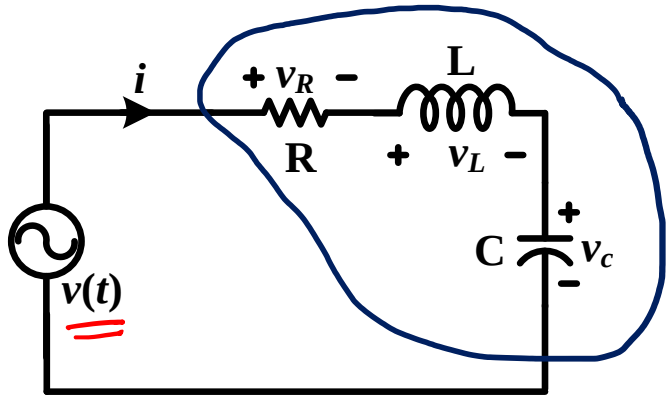
# Expt5: Measurement of AC System quantities




1. Find load impedance.
2. Derive the expression of various responses.
3. Draw the phasor diagram of these responses.
4. Calculate various power components.
5. Calculate Power Factor.
6. Find the value of source frequency at which the power factor will be unity.

$V(t) = 230\sqrt{2}\sin(100\pi t))$ feds power to a load (R = 10 Ω, L = 1 mH, C = 1 mF

**1. Find load impedance.**

$V(t) = 230\sqrt{2}\sin(100\pi t)$

$V_m \sin\omega t$ → ω, f.

$\omega = 100\pi = 2\pi f$

$f = 50\ Hz$

$Z = R + j(X_L - X_C)$ ; $X_L = 2\pi f L = 100\pi * 1\times10^{-3} = 0.314\ \Omega$

$X_C = 1/2\pi f c = \frac{1}{100\pi * 1\times10^{-3}} = 3.185\ \Omega$

$Z = 10 + j(0.314 - 3.185)$

$= (10 - j2.869)\ \Omega$

$= \sqrt{10^2 + (-2.869)^2} \angle \tan^{-1}\left(\frac{-2.869}{10}\right)$

$\Rightarrow Z_{Theo} = 10.4 \angle -16.01^\circ\ \Omega$ / $10.4 \angle -16.0$ Simulation

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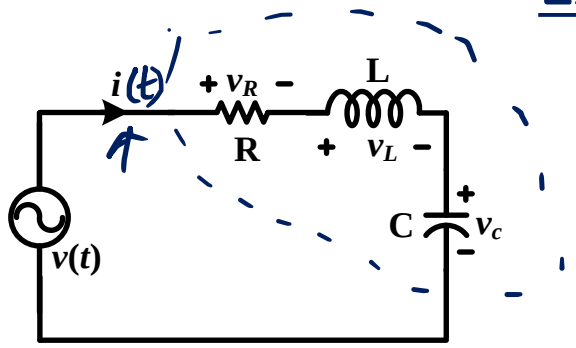


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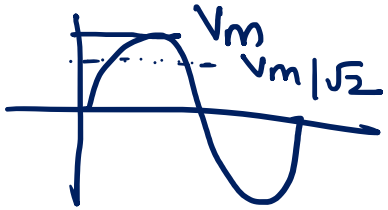
**2. Derive the expression of various responses.**

$$v(t) = \underbrace{230\sqrt{2}}_{V_m} \sin(100\pi t) = 230\angle 0^\circ \text{ RMS}$$




$$Z(t) = 10.4\angle -16.01$$

$$i(t) = \frac{V(t)}{Z(t)} = \frac{230\angle 0}{10.4\angle -16.01} = 22.11\angle 16.01^\circ \text{ A} = 22.11\sqrt{2}\sin(100\pi t + 16.01)$$

$$V_R = i(t)\cdot R = 22.11\angle 16.01 * 10 = 221.1\angle 16.01 \text{ Volts}$$

$$V_L = i(t)\cdot X_L = 22.11\angle 16.01 * j(\underbrace{100\pi * 10^{-3}}_{0.314}) = 22.11\angle 16.01 * 0.314\angle 90^\circ$$
$$= 6.946\angle 106.01^\circ$$

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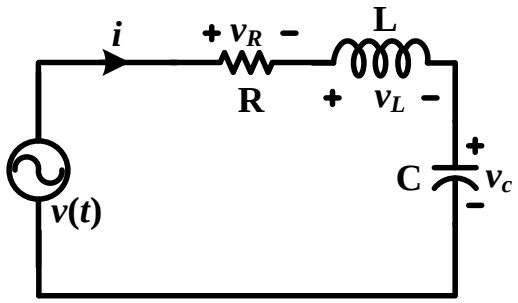


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**2. Derive the expression of various responses.**

$$V_C = i X_C = 22.11 \angle 16.01 * -j3.185 = 22.11 \angle 16.01 * 3.185 \angle -90^\circ$$

$$= 70.42 \angle -74^\circ$$

Simulation

$V_m$ = 325.22 (peak)

$i(t)$ = 31.26 (peak)

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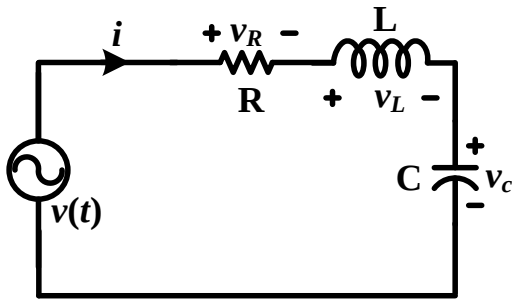


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**3. Draw the phasor diagram of these responses.**

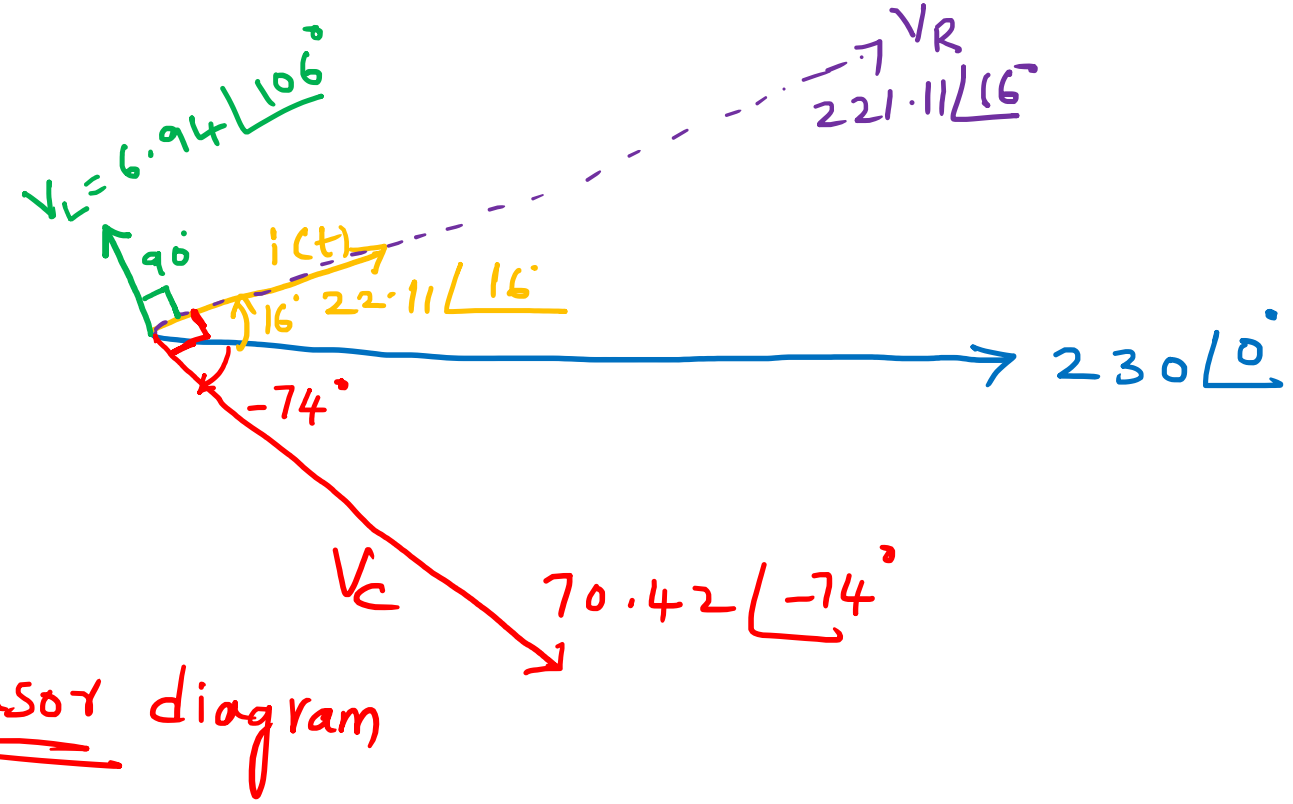
$V(t) = 230 \angle 0^\circ$

$i(t) = 22.11 \angle 16^\circ$

$V_R = 221.1 \angle 16^\circ$

$V_L = 6.94 \angle 106^\circ$

$V_C = 70.42 \angle -74^\circ$




Phasor diagram

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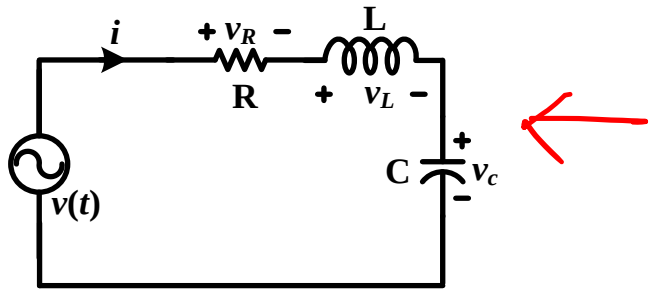


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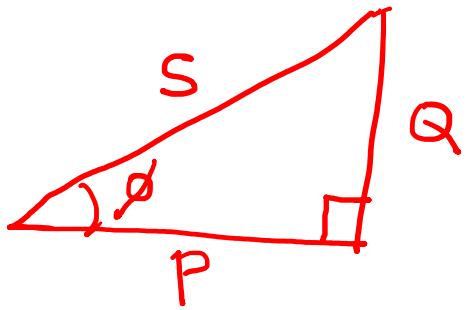
**4. Calculate various power components.**

Real power: 'P'

Reactive Power: 'Q'

Apparent Power: 'S'




$$\cos\phi = \frac{P}{S} = \frac{R}{Z}$$

$S = V \cdot I^* = 230 \angle 0^\circ * 22.11 \angle -16^\circ$

Sim (5082.43 VA) $= 5085 \angle -16^\circ \leftarrow \phi$

$P = VI\cos\phi = S\cdot\cos\phi$

$= 5085 \cdot \cos(-16^\circ)$

$= 4888.3\ W$ (Sim 4885 W)

$Q = VI\sin\phi = S\sin\phi$

Simulat → (−1401.8 Var) $= -1401.7$ VAR

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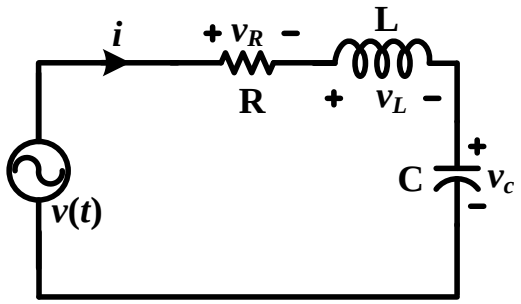


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**5. Calculate Power Factor.**

$$\cos\phi = \frac{P}{S} = 0.9612 \text{ (Simulation)}$$

$$= \frac{4885.3}{5085} = 0.961317 \text{ (Theoretically)}$$

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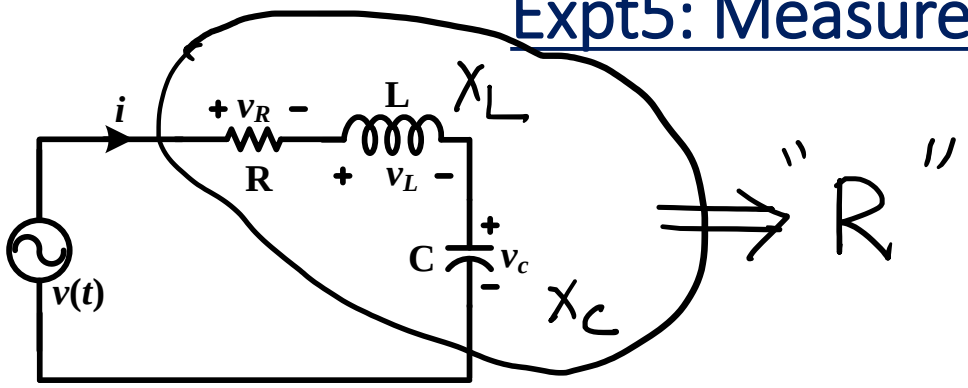


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**6. Find the value of source frequency at which the power factor will be unity.**

$$Z = R + j(X_L - X_C) \Rightarrow X_L - X_C = 0 \Rightarrow X_L = X_C .$$

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

$Z = R$ : pf $\Rightarrow$ Unity .

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

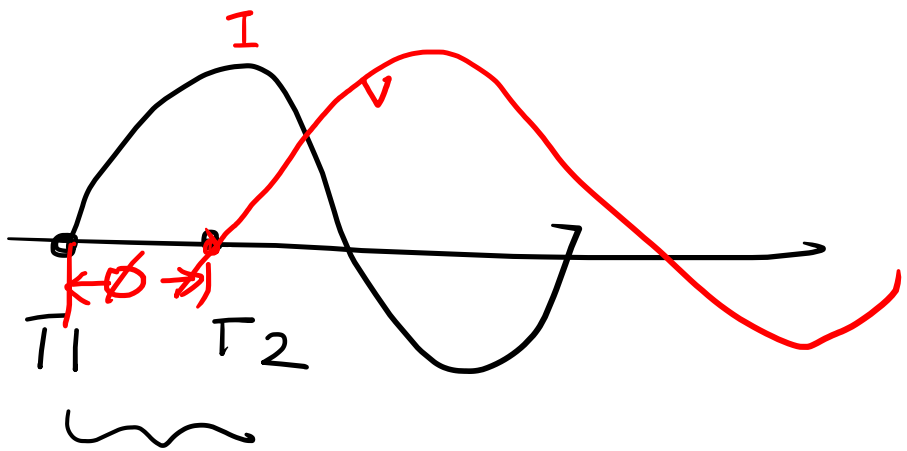
$V(t) = 100\pi = \omega \Rightarrow 2\pi f = 2\pi \times 50$

$= 159.23$ Hz

$\omega_{new}^{UPF} = 2\pi \cdot 159.23 = 1000$ //

# Power factor angle '$\phi$' from Simulation.

## $\phi$ b/w V & I.




$T_2 - T_1 =$

$T2 = 1.6$ sec

$T1 = 1.5991$

$T2 - T1 = 0.0009$ Sec

$\phi = \omega t = 100\pi \cdot (0.0009)$

Simulation $\Rightarrow$ $\phi_{rad} = 0.28269$ rad $* \frac{180}{\pi}$ Deg

$= 16.19^{\circ}$ //