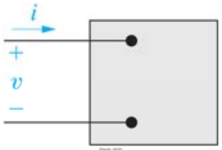
Summary of Formulas from Chapter 10 (Sinusoidal Power)



$$v(t) = V_m \cos(\omega t + \theta_v) \rightarrow V_m \cos(\omega t + \theta_v - \theta_i) \quad \mathbf{V} = V_m \angle\theta_v \rightarrow V_m \angle(\theta_v - \theta_i)$$
$$i(t) = I_m \cos(\omega t + \theta_i) \rightarrow I_m \cos(\omega t) \quad \mathbf{I} = I_m \angle\theta_i \rightarrow I_m \angle 0^\circ$$

$$p(t) = v(t)i(t) = \underbrace{\frac{V_m I_m}{2}\cos(\theta_v - \theta_i)}_{P=\text{Average Power (W)}} + \underbrace{\frac{V_m I_m}{2}\cos(\theta_v - \theta_i)}_{P}\cos(2\omega t) - \underbrace{\frac{V_m I_m}{2}\sin(\theta_v - \theta_i)}_{Q=\text{Reactive Power (VAR)}}\sin(2\omega t)$$
$$= P + P\cos(2\omega t) - Q\sin(2\omega t)$$

$\theta_v - \theta_i =$ power factor angle (pfa)
$\cos(\theta_v - \theta_i) =$ power factor (pf)
$\sin(\theta_v - \theta_i) =$ reactive factor (rf)

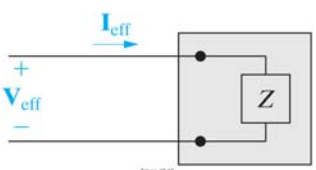
Definitions for a passive load (P > 0, absorbing power):

Q > 0: Inductive load	Absorb magnetizing VARs	Lagging pf (**I** lags **V**)
Q < 0: Capacitive load	Deliver magnetizing VARs	Leading pf (**I** leads **V**)

Effective and RMS values: $V_{rms} = V_{eff} = V_m / \sqrt{2}, \quad I_{rms} = I_{eff} = I_m / \sqrt{2}$

Complex power (VA): $S = P + jQ = \frac{V_m I_m}{2}\exp[j(\theta_v - \theta_i)] = (V_{eff}\angle\theta_v)(I_{eff}\angle -\theta_i) = \frac{1}{2}\mathbf{V}\mathbf{I}^*$

Apparent power (VA): $|S| = \sqrt{P^2 + Q^2} = \frac{V_m I_m}{2} =$ "power" using V & I magnitudes (not phases)



$2|S| =$ peak-to-peak of $p(t)$

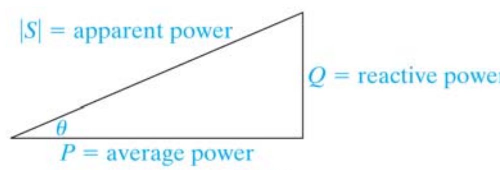


Figure: 10-09

Power for a passive load, $Z = R + jX$: $\quad \mathbf{V} = \mathbf{I}Z, \quad \mathbf{V}_{eff} = \mathbf{I}_{eff}Z$

$$S = \frac{1}{2}\mathbf{V}\mathbf{I}^* = \mathbf{V}_{eff}\mathbf{I}_{eff}^* = P + jQ$$

$$S = \underbrace{|\mathbf{I}_{eff}|^2 R}_{P} + j\underbrace{|\mathbf{I}_{eff}|^2 X}_{Q} = \frac{1}{2}I_m^2 R + j\frac{1}{2}I_m^2 X$$

$$S = \underbrace{|\mathbf{V}_{eff}|^2 \frac{R}{R^2 + X^2}}_{P} + j\underbrace{|\mathbf{V}_{eff}|^2 \frac{X}{R^2 + X^2}}_{Q} = \frac{1}{2}V_m^2 \frac{R}{R^2 + X^2} + j\frac{1}{2}V_m^2 \frac{X}{R^2 + X^2}$$