EEE

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DIGITAL ASSIGNMENT-II

19MID0017

A2 SLOT

Question 1:- Add the following phasors:

(i) $V_1(t) = 10\cos(\omega t) + 10\sin(\omega t)$

Step 1: Convert all functions into cosine functions

$$V_1(t) = 10\cos(\omega t) + 10\cos(\omega t - 90)$$

Step 2: Convert the sinusoidal form to phasor form

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

Step 3: Convert phasors into rectangular form

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

$$= 10(1+0) + 10(0-1)$$

$$V_1(t) = 10 - 10i$$

Step 4: Convert rectangular form to phasor form again

$$V_1(t) = 10 - 10i$$

$$= \sqrt{10^2+10^2}\tan^{-1}(-10/10)$$

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

$$= \sqrt{2}\times 10\angle -45^\circ$$

$$V_1(t) = 10\sqrt{2}\angle -45^\circ$$

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

Step 5: Convert phasor form to sinusoidal form

$$V_1(t) = 14.14\cos(\omega t - 45^\circ)$$

$$V_1(t) = 14.14\sin(\omega t + 45^\circ)$$

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

Step 1: Convert all functions into cosine forms.

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

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

Step 2:

Convert the sinusoidal form to phasor

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

Step 3: Convert the phasor form to rectangular one

$$i_1(t) = 10(\cos 30^\circ + i\sin 30^\circ) + 5(\cos 60^\circ - i\sin 60^\circ)$$

$$= 10\left(\frac{\sqrt{3}}{2} + i\,1/2\right) + 5\left(1/2 - i\sqrt{3}/2\right)$$

$$= 5\sqrt{3} + i\,10/2 + 5/2 - 5\sqrt{3}/2$$

$$= 11.16 + 0.669i$$

$$i_1(t) = 11.16 + 0.669i$$

Step 4: Convert rectangular form to phasor form

$$i_1(t) = \sqrt{11.16^2 + (0.669)^2}\,\tan^{-1}\left(\frac{+0.669}{11.16}\right)$$

$$= 11.18\angle 3.43^\circ$$

Step 5: Convert from phasor form to sinusoidal form

$$i_1(t) = 11.18\cos(\omega t + 3.43^\circ)$$

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

Step 1: Convert all functions into cosine

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

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

Step 2: Convert sinusoidal function to phasor form

$$i_2(t) = 20 \angle 0^\circ + 15 \angle -60^\circ$$

Step 3: Convert phasor form to rectangular form

$$i_2(t) = 20 \cos 0^\circ + 20 i \sin 0^\circ + 15 \cos 60^\circ - 15 i \sin 60^\circ$$

$$= 20 + i0 + 15/2 - \frac{15\sqrt{3}}{2} i$$

$$= 20 + 15/2 - \frac{15\sqrt{3}}{2} i$$

$$= 27.5 - 12.99 i$$

Step 4: Convert rectangular form to phasor form

$$i_2(t) = \sqrt{(27.5)^2 + (12.99)^2} \tan^{-1}\left(\frac{-12.99}{27.5}\right)$$

$$= 30.41 \angle -25.28^\circ$$

Step 5: Convert phasor form to sinusoidal form

$$i_2(t) = 30.41 \cos(\omega t - 25.28^\circ)$$

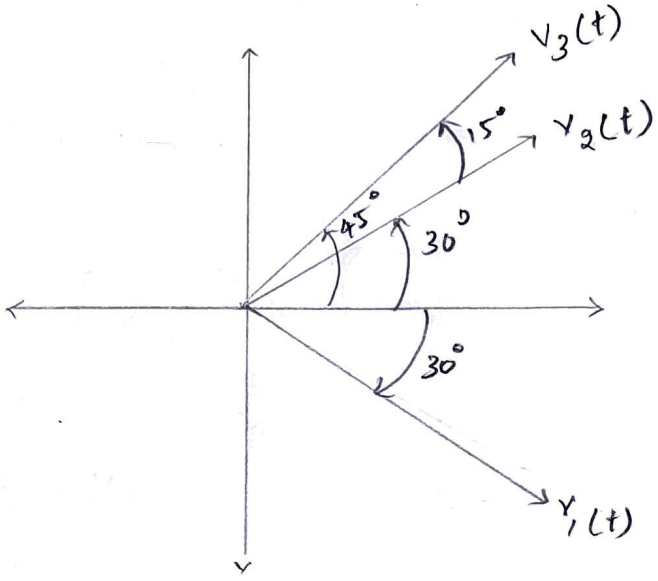
$$= 30.41 \sin(\omega t - 25.28 + 90^\circ)$$

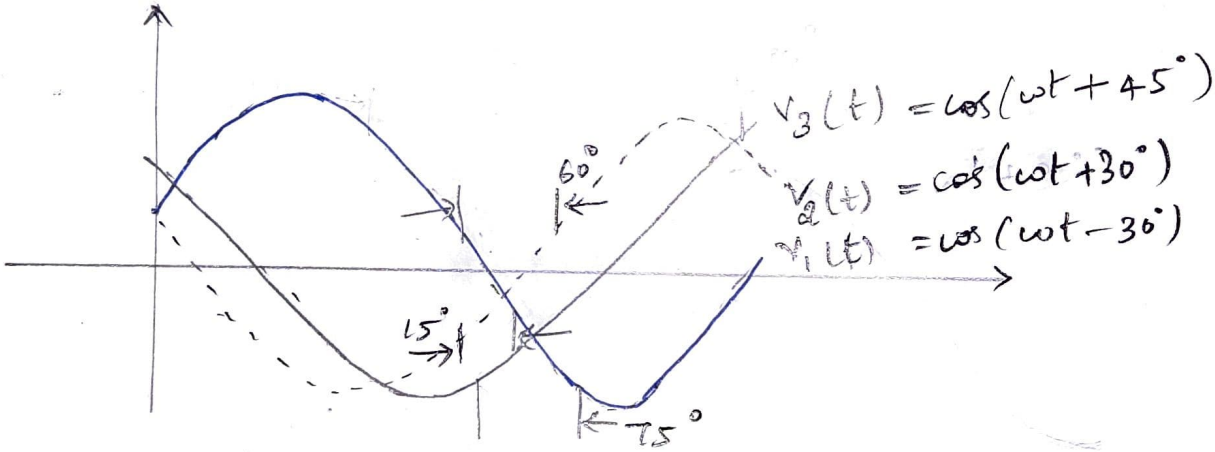
$$= 30.41 \sin(\omega t + 64.72^\circ)$$

2) State the phasor relationship b/w each pair of voltages.

$v_1(t) = \cos(\omega t - 30^\circ)$ $\quad v_2(t) = \cos(\omega t + 30^\circ)$

$v_3(t) = \cos(\omega t + 45^\circ)$





Relationship:

(i) V_2 leads V_1 by 60°

(ii) V_3 leads V_2 by 15°

(iii) V_3 leads V_1 by 75°

(or)

(i) V_1 lags V_2 by 60°

(ii) V_2 lags V_3 by 15°

(iii) V_1 lags V_3 by 75°

Q3) A voltage $V_L(t) = 100\cos(200t)$ is applied to a 0.25 H inductance. Notice that $\omega = 200 rad/s$

a) Find the impendence, phasor current and phasor voltage (of inductor)

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

$$\Rightarrow V_L(t) = \omega L I_m \cos(\omega t + \theta).$$

$$\therefore \theta = 0^\circ, \omega = 200 \text{ rad/s}$$

$$V_m = \omega L I_m = 100$$

$$I_m = \frac{100}{\omega L} = \frac{100}{200 \times 1/4} = 2 A$$

$$V_L = V_m \angle 0^\circ$$

$$V_L = 100 \angle 0^\circ \text{ V}$$

$$I_L = I_m \angle \theta - 90^\circ$$

$$= 2 \angle \theta - 90^\circ$$

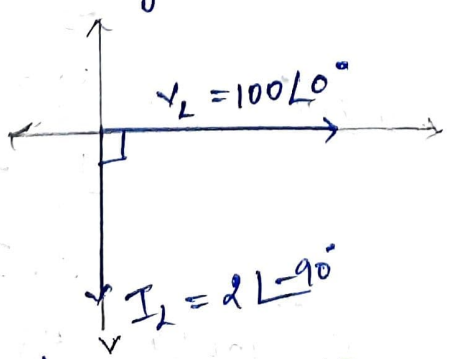
$$I_L = 2 \angle -90^\circ \text{ A}^\circ$$

$$V_L = Z_L I_L$$

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

$$Z_L = 50 \angle 90^\circ \ \Omega$$

b) Draw phasor diagram



$$V_L = 100\cos(200t) V$$

$$I_L = 2\sin(200t) A$$

$\therefore V_L$ leads I_L by 90°

4) A voltage $V_c(t) = 100 \cos(200t)$ is applied to a 100 μF capacitance.

a) Find impedence of a capacitance, phasor current and phasor voltage of capacitor

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

$$\Rightarrow V_c(t) = \frac{1}{\omega C} I_m \cos(\omega t + \theta)$$

$\therefore \theta = 0^\circ, \omega = 200,$

$$V_m = \frac{1}{\omega C} I_m = 100$$

$$I_m = 100 \times \omega C$$

$$= 100 \times 200 \times 100 \times 10^{-6}$$

$$I_m = 2 \text{ A}$$

$$I_C = I_m \angle \theta + 90^\circ$$

$$I_C = 2 \angle 0 + 90 = 2 \angle 90^\circ \text{ A}^\circ$$

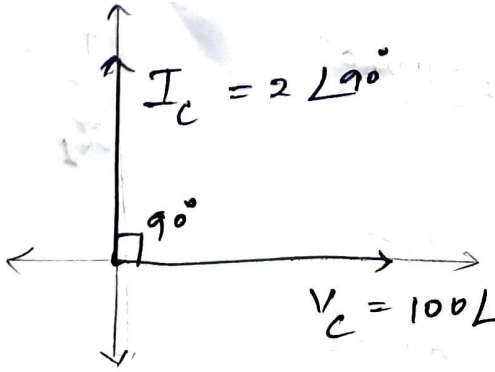
$$V_C = V_m \angle 0^\circ$$

$$V_c = 100 \angle 0^\circ \text{ V}$$

$$Z_C = \frac{V_c}{I_C} = \frac{100 \angle 0}{2 \angle 90} = 50 \angle 0 - 90$$

$$Z_C = 50 \angle -90^\circ \Omega$$

b) Draw Phasor diagram



$Z_C = 50 \sin(200t) \Omega$

$V_c = 100 \cos(200t)$

$I_c = 2 \sin(200t)$

$\therefore I_c$ leads V_c by 90°