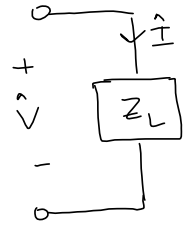
Power Factor



$\hat{V} = V_{rms} \angle\theta$

$\hat{I} = I_{rms} \angle\phi$

$Z_L = \frac{\hat{V}}{\hat{I}} = \frac{V_{rms} \angle\theta}{I_{rms} \angle\phi} = \left(\frac{V_{rms}}{I_{rms}}\right) \angle(\theta - \phi)$

$Z_L = |Z_L| \angle Z_L$

$|Z_L| = \frac{V_{rms}}{I_{rms}}$ $\quad \angle Z_L = \angle\theta - \phi$

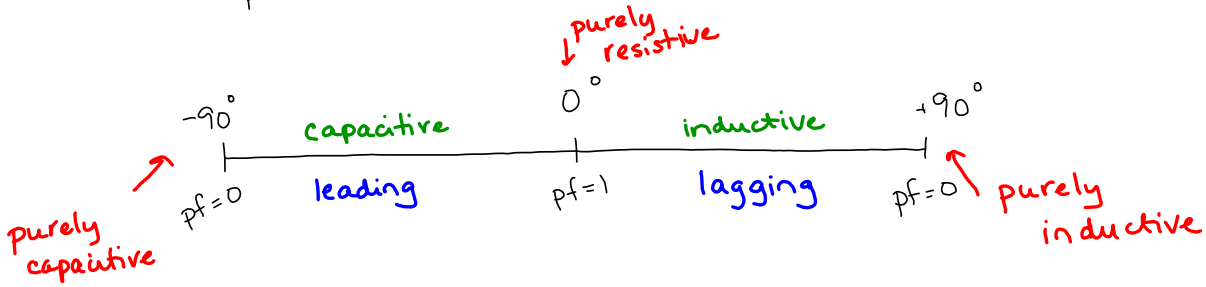
angle $\equiv \theta - \phi \rightarrow$ power angle

power factor (pf) = $\cos(\theta - \phi)$

PF

Z_L : $R_L + jX_L$ polar form

angles are between $+90^\circ$ and -90°



$pf = \cos(\theta - \phi)$

$= \cos(\angle Z_L)$

$\cos(90) = 0$

$\cos(-90) = 0$

$\cos(0) = 1$

Ex: $Z_L = 4 + j8\ \Omega$

$= 8.94 \angle 63.42^\circ\ \Omega$

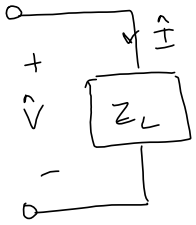
$pf = \cos(63.42) = 0.447$ lagging

0.447 lag

$Z_L = 2.5 \angle -30^\circ\ \Omega$

$pf = \cos(-30) = 0.866$ leading

$= 0.866$ lead



$$\hat{S} = \hat{V} \cdot \hat{I}^*$$

$$= (V_{rms} I_{rms}) \angle(\theta - \phi)$$

$\angle \hat{S}$

$pf = \cos(\theta - \phi)$

$pf = \cos(\angle \hat{S})$

$= \cos(\angle Z_L)$

$$P = V_{rms} I_{rms} \underbrace{\cos(\theta - \phi)}_{pf}$$