Summary of Power Equations
ECE 300 and ECE 301

wlg

Real Power:

$$P = |\hat{V}_{rms}||\hat{I}_{rms}|\cos(\theta_v - \theta_I) = \frac{|\hat{V}_P||\hat{I}_P|}{2}\cos(\theta_v - \theta_I)$$

$$P = |\hat{S}|\cos(\theta_v - \theta_I) = \text{Re}[\hat{S}]$$

where $\hat{S}$ is the complex power

$$P = \frac{|\hat{I}_P|^2}{2}|\hat{Z}|\cos(\theta_v - \theta_I) = \frac{|\hat{V}_P|^2}{2|\hat{Z}|}\cos(\theta_v - \theta_I)$$

$\hat{V}_P$ and $\hat{I}_P$ are peak values of voltage and current, respectively

The units of power is watts (W)

Reactive Power: (also called quadrature power)

$$Q = |\hat{V}_{rms}||\hat{I}_{rms}|\sin(\theta_V - \theta_I) = |\hat{S}|\sin(\theta_V - \theta_I) = \text{Im}[\hat{S}]$$

$$Q = \frac{|\hat{I}_P|^2}{2}|\hat{Z}|\sin(\theta_V - \theta_I) = \frac{|\hat{V}_P|^2}{2|\hat{Z}|}\sin(\theta_V - \theta_I)$$

The units of Q are VARs (volts-amps-reactive)

Complex Power:

$$\hat{S} = P + jQ = (\hat{V}_{rms})(\hat{I}_{rms})^* = \frac{(\hat{V}_P)(\hat{I}_P)^*}{2} = |I_{rms}^2|\hat{Z} = \frac{|V_{rms}^2|}{\hat{Z}^*}$$

The units of Complex Power are (volts)(amps) VA

Apparent Power:

$$|\hat{S}| = |\hat{V}_{rms}||\hat{I}_{rms}| = \frac{|\hat{V}_P||\hat{I}_P|}{2}$$

The units of Apparent Power are (volts)(amps) VA

Power Factor:

$$power\ factor = p.f. = \cos(\theta_V - \theta_I) = \frac{P}{|\hat{S}|} = \frac{R}{|\hat{Z}|}$$

Leading pf if $\angle Z$ is negative (current leads the voltage)
Lagging pf if $\angle Z$ is positive (current lags the voltage)
$$\angle Z = \angle S$$