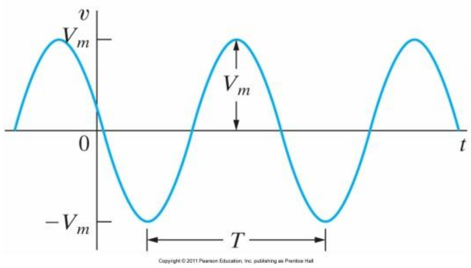
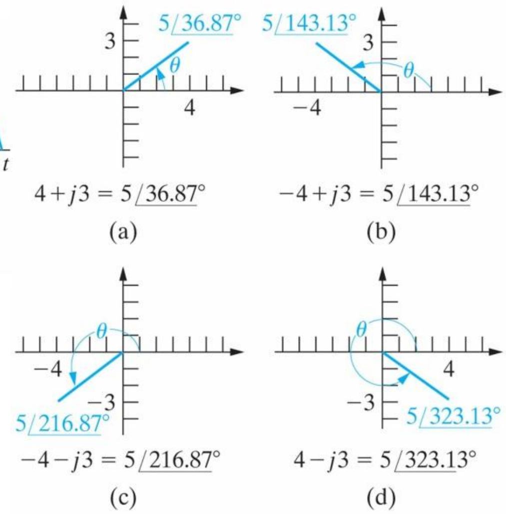
TABLE 9.1 Impedance and Reactance Values

Circuit Element	Impedance	Reactance
Resistor	R	—
Inductor	$j\omega L$	ωL
Capacitor	$j(-1/\omega C)$	$-1/\omega C$





$$\boldsymbol{V} = Z\boldsymbol{I} \qquad M = k\sqrt{L_1 L_2} \qquad L = N^2\wp$$

$$w(t) = \frac{L_1 i_1^2}{2} + \frac{L_2 i_2^2}{2} \pm i_1 i_2 M$$

$$v = V_m\cos(\omega t + \phi) \qquad f = \frac{\omega}{2\pi} \qquad V_{eff} = \frac{V_m}{\sqrt{2}}$$

Rectangular to Polar conversion

$$\boldsymbol{V} = A + jB = \sqrt{A^2 + B^2}\angle\left(\tan^{-1}\frac{B}{A}\right)°$$

Polar to Rectangular conversion

$\boldsymbol{V} = V_m\angle\phi° = V_m\cos\phi + jV_m\sin\phi$ (Note that V_m is a magnitude and should be positive, thus angle differs)

Complex Arithmetic

Addition/Subtraction – must be in rectangular coordinates; combine real terms and imaginary terms. Ex.$(A_1 + jB_1) + (A_2 + jB_2) = (A_1 + A_2) + j(B_1 + B_2)$

<u>Multiplication</u>

Rectangular coordinates; distribute (FOIL)
Polar coordinates; multiply the magnitudes and add the angles

<u>Division</u>

Polar coordinates; divide the magnitudes and subtract the angles
Rectangular coordinates; multiply the denominator and numerator by the complex conjugate of the denominator, then simplify

Complex Number Identities $\quad j^2 = -1 \quad$ and $\quad \frac{1}{j} = -j$

Average Power

$$P = \frac{V_m I_m}{2}\cos(\theta_v - \theta_i) = V_{eff}I_{eff}\cos(\theta_v - \theta_i) = \left|\overrightarrow{I_{eff}}\right|^2 R = \frac{1}{2}I_m^2 R = \frac{\left|\overrightarrow{V_{eff}}\right|^2}{R}$$

Reactive Power

$$Q = \frac{V_m I_m}{2}\sin(\theta_v - \theta_i) = V_{eff}I_{eff}\sin(\theta_v - \theta_i) = \left|\overrightarrow{I_{eff}}\right|^2 X = \frac{1}{2}I_m^2 X = \frac{\left|\overrightarrow{V_{eff}}\right|^2}{X}$$

Complex power $S = P + jQ$

$$S = \frac{1}{2}V_m I_m\angle(\theta_v - \theta_i) = V_{eff}I_{eff}\angle(\theta_v - \theta_i) = \overrightarrow{V_{eff}}\,\overrightarrow{I_{eff}}^{*} = \frac{1}{2}\vec{V}\vec{I}^{*} = \left|\overrightarrow{I_{eff}}\right|^2 Z$$

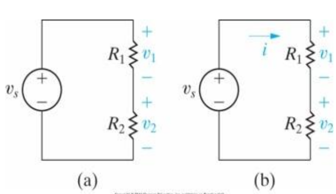
Apparent Power $|S| = \sqrt{P^2 + Q^2}$ $\qquad$ Power factor $\mathrm{pf} = \cos(\theta_v - \theta_i)$

<u>Lagging power factor:</u> implies that the current lags the voltage – hence *inductive load*
<u>Leading power factor:</u> implies that the current leads the voltage – hence *capacitive load*

Voltage Divider

$$v_1 = iR_1 = \left(\frac{R_1}{R_1 + R_2}\right)v_s$$

$$v_2 = iR_2 = \left(\frac{R_2}{R_1 + R_2}\right)v_s$$



Current Divider

$$i_1 = \left(\frac{R_2}{R_1 + R_2}\right)i_s$$

$$i_2 = \left(\frac{R_1}{R_1 + R_2}\right)i_s$$