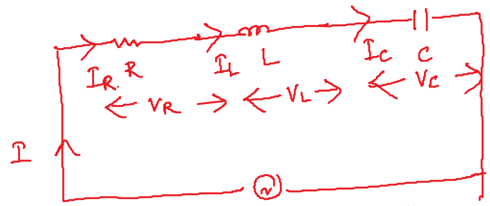
Thursday, January 6, 2022
11:30 AM

Series R-L-C Circuit

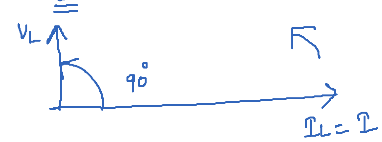


$v = V_m \sin\omega t$

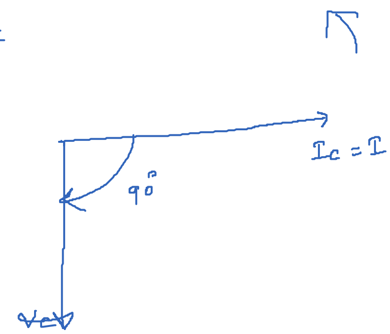
$= |V| \angle 0^\circ$

R

L



C



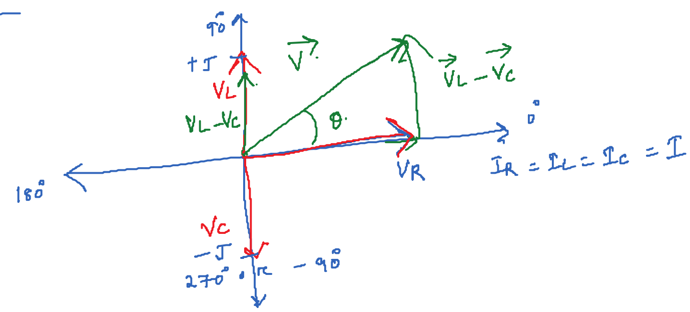
R - L - C

Case 1

$X_L > X_C$

$IX_L > IX_C$

$V_L > V_C$



$$\vec{V} = \vec{V_R} + J(\vec{V_L} - \vec{V_C})$$

$$IZ = IR + J(IX_L - IX_C)$$

$$\boxed{Z = R + J(X_L - X_C)} \quad (1)$$

$$= |Z| \angle \theta$$

$$= \sqrt{R^2 + (X_L - X_C)^2} \angle \tan^{-1}\left(\frac{X_L - X_C}{R}\right) \quad (2)$$

$$I = \frac{V}{Z} = \frac{|V| \angle 0^\circ}{|Z| \angle \theta} = \frac{|V|}{|Z|} \angle -\theta \quad (3)$$

$$v = V_m \sin\omega t$$

$$i = \frac{V_m}{\sqrt{R^2 + (X_L - X_C)^2}} \sin(\omega t - \theta) \quad (4)$$

$$\boxed{\theta = \tan^{-1}\left(\frac{X_L - X_C}{R}\right)}$$

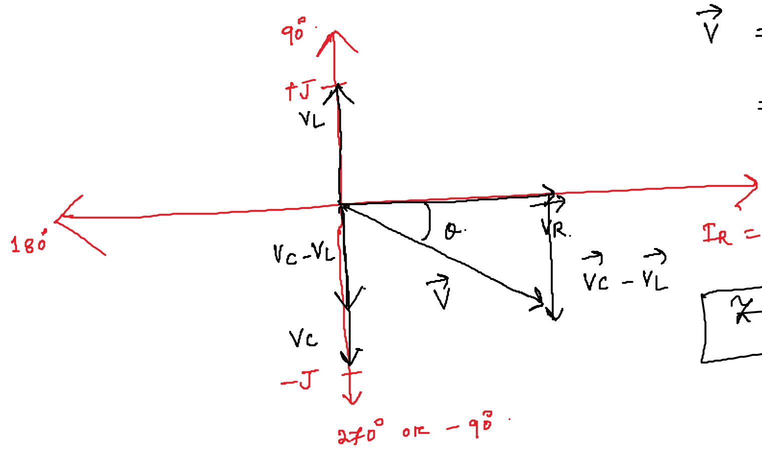
=

Case II

$X_L < X_C$

$IX_L < IX_C$

$V_L < V_C$



$\vec{V} = \vec{V_R} - J(\vec{V_C} - \vec{V_L})$

$= \vec{V_R} + J(\vec{V_L} - \vec{V_C})$

$= IR + J(IX_L - IX_C)$

$I_R = I_L = I_C = I$

$$\boxed{Z = R + J(X_L - X_C)}$$

$= |Z| \angle +\theta$

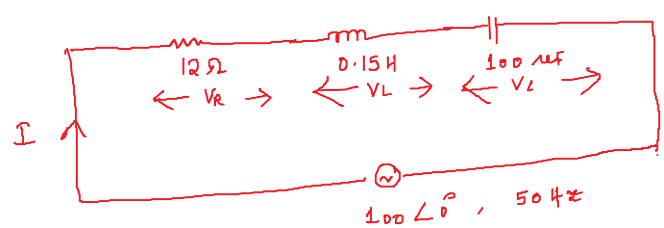
$= \sqrt{R^2 + (X_L - X_C)^2} \angle \tan^{-1}\left|\frac{X_L - X_C}{R}\right|$

(1) If $X_L > X_C$, θ is $-ve$ the circuit behaves as purely inductive ckt.

2) If $X_C > X_L$, θ is $+ve$, the circuit behaves as purely capacitive ckt.

(3) If $X_C = X_L$, $\theta = 0°$, the circuit behaves as purely resistive ckt.

Q. 1.



Calculate a) Z (e) pf

Apparent

Calculate

a) Z (e) pf

(b) I (f) Apparent power.

(c) phase angle (g) Avg power

(d) V_R, V_L, V_C (h) phasor diagram

(a) $R = 12\Omega$ $X_L = 2 \times 3.142 \times 50 \times 0.15$

$= 47.1\Omega$

$$X_C = \frac{1}{2\pi f C} = 31.8\Omega$$

$$Z = 12 + j(47.1 - 31.8)$$

$$= 12 + j15.3$$

$$= 19.4 \angle 51.9^\circ$$

(b) $$I = \frac{V}{Z} = \frac{100\angle 0^\circ}{19.4 \angle +51.9^\circ}$$

$$= 5.15 \angle -51.9^\circ$$

(c) $\phi = -51.9^\circ$

(d) $V_R = IR = 5.15 \times 12$

$= 61.8\ V$

$V_L = IX_L = 5.15 \times \cancel{31.8}\ 47.1$

$= 242.6\ V$

$V_C = IX_C = 5.15 \times 31.8 = 163.8\ V$

(e) $pf = \cos(51.9^\circ) = 0.617$ lagging

(f) $P_{app} = V_{rms} I_{rms} = 100 \times 5.15$

$= 515\ VA$

(g) $P_{avg} = VI\cos\theta$

$= 100 \times 5.15 \times 0.617$ W

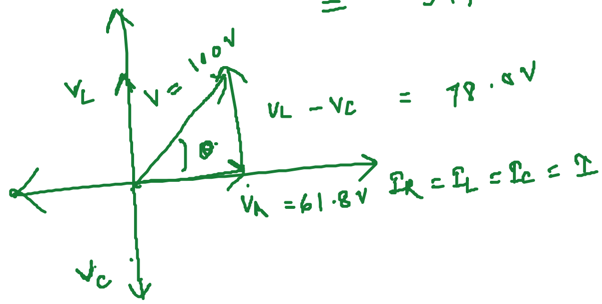
$= 317.7\ W.$

(148.6)

$$\sqrt{(61.8)^2 + (78.6)^2}$$

$= 110\,V$

$= 317.7\,W$



Q.2.

$R = 100\Omega$, $L = 0.2H$, $C = 20\mu F$

$V = 240\angle 0^\circ$,

Calculate (a) Z (b) I (c) pf (d) V_R, V_L, V_C

(e) power consumed

(f) phasor diagram

a) $Z = R + J(X_L - X_C)$

$= 100 + J(62.8 - 159)$

$= 139\angle -43.9^\circ$

b) $I = \dfrac{V}{Z} = \dfrac{240\angle 0^\circ}{139\angle -43.9^\circ} = 1.725\angle 43.9^\circ$

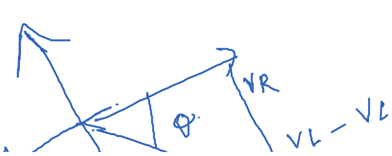
(c) $pf = 0.72$ leading

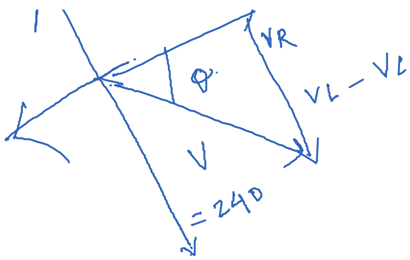
(d) $V_R = IR = 1.725 \times 100\angle 43.9^\circ$

$= 172.5\angle 43.9^\circ$

(e) $V_L = IX_L = 1.725\angle 43.9^\circ \times 62.9\angle 90^\circ$

$= 108.5\angle 133.9^\circ$





$= 108.5 \angle 133.4$

(f) $V_C = I X_C = 1.725 \angle 43.9^\circ \times 159 \angle -90^\circ$

$= 274.2 \angle$ ——

(g) $P = I_{rms}^2 R.$

$= (1.725)^2 \times 100 = 298\ W$