0.5)] + 5[0.866 + i(0.5)]$

$\Rightarrow 8.66 + i(5) + 4.33 + i(2.5)$

$i_1(t) \Rightarrow 12.99 + i(2.5) \Rightarrow 11.16 + 0.67i$

$i_1(t) = \sqrt{(12.99)^2 + (2.5)^2}\ \tan^{-1}\left(\frac{2.5}{12.99}\right)$

$\Rightarrow 13.2283\angle 10.89$

$i_1(t) \Rightarrow \sqrt{(11.16)^2 + (0.67)^2}\ \tan^{-1}\left(\frac{0.67}{12.99}\right)$

$\Rightarrow 11.18\angle 3.435$

$i_1(t) \Rightarrow 11.18\cos(\omega t + 3.435)$

3) $i_2(t) \Rightarrow 20 \sin(\omega t + 90^\circ) + 15 \cos(\omega t - 60^\circ)$

$\Rightarrow 20 \cos(\omega t + 90^\circ - 90^\circ) + 15 \cos(\omega t - 60^\circ)$

$\Rightarrow 20 \cos(\omega t) + 15 \cos(\omega t - 60^\circ)$

$\bar{i}_2(t) \Rightarrow 20 \angle 0^\circ + 15 \angle -60^\circ$

$\Rightarrow 20 [\cos(0^\circ) + i \sin(0^\circ)] + 15 [\cos(-60^\circ) + i \sin(-60^\circ)]$

$\Rightarrow 20 [1 + i(0)] + 15 [\cos(60^\circ) - i \sin(60^\circ)]$

$\Rightarrow 20 [1] + 15 [0.5 - i(0.866)]$

$\bar{i}_2(t) \Rightarrow 20 + 7.5 - i(12.99)$

$\bar{i}_2(t) \Rightarrow 27.5 - i(12.99)$

$\Rightarrow \sqrt{(27.5)^2 + (12.99)^2} \; \tan^{-1}\left(\frac{-12.99}{27.5}\right)$

$\Rightarrow 30.41 \angle -25.28$

$i_2(t) \Rightarrow 30.41 \cos(\omega t - 25.28)$

$V_1(t) \Rightarrow \cos(\omega t - 30^\circ)$

$V_2(t) \Rightarrow \cos(\omega t + 30^\circ)$

$V_3(t) \Rightarrow \cos(\omega t + 45^\circ)$

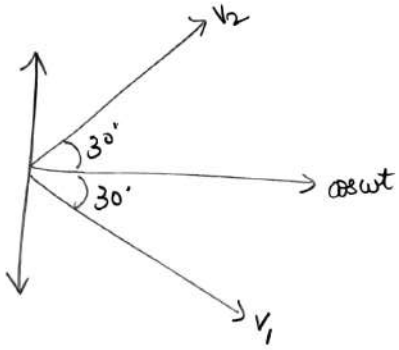
Case I: Comparing $V_1(t)$ and $V_2(t)$

$V_1(t) \Rightarrow \cos(\omega t - 30^\circ)$

$V_1(t) \Rightarrow 1 \angle -30^\circ$

$V_2(t) \Rightarrow \cos(\omega t + 30^\circ)$

$V_2(t) \Rightarrow 1 \angle 30^\circ$



V_2 leads V_1 by 60°

V_1 lags V_2 by 60°

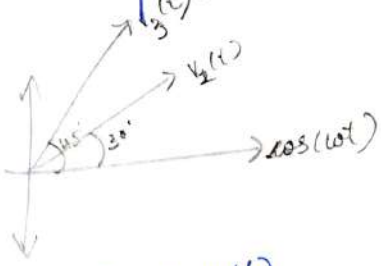
Case II: Comparing $V_2(t)$ and $V_3(t)$

$V_2(t) \Rightarrow \cos(\omega t + 30^\circ)$

$V_2(t) \Rightarrow 1 \angle +30^\circ$

$V_3(t) \Rightarrow \cos(\omega t + 45^\circ)$

$V_3(t) \Rightarrow 1 \angle 45^\circ$



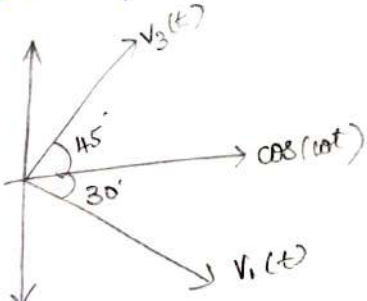
V_3 leads V_2 by 15°

V_2 lags V_3 by 15°

Case III: Comparing $V_1(t)$ and $V_3(t)$

$V_1(t) \Rightarrow 1 \angle -30^\circ$

$V_3(t) \Rightarrow 1 \angle 45^\circ$



V_3 leads V_1 by 75°

V_1 lags V_3 by 75°

2) $V_L(t) \Rightarrow 100 \cos(200t)$

$L \rightarrow 0.25\,H$

$\omega \Rightarrow 200$ rad/s

i) $Z_L \Rightarrow ?$

$V_L \rightarrow ?$

$I_L \Rightarrow ?$

$Z_L \Rightarrow j\omega L$

$\Rightarrow j(200)(0.25)$

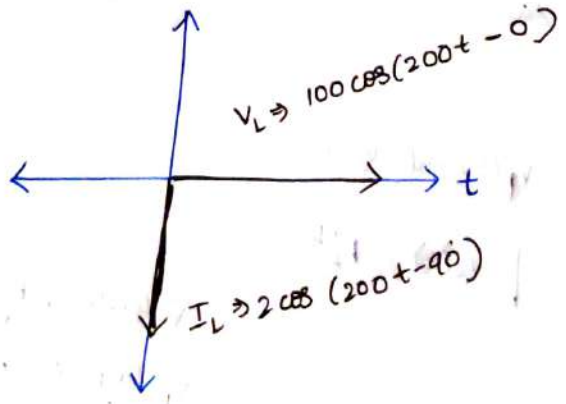
$\Rightarrow j(50.00) \Rightarrow 50j$

$Z_L \Rightarrow 50j \Rightarrow 50 \angle 90^\circ$

$V_L(t) \Rightarrow 100 \cos(200t) \Rightarrow 100 \angle 0^\circ$

$I_L \Rightarrow \frac{V_L}{Z_L} \Rightarrow \frac{100 \angle 0^\circ}{50 \angle 90^\circ} \Rightarrow 2 \angle 0-90^\circ \Rightarrow 2 \angle -90^\circ$

$I_L \Rightarrow 2 \cos(200t - 90^\circ)$



In an inductor circuit, voltage always leads the current by 90°

current lags voltage by 90°

3)

$V_c(t) \Rightarrow 100 \cos(200t)$

$C \Rightarrow 100\,\mu F \qquad \omega \Rightarrow 200\ rad/s$

$$Z_C \Rightarrow \frac{-j}{\omega C}$$

$$\Rightarrow \frac{-j}{200(100*10^{-6})} \Rightarrow \frac{-j}{2*10^{-2}}$$

$$\Rightarrow \frac{-j(100)}{2} \Rightarrow -j(50)$$

$$\Rightarrow -50j \; * \frac{j}{j} \Rightarrow \frac{-50j^2}{j} \Rightarrow \frac{50}{j}$$

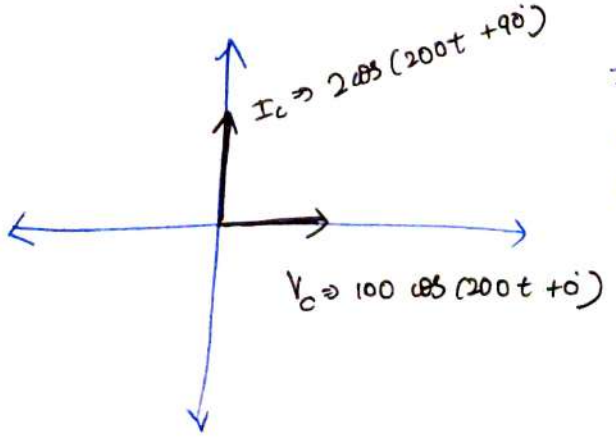
$$Z_C \Rightarrow 50\angle -j \Rightarrow 50\angle -90^\circ \Rightarrow 50\cos(200t - 90^\circ)$$

$V_L \Rightarrow 100\cos(200t)$

$\Rightarrow 100(\cos(200t + 0^\circ)) \Rightarrow 100\angle 0^\circ$

$$I_C \Rightarrow \frac{V_L}{Z_C} \Rightarrow \frac{100\angle 0^\circ}{50\angle -90^\circ} \Rightarrow 2\angle 0^\circ + 90^\circ \Rightarrow 2\angle 90^\circ$$

$\Rightarrow 2\cos(200t + 90^\circ)$



In a capacitor circuit current leads the voltage by 90°

(or)

voltage lags the current by 90°