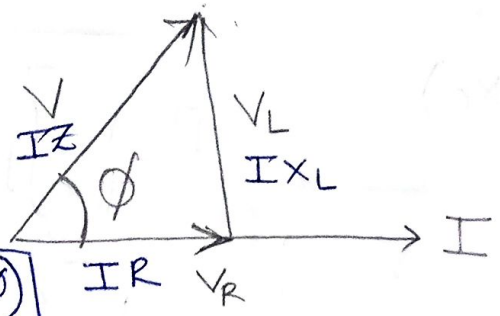
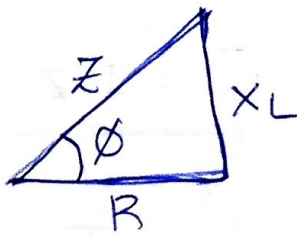
→ For pure resistance; V & I are at 0°
i.e. V & I are in phase.

⇒ Phasor :



$\phi = 0$ To $90°$

$v = v_m \sin\omega t$
$i = i_m \sin(\omega t - \phi)$



Impedance Δ^le.

clockwise → +ve → lagging angle

$$P = \frac{1}{\pi}\int_0^{\pi} p\, d\theta$$

$$= \frac{1}{\pi}\int_0^{\pi} V_m I_m \sin\theta \sin(\theta-\phi)\, d\theta$$

$$= \frac{V_m I_m}{\pi}\int_0^{\pi}\left[\cos\frac{(\phi)}{2} - \cos\frac{(2\theta-\phi)}{2}\right] d\theta$$

$$= \frac{V_m I_m}{\pi}\int_0^{\pi}\left[\cos\frac{\phi}{2} - \cos\frac{(2\theta-\phi)}{2}\right] d\theta$$

$$= \frac{V_m I_m}{2\pi} \cdot \cos\phi \cdot \pi$$

$\cos\phi$ = Power factor

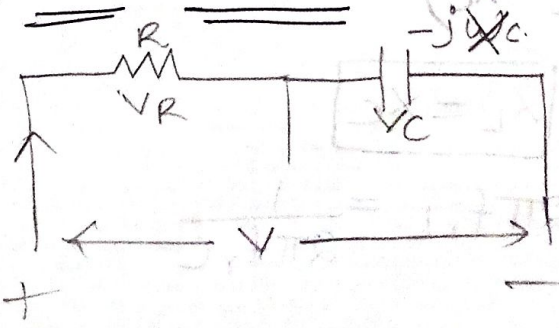
$$\boxed{P = \frac{V_m I_m}{2}\cos\phi}$$

$$P = V_{rms} I_{rms} \cos\phi$$

$$\boxed{P = VI\cos\phi}$$

* ϕ should be close to 0° so as to get max. power.

*SERIES RC CIRCUIT:



$\bar{V} = \bar{V}_R + \bar{V}_C$

$= IR + I(-jX_C)$

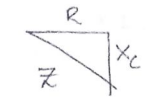
$= I(R - jX_C)$

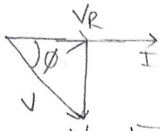
$\boxed{Z = R - jX_C}$

$\bar{V} = IZ$

$\boxed{Z = \frac{V}{I}}$

$\boxed{P = VI}$





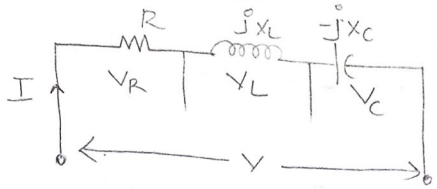
$P = \frac{1}{\pi}\int_0^{\pi} p\,d\theta$

$= \frac{1}{\pi}\int_0^{\pi} V_m \sin\theta \cdot I_m \sin(\theta - \phi)\,d\theta$

$= \frac{V_m I_m}{\pi}\int_0^{\pi} \sin\theta \cdot \sin(\theta - \phi)\,d\theta$

$\boxed{P = \frac{V_m I_m}{2}\cos\phi}$

* SERIES LCR CIRCUIT:



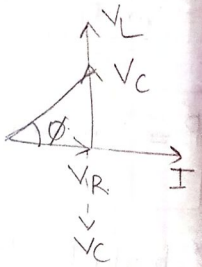
$V = V_R + V_L + V_C$

$= IR + Ij X_L - Ij X_C$

$= IR + Ij(X_L - X_C)$

$V = I(R + j(X_L - X_C))$

$Z = R + j(X_L - X_C)$



$X_L = 2\pi f L$

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

$\boxed{X_L = X_C}$

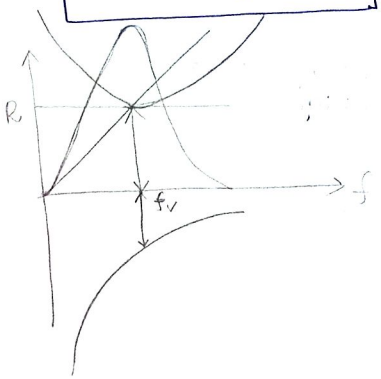
$2\pi f_r L = \frac{1}{2\pi f_r C}$

05/07/2022

$f_r^2 = \frac{1}{4\pi^2 LC} \Rightarrow \boxed{f_r = \frac{1}{2\pi\sqrt{LC}}}$

at $Z = R$ i.e. $X_L = X_C = 0$

$\Rightarrow \boxed{I_{max} = \frac{V}{Z} = \frac{V}{R}}$



* $f = 50Hz$ $R = 10\Omega$ $L = 10mH$; $C = 10\mu F$ $V = 250V$

$X_L = 2\pi f L$

$= 314 \times 10 \times 10^{-3}$

$\boxed{X_L = 3.14\Omega}$

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

$= \frac{1}{314 \times 10^{-5}}$

$= \frac{10^5}{314}$

$\boxed{X_C = 318.47\Omega}$

$\omega = \frac{1}{2\pi\sqrt{LC}}$

$f_r = \frac{1}{2\pi\sqrt{LC}}$

$= 503.54Hz$

$I = \frac{250}{10} = 25A$

$(X_L)_r = 31.629\Omega$ | $(X_C)_r = \frac{1}{2\pi f_r C} = 31.623\Omega$

$V_L = 25 \times 31.219 = 790.57V$ | $V_C = 790.57V$

* $R = 7\Omega$; $L = 31.8mH$; $V = 230V$; $f = 50Hz$

$X_L = 2 \times 3.14 \times 50 \times 31.8 \times 10^{-3}$

$= 9.98\Omega$

$jX_L = 9.98j$

$= 10j$

$Z = R + jX_L$

$= \sqrt{7^2 + 10^2} = \sqrt{} \approx 12.2\Omega$

$I = \frac{230}{7+10j} = \frac{230}{7+10j} = 18.85$

$\tan\phi = \frac{X_L}{R} = \frac{12.2}{} \quad \frac{10}{7} =$

*

$\phi = 55^\circ$

$\cos\phi = 0.57$

$P = VI\cos\phi = 2471.23W$

Voltage across $R = IR = 18.85 \times 7$

$= 131.95V$

across $L = IX_L = 188.5V$

* $V = 250V$; $f = 50Hz$ $I = 5A$ $P = 750W$

$\cos\phi = \frac{P}{VI} = \frac{750}{250 \times 5} = \frac{3}{5} = 0.6$ lag

$Z = \frac{V}{I} = 50\Omega$

$I^2R = 750$ ∴ no power through L

$R = \frac{750}{25} = 30\Omega$

$Z^2 = R^2 + X_L^2$

$R^2 \; 2500$

$X_L^2 = 2500 - 900 = 1600$

$X_L = 40\Omega$

$2\pi fL = 40$

$L = \frac{40}{2 \times 3.14 \times 50} =$

$L = 0.127H$

* $i(t) = 5\sin(314t + 2\pi/3)$

$v(t) = 15\sin(314t + 5\pi/6)$

(i) Impedance

(ii) Resistance (iii) Inductance (iv) average Power

(v) Power factor ($\cos\phi$).

$\phi = \frac{5\pi}{6} - \frac{2\pi}{3} = \frac{\pi}{6} = 30^\circ$

current lags the voltage applied by 30°.

$Z = \frac{V_m}{I_m} = \frac{15}{5} = 3\Omega$

$\cos\phi = \frac{\sqrt{3}}{2} = \frac{R}{Z}$

$R = \frac{3\sqrt{3}}{2}\Omega$

$L = \frac{3}{2} \times \frac{1}{314}$

$= 4.7 \times 10^{-3}$

$= 4.7mH$

$Z^2 = X_L^2 + R^2$

$X_L^2 = 9 - \frac{9 \times 3}{4}$

$X_L^2 = \frac{36 - 27}{4}$

$X_L = \frac{3}{2}$

$\omega = 314 = 2\pi f$

f

$P = I^2R = VI\cos\phi = \frac{15}{\sqrt{2}} \cdot \frac{5}{\sqrt{2}} \cos 30 = \frac{75}{2} \times \frac{\sqrt{3}}{2}$

$P = 75\sqrt{3}/4$

* $C = 79.5\mu F$ $R = 30\Omega$ $V = 100V$

$f = 50Hz$

$Z = \sqrt{R^2 + X_C^2} = \sqrt{30^2 + X_C^2}$

$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C} = 40\Omega$

$Z = \sqrt{900+1600} = 50\Omega$.

$I = \frac{V}{Z} = 2A$

$\cos\phi = \frac{R}{Z} \Rightarrow \phi = \cos^{-1}\left(\frac{R}{Z}\right)$

$= \cos^{-1}\left(\frac{30}{50}\right) = 53^\circ$ lead.

$I_m = 2\sqrt{2}A$

$\omega = 2\pi f = 314$ rad/sec

$I = 2.428 \sin(314t + 53$

07/07/2022

* COMPLEX POWER(S): ⇒ Apparent Power.

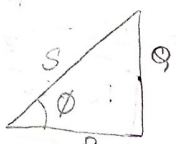
(L) + → consumption
(C) − → supply

$S = VI^*$ → conjugate.

$V = V\angle 0^\circ$

$I = I\angle -\phi$

$S = VI\angle -\phi$



$S = VI^* = VI\angle\phi = VI\cos\phi + jVI\sin\phi$

(P) (Q).

$VI\cos\phi$ = Active Power (P)

$VI\sin\phi$ = Reactive Power (Q)

VI = Apparent Power (S)

* $V = 100\sin 500t$

$I = 25\sin(500t - 30^\circ)$

Determine circuit elements & their values.

Determine P, Q, S.

$V_{rms} = \frac{100}{\sqrt{2}}\angle 0^\circ$

$I_{rms} = \frac{25}{\sqrt{2}}\angle -30^\circ$

$Z = \frac{V}{I} = 40\angle 30^\circ$ ($250\times\frac{\sqrt{3}}{2}$)

$= 3.46 + 2j$

R X_L

$R = 3.46\Omega$

$X_L = 2j$

$2\pi f L = 2\Omega$

$L = \frac{2}{500} = 4\times10^{-3}$ H

$P = VI\cos\phi = \frac{2500}{2}\angle -30^\circ$ $\cos\phi \cdot \frac{\sqrt{3}}{2}$.

~~$= 1082.53 + 625i$~~

$S = VI^* = \frac{2500}{2}\angle 30^\circ = 1082.53 + 625i$

$VI\cos\phi = P = 1082.53W$

$VI\sin\phi = Q = 625$.

$VI = S = 1250$

* $V(t) = 100\sin 314t$ $R = 10\Omega$; $L = 0.0318H$,

$C = 63.6\mu F$

$i(t)$, ϕ, power factor, active power, peak value of pulsating power.

$X_L = \omega L = 314\times0.0318 = 9.98 \simeq 10$

$X_C = \frac{1}{\omega C} = \frac{1}{314\times63.6} = 5\times10^{-5}\times10^6$

$= 50$

$X = X_L - X_C = -40$

$$Z = \sqrt{R^2 + Z^2} = \sqrt{(10)^2 + (-40)^2} = \sqrt{100 + 1600}$$

$$\boxed{Z = 41.2\,\Omega}$$

$$I = \frac{V}{Z}$$

$$= \frac{100/\sqrt{2}}{41.2} = 1.716\,A$$

$$I_m = \sqrt{2}\,I = 1.414 \times 1.716 = 2.426A$$

$$\phi = \tan^{-1}(-40/10) = \tan^{-1}(-4) = 76^\circ \text{ lead}$$

$$i = I_m \sin(314 + \phi)$$

$$= 2.43 \sin(314 + 76^\circ)$$

$$\cos\phi = \cos 76^\circ = 0.24$$

$$VI = 100 \sin 314t \cdot 2.43 \sin(314t + 76)$$

$$= 243\left[\cos(76) - \cos(628t + 76)\right]$$

$$= \left[58.78 - 243\cos(628t + 76)\right]$$

$$= 58.78 + 243 \sin(90 - 628t - 76)$$

$$= \frac{58.78}{2} + \frac{243}{2} \sin(628t - 14)$$

$$= 29.39 + 121.5 \sin(628t - 14)$$