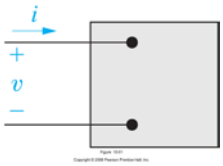
Summary of Formulas from Chapter 8 (AC Power)



$$v(t) = V_m \cos(\omega t + \phi_v) \qquad \mathbf{V} = V_m \angle \phi_v$$
$$i(t) = I_m \cos(\omega t + \phi_i) \qquad \mathbf{I} = I_m \angle \phi_i$$

$$p(t) = v(t)i(t) = \underbrace{\frac{V_m I_m}{2}\cos(\phi_v - \phi_i)}_{P_{av}=\text{Average Power (W)}} + \underbrace{\frac{V_m I_m}{2}\cos(\phi_v - \phi_i)}_{P_{av}}\cos(2(\omega t + \phi_i)) - \underbrace{\frac{V_m I_m}{2}\sin(\phi_v - \phi_i)}_{Q=\text{Reactive Power (VAR)}}\sin(2(\omega t + \phi_i))$$
$$= P_{av} + P_{av}\cos(2(\omega t + \phi_i)) - Q\sin(2(\omega t + \phi_i)) = P_{av} + \Re\{[P_{av} + jQ]\cdot\exp[j2(\omega t + \phi_i)]\}$$

$\phi_v - \phi_i$ = power factor angle (pfa)
$\cos(\phi_v - \phi_i)$ = power factor (pf)
$\sin(\phi_v - \phi_i)$ = reactive factor (rf)

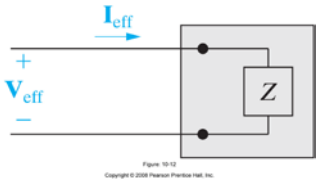
Definitions for a passive load ($P_{av} > 0$, absorbing power):

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

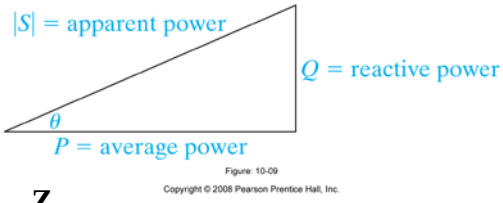
Effective and RMS values: $V_{rms} = V_{eff} = V_m/\sqrt{2}, \quad I_{rms} = I_{eff} = I_m/\sqrt{2}$

Complex power (VA): $\mathbf{S} = P_{av} + jQ = \frac{V_m I_m}{2}\exp[j(\phi_v - \phi_i)] = (V_{eff}\angle\phi_v)(I_{eff}\angle -\phi_i) = \frac{1}{2}\mathbf{V}\mathbf{I}^* = \mathbf{V}_{rms}\mathbf{I}^*_{rms}$

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



$2|\mathbf{S}| = \text{peak - to - peak of } p(t)$



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

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

$$\mathbf{S} = \underbrace{|\mathbf{I}_{eff}|^2 R}_{P_{av}=\Re[\mathbf{S}]} + j\underbrace{|\mathbf{I}_{eff}|^2 X}_{Q=\Im[\mathbf{S}]} = \frac{1}{2}I_m^2 R + j\frac{1}{2}I_m^2 X = I_{rms}^2 R + jI_{rms}^2 X$$

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

$$S = |\mathbf{S}| = I_{rms}^2|\mathbf{Z}| = \frac{V_{rms}^2}{|\mathbf{Z}|}, \quad P_{av} = I_{rms}^2 R, \quad Q = I_{rms}^2 X, \quad pf = \frac{P_{av}}{S}$$