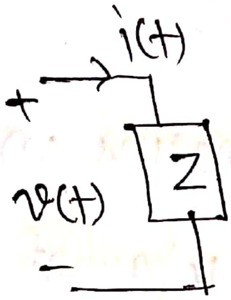
Complex Power (Due to both real and Imaginary part)

- The product of the rms voltage phasor and the complex conjugate of the rms current phasor is known as complex power.

→ rms voltage Phasor → $\overline{V_{rms}}$

→ complex conjugate of rms current Phasor → $\overline{I_{rms}}$

Example



→ $v(t) \Rightarrow V_{rms},\ \theta_v$ ← phase angle

$$\boxed{\overline{V_{rms}} = V_{rms} \angle \theta_v}$$

→ $i(t) \Rightarrow I_{rms},\ \theta_i$

$$\vec{I_{rms}} = I_{rms} \angle \theta_i$$

$$\boxed{\overline{I_{rms}}^{*} = I_{rms} \angle -\theta_i}$$

Therefore,

$$\text{complex power } (\bar{S}) = \overline{V_{rms}} \cdot \overline{I_{rms}}^{*}$$

$$\bar{S} = V_{rms} \angle \theta_v \cdot I_{rms} \angle -\theta_i$$

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$$\boxed{\bar{S} = V_{rms} \cdot I_{rms} \angle (\theta_v - \theta_i)}$$

Formula for average power:

$$\boxed{P = \frac{1}{2} V_m I_m \cos(\theta_v - \theta_i)}$$

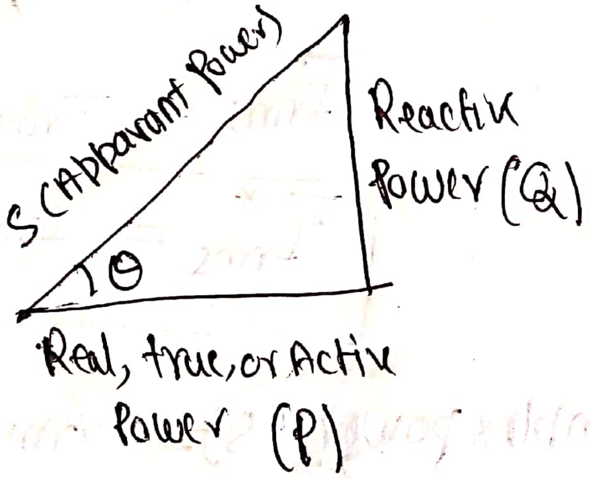
$$P = \text{Real}\left\{ \frac{1}{2} V_m I_m e^{j(\theta_v - \theta_i)} \right\}$$

$$P = \text{Real}\left\{ \frac{V_m}{\sqrt{2}} e^{j\theta_v} \cdot \frac{I_m}{\sqrt{2}} e^{-j\theta_i} \right\}$$

$$P = \text{Real}\left\{ \underbrace{V_{rms}\angle\theta_v \cdot I_{rms}\angle-\theta_i}_{\text{Complex}} \right\}$$

$$\boxed{\bar{S} = \bar{V}_{rms} I_{rms}^{*}}$$ Proof

Note: complex power always measure in Volt Ampere.
↳ Also called as apparant power.



$$S = P + jQ$$

$$\boxed{|S| = \sqrt{P^2 + Q^2}}$$

Summary:

Complex Power (S) = $V_{rms} \cdot I_{rms}^{*} \angle \theta_v - \theta_i$

Example: $m\angle\theta$

$$\boxed{S = V_{rms} I_{rms}\left[\cos(\theta_v - \theta_i) + j\sin(\theta_v - \theta_i)\right]}$$

$$\boxed{S = P\angle\theta}$$