

Average Power
or Real Power

Reactive Power

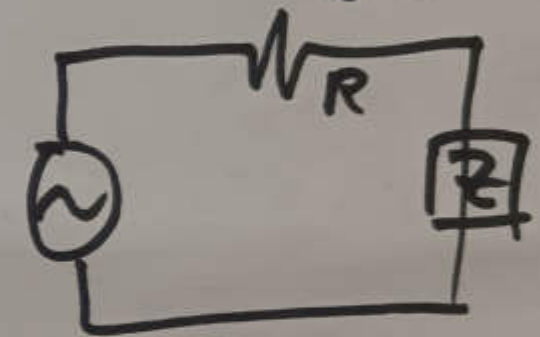
$$P_{max} = P + \sqrt{P^2 + Q^2}$$

$$P_{min} = P - \sqrt{P^2 + Q^2}$$

instantaneous power

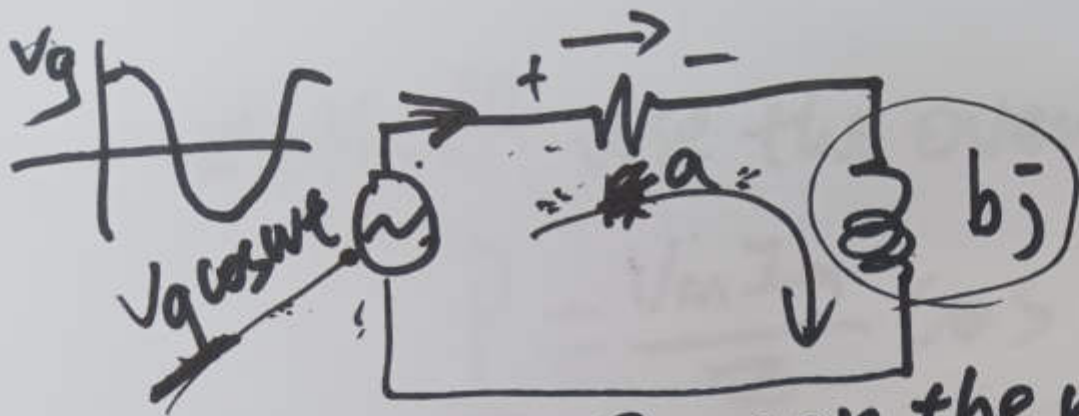
$$P = VI$$

$$VI = P$$



amplitude
magnitude
Modulus

①



$a + bj$ real/average power
 $\sqrt{a^2 + b^2}$
 $\frac{V}{a + bj} = I$

Method I: (Focus on the resistor)

$$\frac{V_g / \sqrt{2}}{\sqrt{a^2 + b^2}} = I_{rms}$$

$$\frac{V}{I} = a + bj$$

$$\frac{V \angle 0^\circ}{I \angle \theta} = \sqrt{a^2 + b^2} \angle \theta$$

cancel $\frac{b}{a}$

$$V_{rms} = \frac{V_g}{\sqrt{2}}, \quad V_{rms} = \frac{(V_g / \sqrt{2}) \cdot a}{\sqrt{a^2 + b^2}}$$

$$P = V_{rms} \cdot I_{rms} = \frac{V_g \cdot a}{(a^2 + b^2) \cdot 2}$$

$\frac{V \angle 0^\circ}{I \angle \theta} = \frac{V \cos \theta}{I \cos \theta} = \frac{V \cos \theta}{I}$

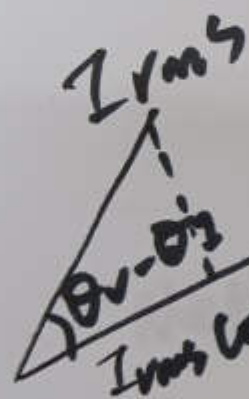
$\frac{V \cos \theta}{I} = \frac{V \cos \theta}{I} = \frac{V \cos \theta}{I}$

Method II: use the overall impedance

$$\begin{aligned}
 \underline{P} &= \frac{V_m I_m}{2} \cos(\theta_v - \theta_i) \\
 &= \frac{V_m}{\sqrt{2}} \cdot \frac{I_m}{\sqrt{2}} \cos(\theta_v - \theta_i) \\
 &= V_{rms} I_{rms} \cos(\theta_v - \theta_i)
 \end{aligned}$$

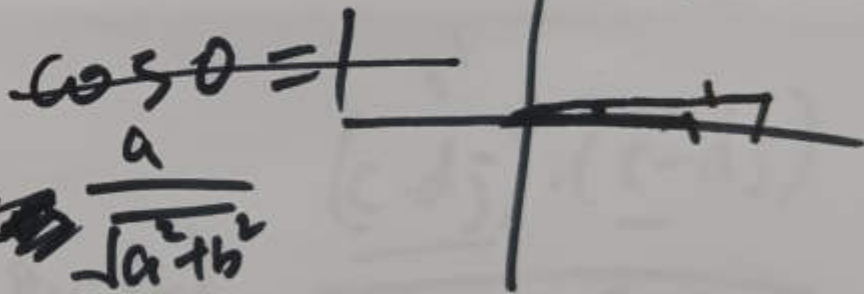
power factor
pf

$\cos(\theta_v - \theta_i)$
 \Downarrow
 impedance phase angle

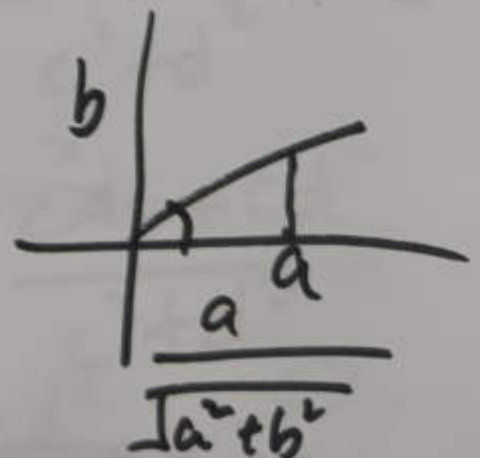


$$I_{rms} \cos(\theta_v - \theta_i) = \frac{V_g}{\sqrt{2}}$$

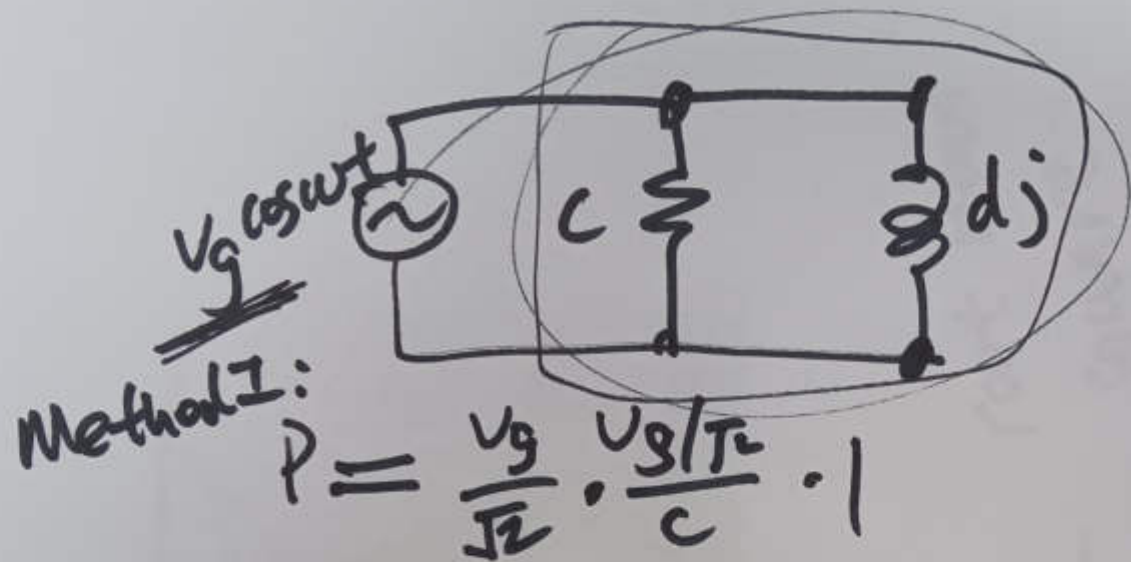
$$\frac{V_g}{\sqrt{2}} = \frac{V_s / \sqrt{2}}{\sqrt{a^2 + b^2}} \cdot \frac{a}{\sqrt{a^2 + b^2}}$$



$$= \frac{V_g^2 a}{2(a^2 + b^2)}$$



(3)



$$P = \frac{V_g}{\sqrt{2}} \cdot \frac{V_g/\sqrt{2}}{C} \cdot 1$$

$$= \frac{V_g^2}{2 \cdot C}$$

Method II:

$$P = \frac{V_g}{\sqrt{2}} \frac{V_g/\sqrt{2}}{\sqrt{\left(\frac{Cd^2}{C^2+d^2}\right)^2 + \left(\frac{C^2d}{C^2+d^2}\right)^2}} \cos(\theta_v - \theta_i)$$

~~$$\frac{C+dj}{\sqrt{C^2+d^2}}$$~~

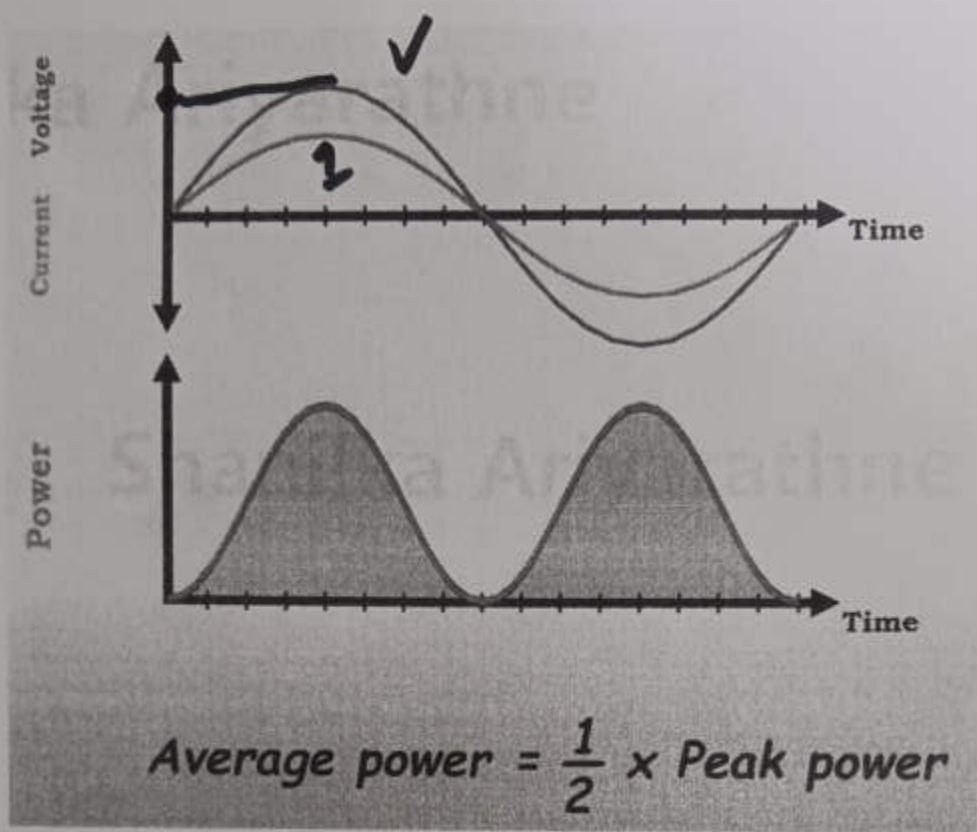
$$\frac{C \cdot dj}{C+dj}$$

$$\frac{(C \cdot dj) \cdot (C - dj)}{C^2 + d^2}$$

$$= \frac{C^2 dj + Cd^2}{C^2 + d^2}$$

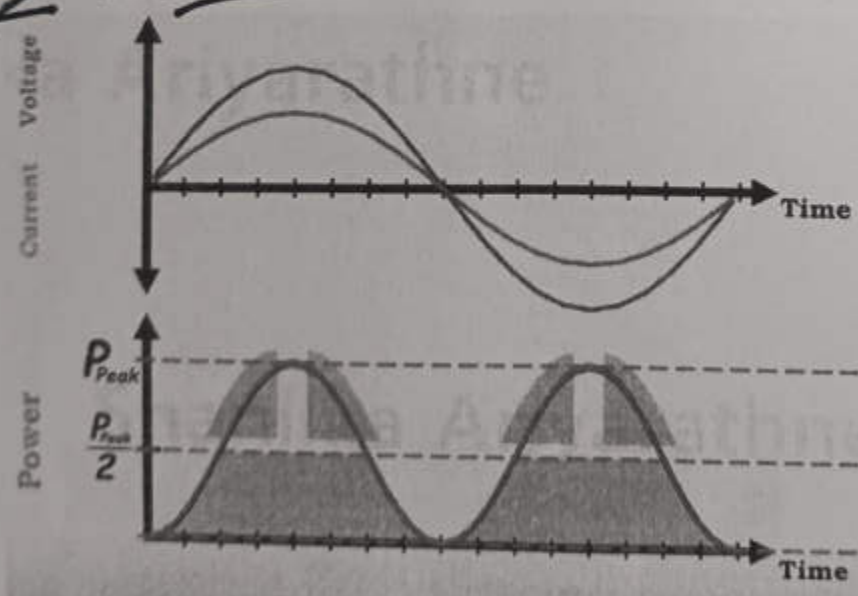
$$= \frac{Cd^2}{C^2 + d^2} + \frac{C^2 d}{C^2 + d^2} j$$

(4)



V_{rms}

120V / 60Hz



root mean square
 V_{rms} I_{rms}

Average power = $\frac{1}{2} \times \text{Peak power}$

$$= \frac{\text{Peak Power}}{2} = \left(\frac{V_m}{\sqrt{2}}\right) \left(\frac{I_m}{\sqrt{2}}\right)$$