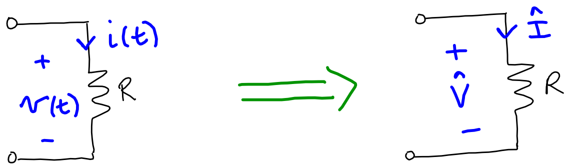
$\hat{V} = Z\hat{I}$ $\quad Z \equiv$ impedance $[\Omega]$

$\uparrow$ freq domain quantity

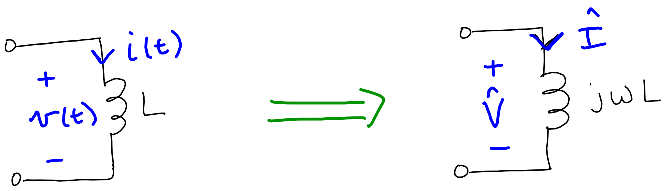


$v(t) = R \cdot i(t)$

$\hat{V} = Z_R \hat{I}$

$Z_R = R + j0 \ \Omega$
$= R \angle 0^\circ \ \Omega$

Z_R is purely real
voltage and current are "in phase"

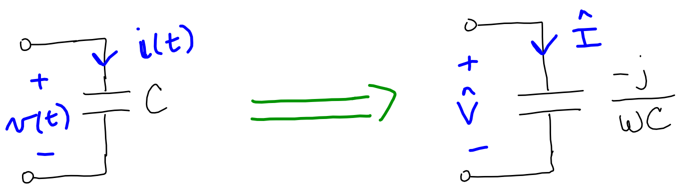


$v(t) = L \dfrac{di(t)}{dt}$

$\hat{V} = Z_L \hat{I}$

$Z_L = 0 + j\omega L \ \Omega$
$= \omega L \angle 90^\circ \ \Omega$

Z_L is purely imaginary
voltage and current are 90° out of phase



$i(t) = C \dfrac{dv(t)}{dt}$

$\hat{V} = Z_C \hat{I}$

$Z_C = 0 - \dfrac{j}{\omega C} \ \Omega$
$= \dfrac{1}{\omega C} \angle -90^\circ \ \Omega$

Z_C is purely imaginary
voltage and current are -90° out of phase

$\underbrace{\text{phasors} \quad \text{magnitudes of phasors}}_{\text{my convention}}$

phasors	magnitudes of phasors	phasors (book)	mag. of phasors (book)
$\hat{V}$	$\lvert\hat{V}\rvert$	$\mathbf{V}$	V
$\hat{I}$	$\lvert\hat{I}\rvert$	$\mathbf{I}$	I
	$\angle\hat{V}$	$\angle\mathbf{V}$	
	$\angle\hat{I}$	$\angle\mathbf{I}$	

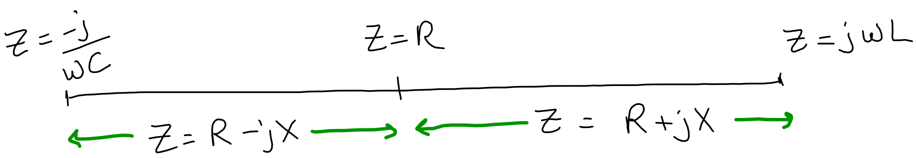
impedances $Z = R \pm jX$

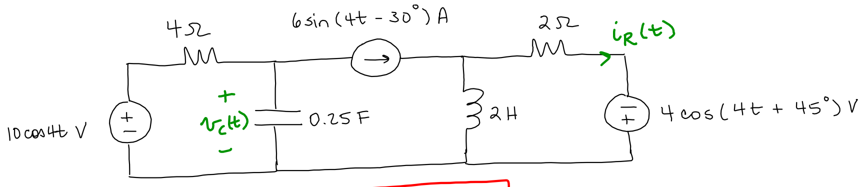
R is the real part $\equiv$ resistance $[\Omega]$

X is the imaj. part $\equiv$ reactance $[\Omega]$

if X is positive $\Rightarrow$ Z is inductive

if X is negative $\Rightarrow$ Z is capacitive





$\boxed{\omega = 4 \text{ rad/s}}$

Sources

$10\cos 4t \longrightarrow 10\angle 0^\circ$ V

$4\cos(4t+45^\circ) \longrightarrow 4\angle 45^\circ$ V

$6\sin(4t-30^\circ)$

$6\cos(4t-30^\circ-90^\circ)$

$6\cos(4t-120^\circ) \longrightarrow 6\angle -120^\circ$ A

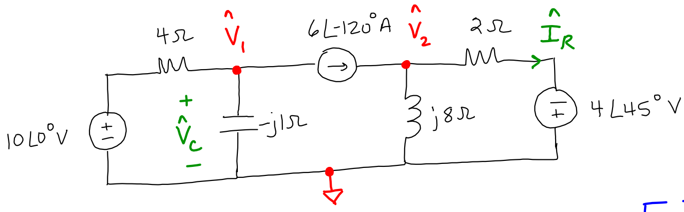
Impedances

$4\Omega \longrightarrow 4\Omega$

$2\Omega \longrightarrow 2\Omega$

$2\text{ H} \longrightarrow j\omega L = j(4)(2) = j8\Omega$

$0.25\text{ F} \longrightarrow \dfrac{-j}{\omega C} = \dfrac{-j}{(4)(.25)} = -j1\Omega$



Solve for $\hat{I}_R$ & $\hat{V}_c$ use nodal analysis

$$\hat{I}_R = \frac{\hat{V}_2 + 4\angle 45}{2}$$

$$\hat{V}_c = \hat{V}_1$$

N1: $$\frac{\hat{V}_1 - 10\angle 0^\circ}{4} + \frac{\hat{V}_1}{-j1} + 6\angle -120^\circ = 0$$

N2: $$\frac{\hat{V}_2 + 4\angle 45}{2} + \frac{\hat{V}_2}{j8} + (-6\angle -120^\circ) = 0$$

N1: $$\hat{V}_1\left(\frac{1}{4} + \frac{1}{-j1}\right) = \frac{10\angle 0}{4} - 6\angle -120^\circ$$

N2: $$\hat{V}_2\left(\frac{1}{2} + \frac{1}{j8}\right) = 6\angle -120 - \frac{4\angle 45}{2}$$

$$\hat{V}_1(0.25 + j1) = 2.5\angle 0 - 6\angle -120$$
$$2.5 + j0 - (-3 - j5.2)$$

$$\boxed{\hat{V}_1(0.25 + j1) = 5.5 + j5.2}$$

$$\hat{V}_1(1.03\angle 75.96^\circ) = 7.57\angle 43.39^\circ$$

$$\hat{V}_1 = \frac{7.57\angle 43.39}{1.03\angle 75.96} = 7.34\angle -32.57^\circ \text{ V}$$

$$\hat{V}_2 = 15.42\angle -109.70^\circ \text{ V}$$

$$\hat{V}_c = 7.34\angle -32.57^\circ \text{ V}$$

$$\hat{I}_R = 5.96\angle -101.46^\circ \text{ A}$$

$$= \frac{15.42\angle -109.70 + 4\angle 45}{2}$$

$$\boxed{\begin{aligned} v_c(t) &= 7.34\cos(4t - 32.57^\circ)\text{ V} \\ i_R(t) &= 5.96\cos(4t - 101.46^\circ)\text{ A} \end{aligned}}$$