

Lesson 21:

AC Circuit Analysis 2

Impedances of passive elements

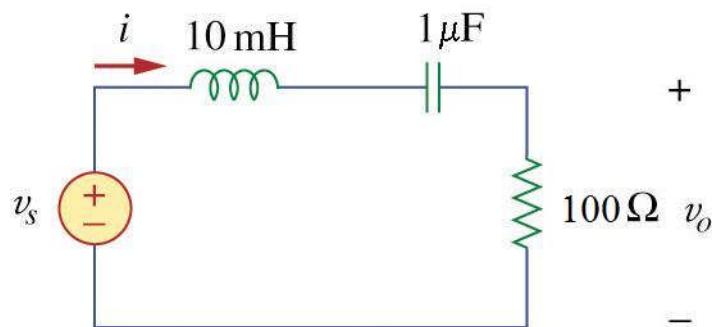
TABLE 9.3

Impedances and admittances
of passive elements.

Element	Impedance	Admittance
R	$\mathbf{Z} = R$	$\mathbf{Y} = \frac{1}{R}$
L	$\mathbf{Z} = j\omega L$	$\mathbf{Y} = \frac{1}{j\omega L}$
C	$\mathbf{Z} = \frac{1}{j\omega C}$	$\mathbf{Y} = j\omega C$

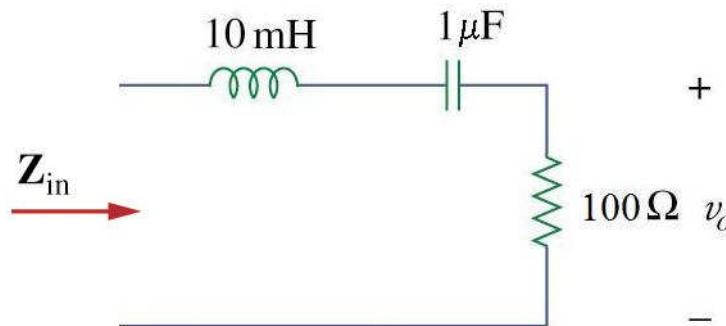
Impedance review

- Consider the effect of frequency on impedance.
- Plot the impedances in complex plane.
- Tie together phasor diagrams with waveforms in the time-domain.



Impedance

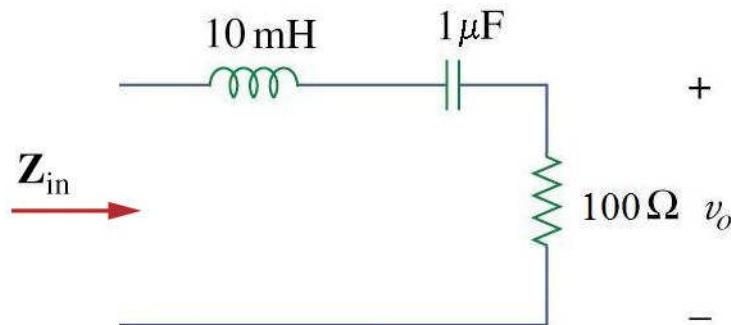
- Calculate the impedance of the circuit as seen by the source for the three frequencies below.
 - **Case 1:** $\omega = 5,000 \text{ rad/s}$
 - **Case 2:** $\omega = 10,000 \text{ rad/s}$
 - **Case 3:** $\omega = 20,000 \text{ rad/s}$



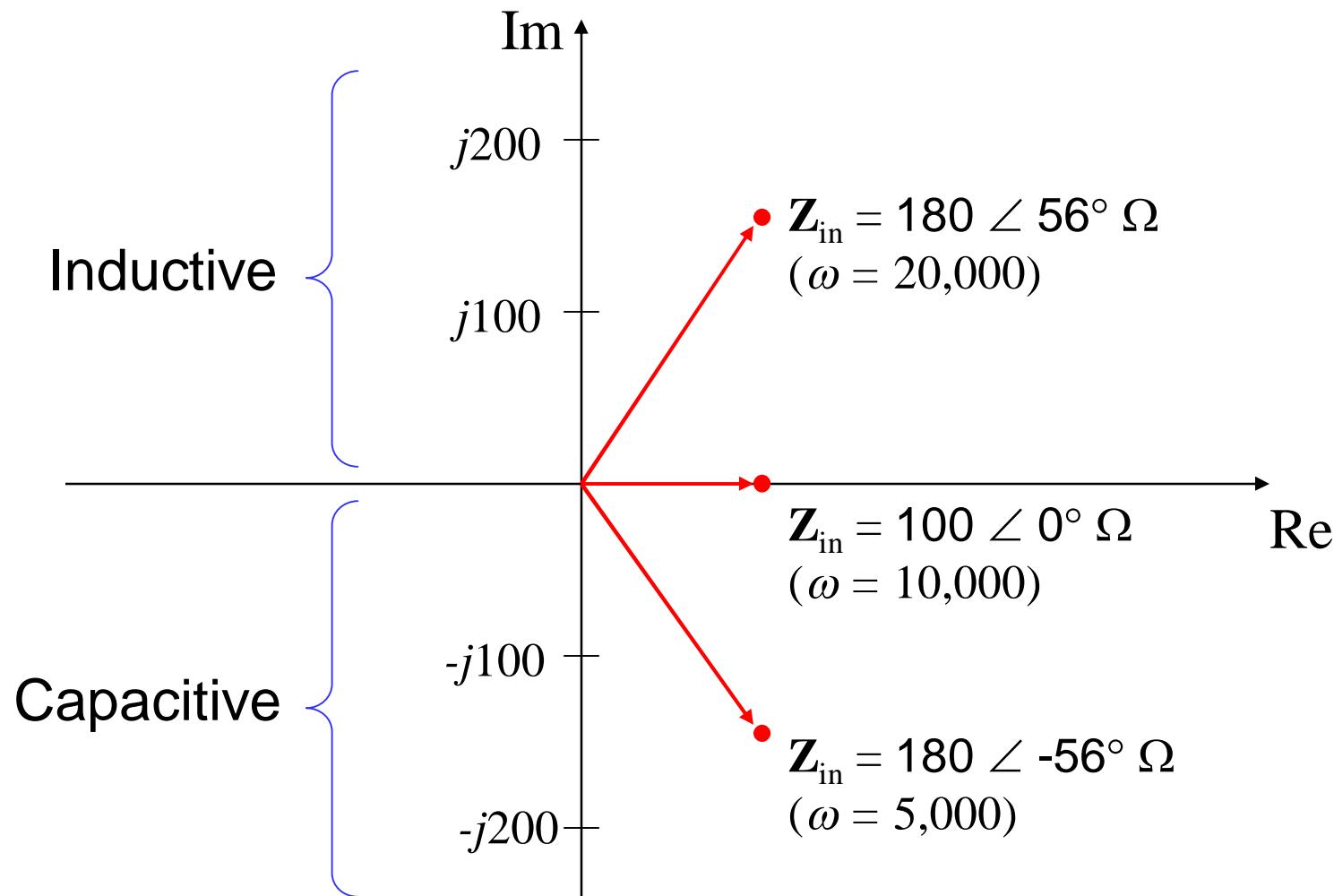
Impedance

- Calculate the impedance of the circuit as seen by the source for the three frequencies below.

Frequency (ω)	Impedance (Z_{in})	
5,000	$100 - j150 \Omega$	$180 \angle -56^\circ \Omega$
10,000	$100 + j0 \Omega$	$100 \angle 0^\circ \Omega$
20,000	$100 - j150 \Omega$	$180 \angle 56^\circ \Omega$



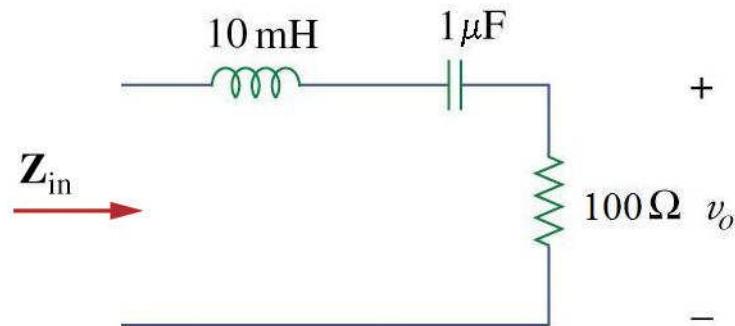
Phasor diagram



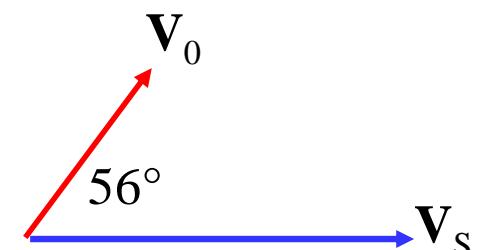
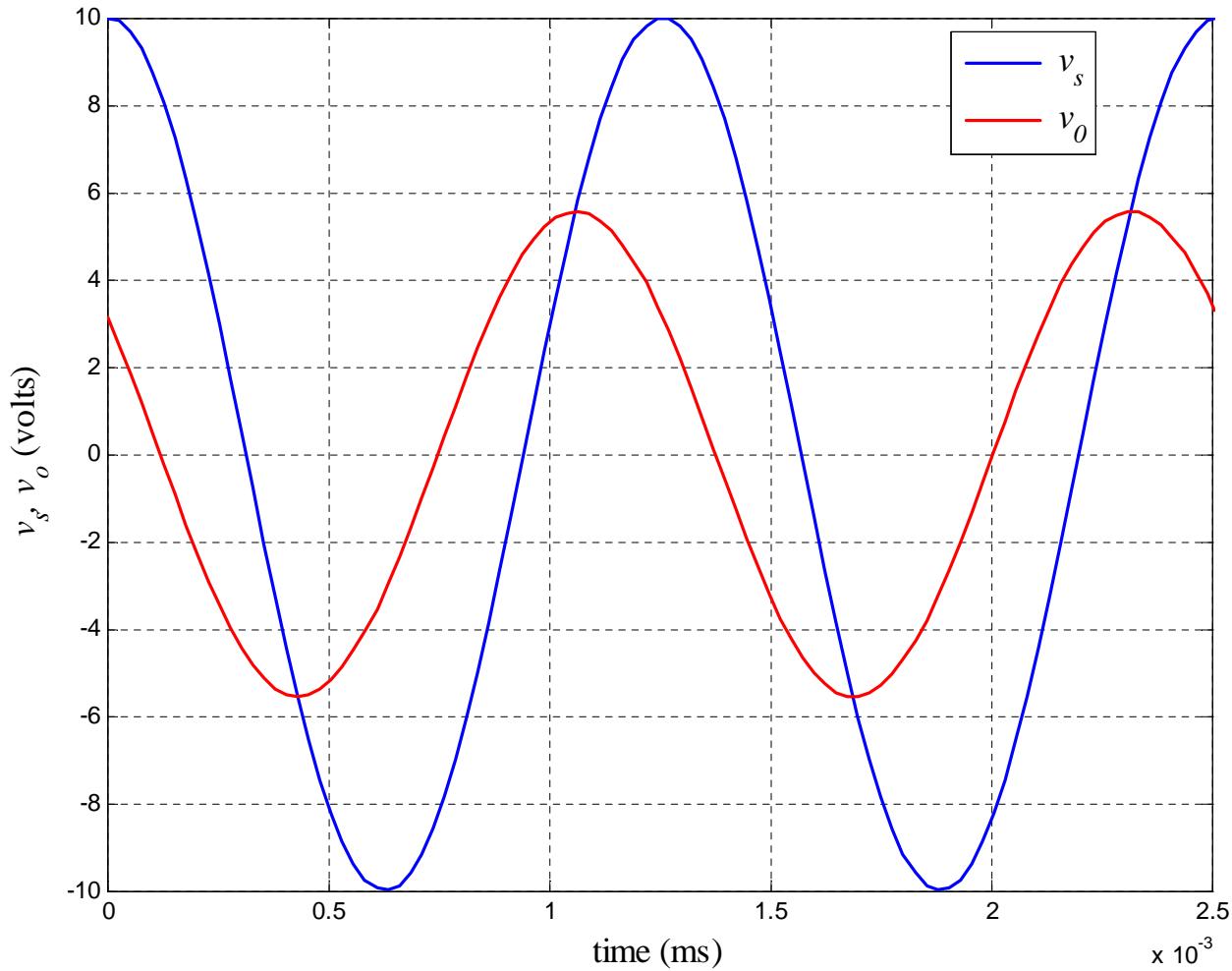
Output voltage

$$\mathbf{V}_0 = \frac{R}{\mathbf{Z}_L + \mathbf{Z}_C + R} \mathbf{V}_S = \frac{R}{\mathbf{Z}_{in}} \mathbf{V}_S$$

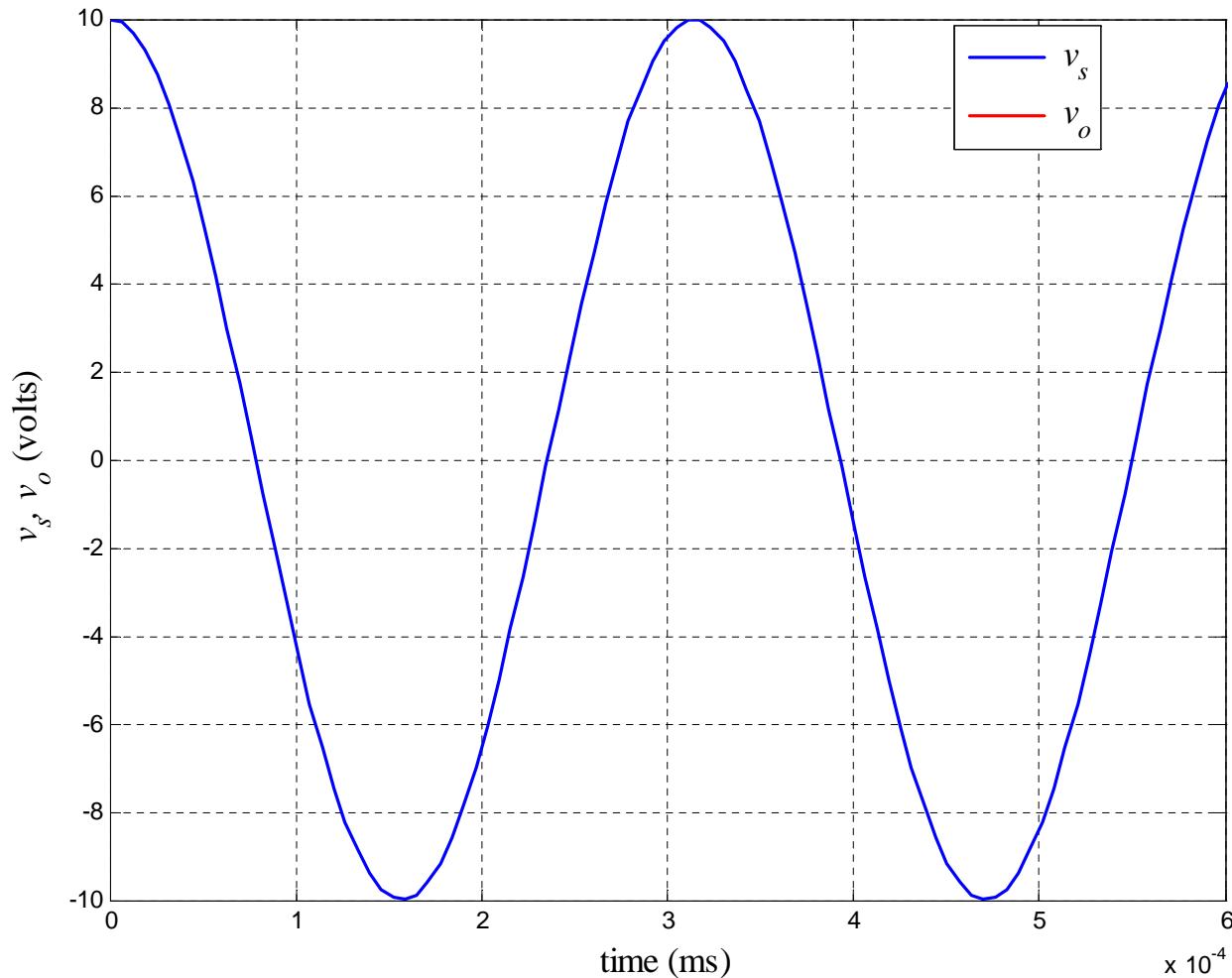
Frequency (ω)	\mathbf{Z}_{in}	\mathbf{V}_0
5,000	$180 \angle -56^\circ \Omega$	$5.6 \angle 56^\circ V$
10,000	$100 \angle 0^\circ \Omega$	$10 \angle 0^\circ V$
20,000	$180 \angle 56^\circ \Omega$	$5.6 \angle -56^\circ V$



Output voltage ($\omega = 5,000$)

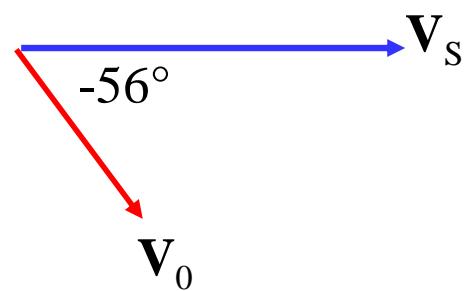
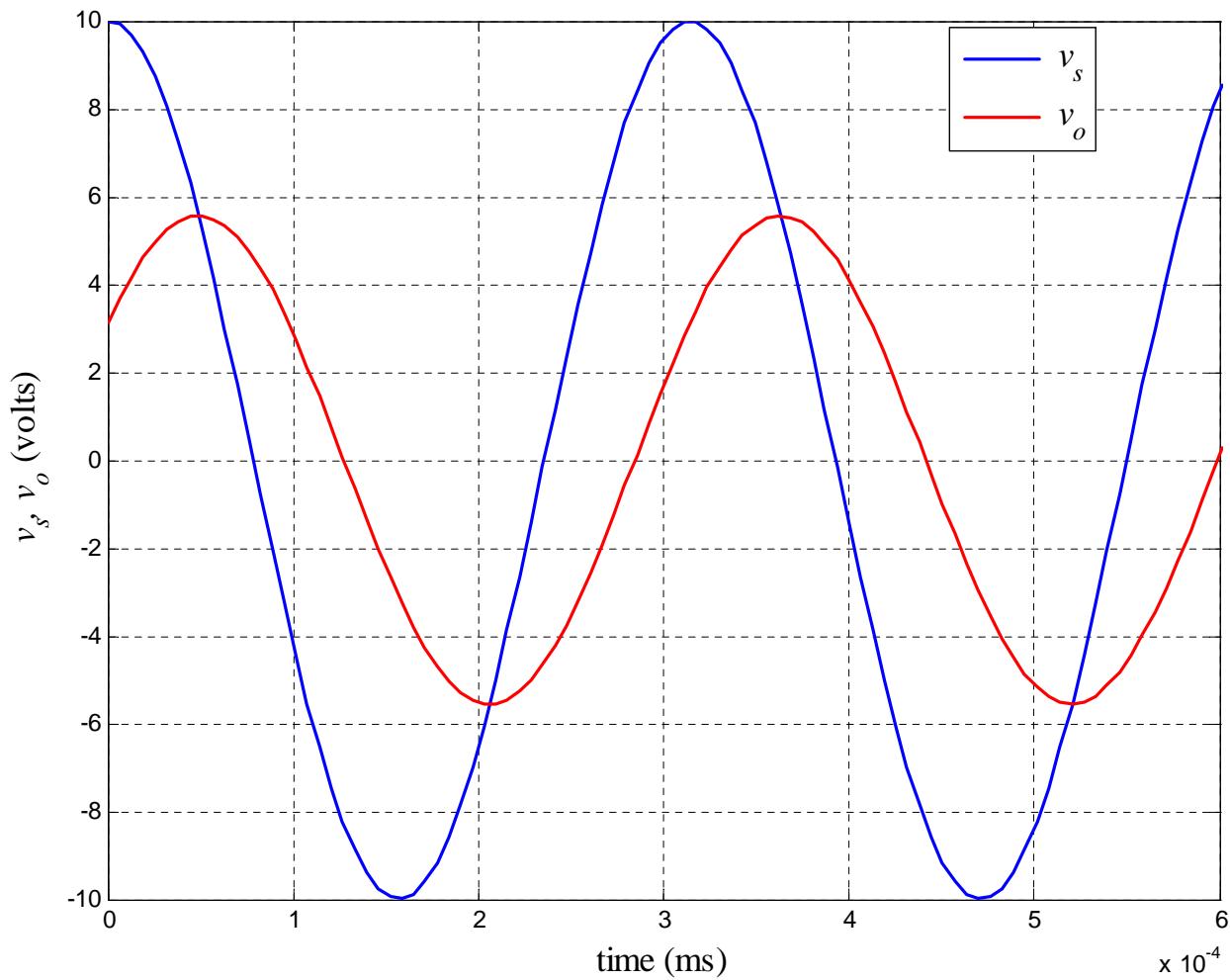


Output voltage ($\omega = 10,000$)



V_s, V_0

Output voltage ($\omega = 20,000$)



Output voltage

