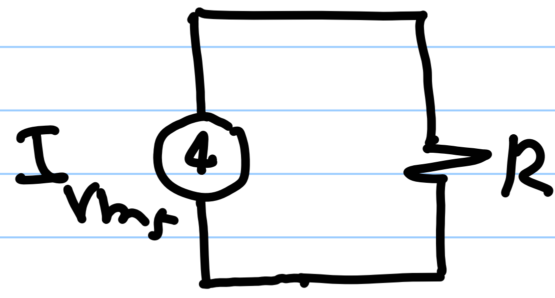
Lecture 27

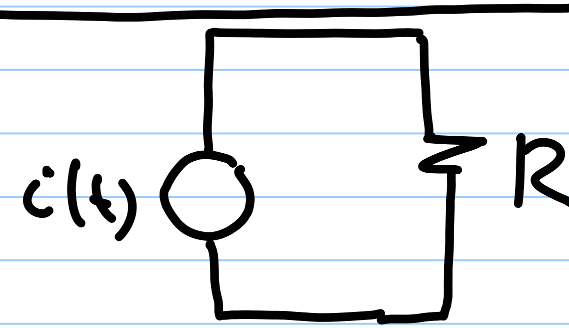
From Sections 9.4 - 9.6

Solve E9.7 - E9.12, 9.44, 9.47, 9.50, 9.53, 9.56, 9.61, 9.66, 9.69

Root Mean Square (RMS) value



DC



$$P_{av} = I_{rms}^2 R \qquad\qquad P_{av} = \frac{1}{T}\int_{t_0}^{t_0+T} i^2(t)\, R\, dt$$

To have the same power, we must have

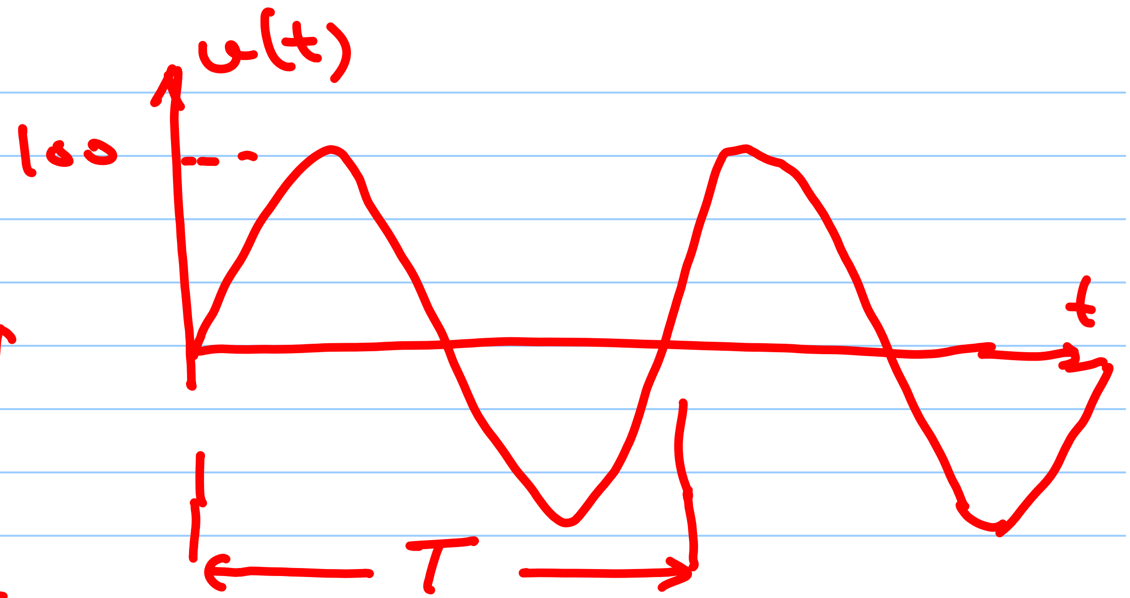
$$I_{rms}^2 R = \frac{1}{T}\int_{t_0}^{t_0+T} i^2(t)\, R\, dt$$

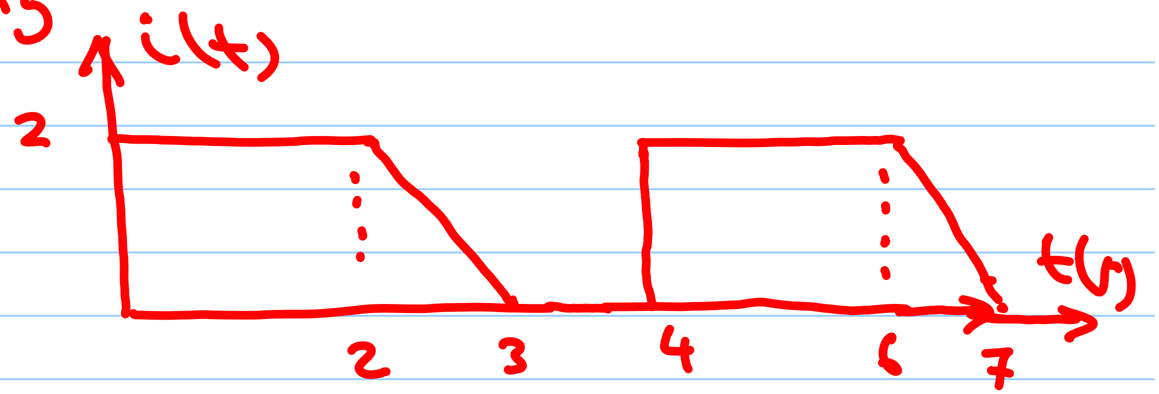
or

$$I_{rms} = \sqrt{\frac{1}{T}\int_{t_0}^{t_0+T} i^2(t)\, R\, dt}$$

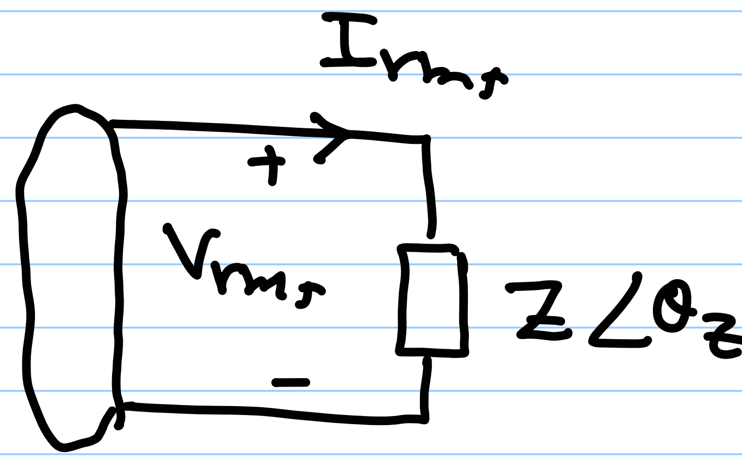
Example

find the RMS values for the following waveforms





Complex Power



* $v(t) = A_v \cos(\omega t + \theta_v)$

$\bar{V} = A_v \angle \theta_v$

$\bar{V}_{rms} = \frac{A_v}{\sqrt{2}} \angle \theta_v$

$\bar{V}_{rms} = V_{rms} \angle \theta_v$

* $i(t) = A_i \cos(\omega t + \theta_i)$

$\bar{I} = A_i \angle \theta_i$

$\bar{I}_{rms} = \frac{A_i}{\sqrt{2}} \angle \theta_i = I_{rms} \angle \theta_i$

Complex Power

* Complex Power is defined as

$$S = \bar{V}_{rms} \bar{I}^*_{rms} = V_{rms} \angle \theta_v \, I_{rms} \angle -\theta_i$$

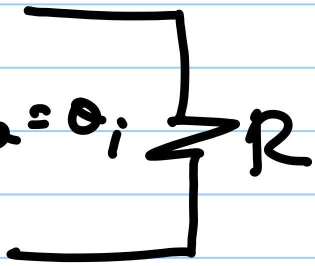
$$S = V_{rms} I_{rms} \angle \theta_v - \theta_i = V_{rms} I_{rms} e^{j(\theta_v - \theta_i)}$$

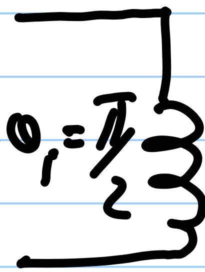
$$S = V_{rms} I_{rms} \cos(\theta_v - \theta_i) + j V_{rms} I_{rms} \sin(\theta_v - \theta_i)$$

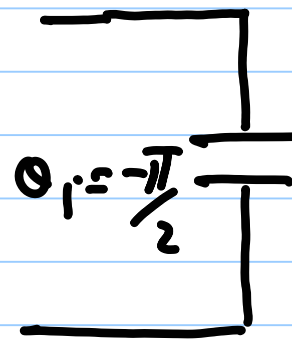
$$S = P + jQ$$

real power   reactive power

Complex Power (cont'd)

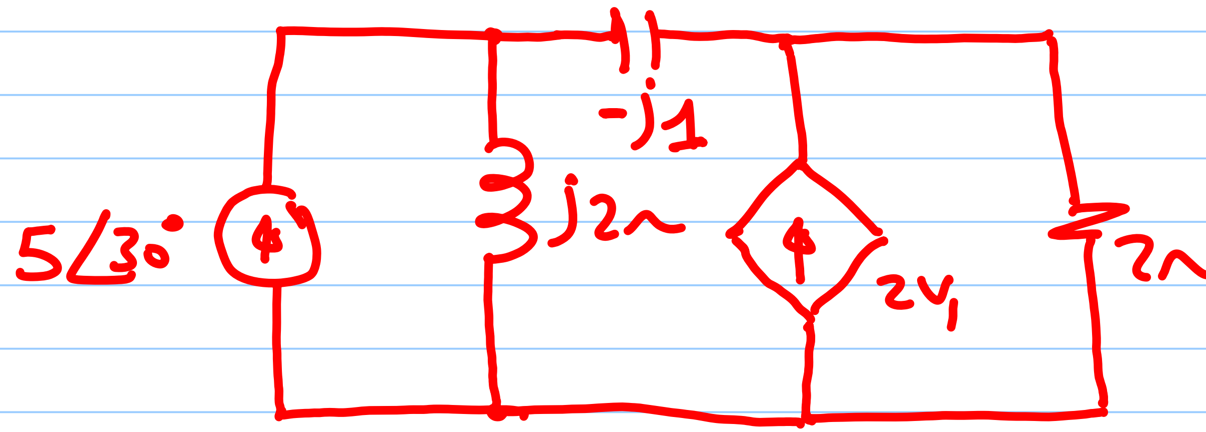






$\theta_v = \theta_i$	$\theta_v - \theta_i = \pi/2$	$\theta_v - \theta_i = -\pi/2$
$P = V_{rms} I_{rms}$	$P = 0$	$P = 0$
$Q = 0$	$Q = V_{rms} I_{rms}$	$Q = -V_{rms} I_{rms}$
$P = I_{rms}^2 R$	$Q = I_{rms}^2 \omega L$	$Q = -V_{rms}^2 \omega C$
$S = P$	$S = JQ$	$S = JQ$

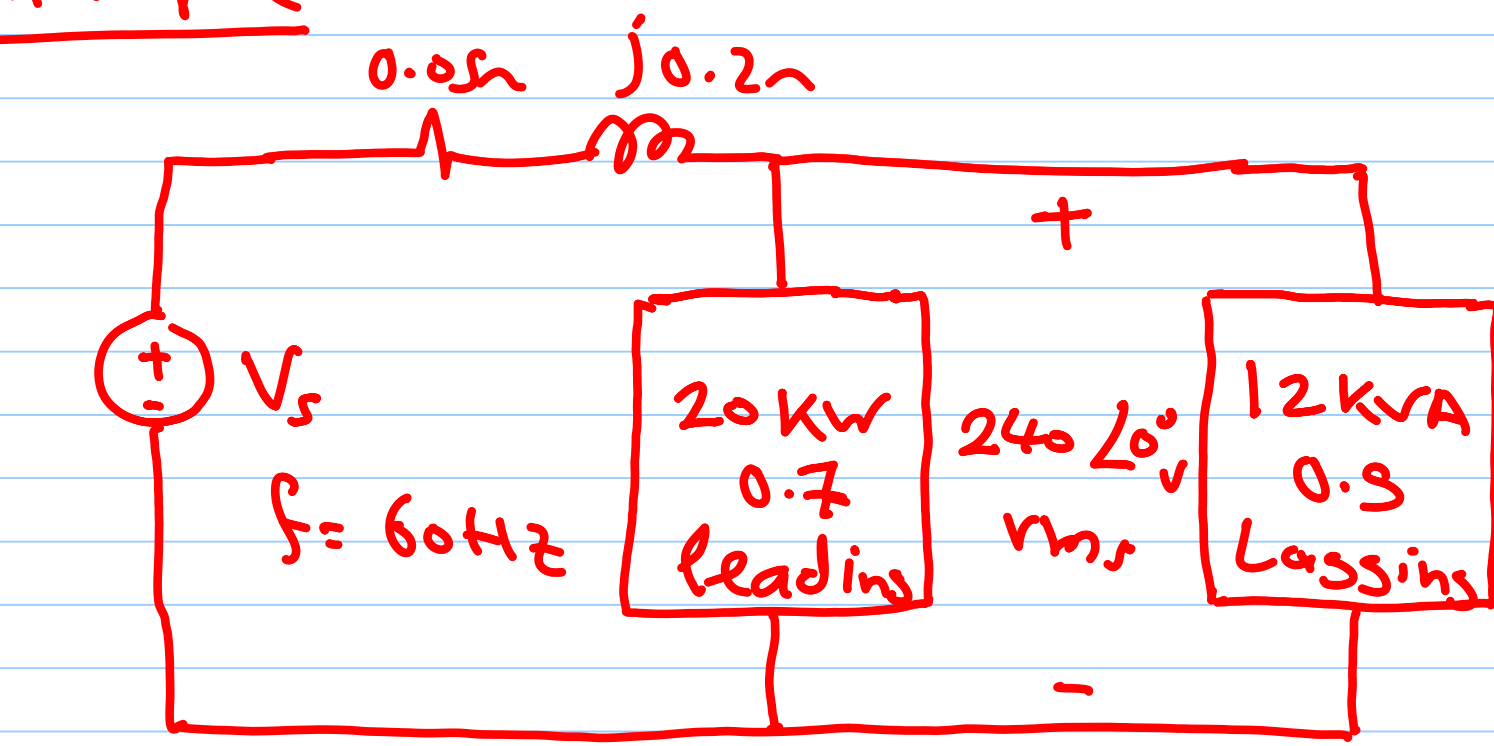
Example



* Find the complex power supplied by the two current sources

* Verify conservation of complex power

Example



Find the complex power supplied by the source, the power factor of the source, and $v_s(t)$