# 3. Types of Power, R-C Circuit, LCR Circuit

01 March 2024 09:01

## Types of Power

- Pure inductor / capacitor ⟶ $P_{avg} = 0$

  Power circulates from source to load and vice versa, is not consumed. } Reactive power

- Inductor, capacitor ⟶ reactive elements $Q = VI \sin\phi$
- Denoted by Q, units: VAR

Apparent power

- Product of RMS value of voltage & current ⟶ apparent power
- Denoted by S, units: VA

Resistor: Power absorbed is consumed

Reactive power = 0

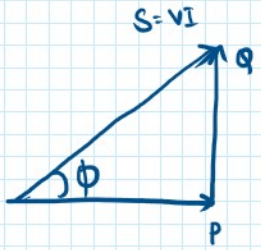
Inductor / Capacitor: Power consumed is zero

Active power = 0

## Active Power

Power consumed by the load, denoted by P, units: Watts

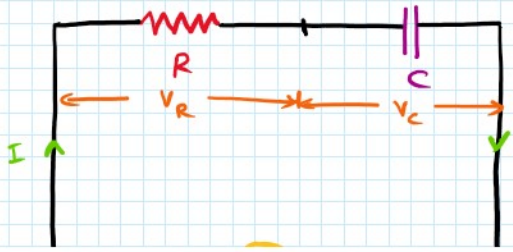
## Power Factor

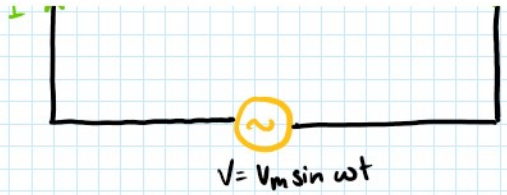



Ratio of active power to apparent power ⟶ power factor

$$\text{Power factor} = \frac{P}{S} = \cos\phi$$

## Series R-C Circuit Response



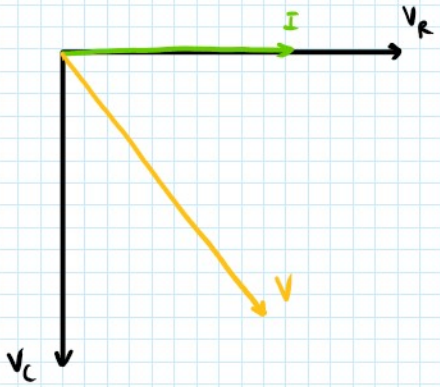



$$\bar{V} = \bar{V}_R + \bar{V}_C$$

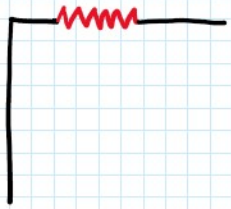
$$V = \sqrt{(IR)^2 + (IX_C)^2}$$

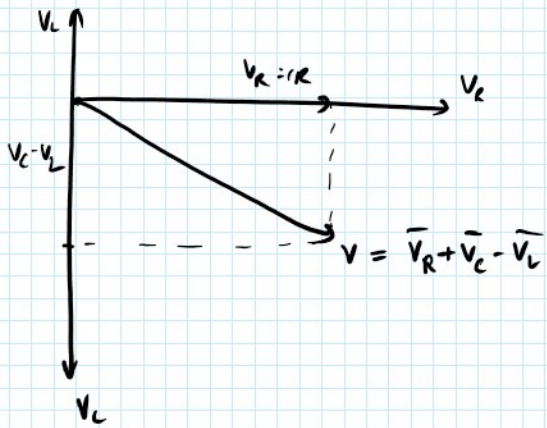
$$V = I\sqrt{R^2 + X_C^2} \rightarrow Z$$

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




## Series LCR Circuit Response





## Power Expressions : Summary

| Element / Network | Phase Angle | Active Power $P = VI\cos\phi$ | Reactive Power $Q = VI\sin\phi$ | Apparent Power $S = VI$ |
|---|---|---|---|---|
| R | $0°$ | $VI$ | $0$ | $VI$ |
| L | $90°$ | $0$ | $VI$ | $VI$ |
| C | $-90°$ | $0$ | $-VI$ | $VI$ |
| Series RL Circuit | $\tan^{-1}\left(\frac{X_L}{R}\right)$ | $VI\cos\phi$ | $VI\sin\phi$ (+ve) | $VI$ |
| Series RC Circuit | $-\tan^{-1}\left(\frac{X_C}{R}\right)$ | $VI\cos\phi$ | $VI\sin\phi$ (-ve) | $VI$ |

## Numericals

① Series RL circuit is connected to a sinusoidal voltage source $v(t) = 100\sin(\omega t)$ V. It draws a current of $10\sin(\omega t - 60°)$ A. Determine :

(i) Active, reactive, apparent power

(ii) Power factor of the circuit

Soln: $V = \frac{V_m}{\sqrt{2}} = \frac{100}{\sqrt{2}}$ V

$I = \frac{I_m}{\sqrt{2}} = \frac{10}{\sqrt{2}}$ V

$\phi = \angle\bar{V} - \angle\bar{I} = 0° - (-60°) = 60°$

$P = VI\cos\phi = \frac{1000}{4} = 250$ W

$Q = VI\sin\phi = \frac{1000}{2}\sin 60 = 433.012$ VAR

$S = VI = \frac{1000}{2} = 500$ VA

Power factor $= \frac{P}{S} = \cos 60 = \frac{1}{2}$ lag