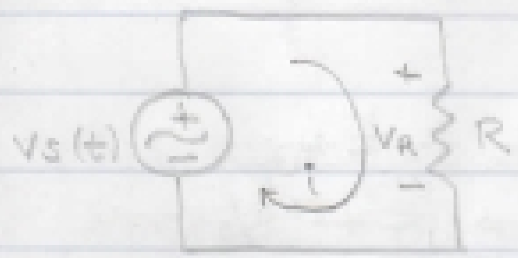
* Resistor in an AC Circuit



$v_s(t) = V_{max}\cos(\omega t)$

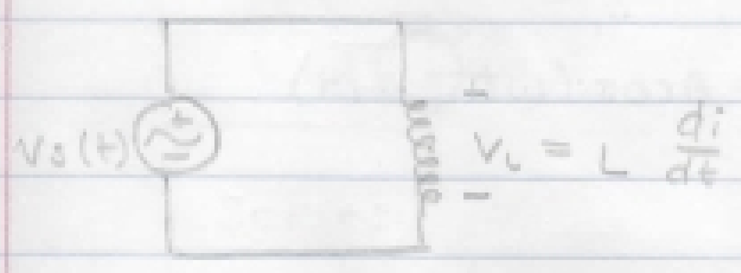
Using KVL:

$$\sum v = -v_s + iR = 0$$

$$i = \frac{v_s}{R} = \frac{V_{max}}{R}\cos(\omega t)$$

* V and I have same frequencies and phase angles, but different magnitudes

* Inductor in an AC Circuit



$v_s(t) = V_{max}\cos(\omega t)$

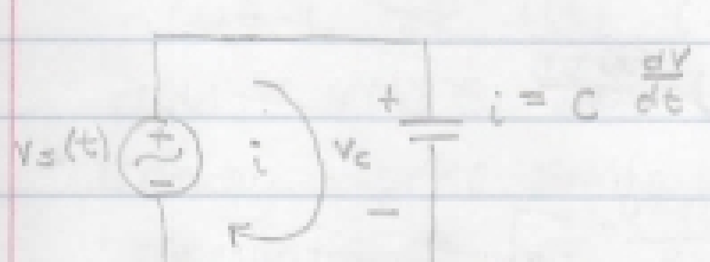
KVL: $-v_s + L\frac{di}{dt} = 0$

$$i = \frac{V_{max}}{\omega L}\cos(\omega t - \pi/2)$$

HW - Chapter #4 March 23, 2015

37, 38, 39, 43, 47, 54, 55, 69, 74, 82, 71, 73, 81

* Capacitor in an AC Circuit

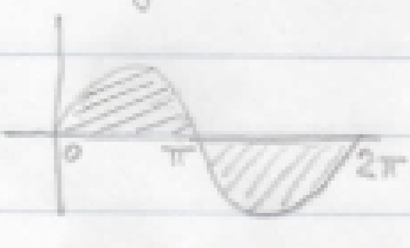


$v_s(t) = V_{max}\cos(\omega t)$

$$i = CV_{max}\,\omega\cos\left(\omega t + \frac{\pi}{2}\right)$$

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$

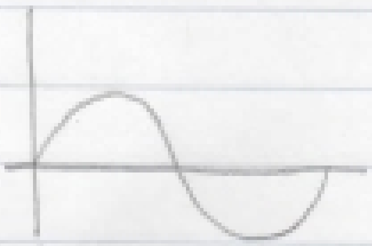
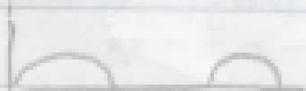
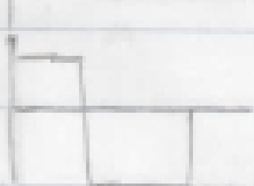
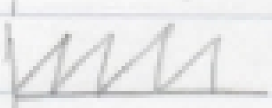
*Average Value



$i(t) = I_m \sin \omega t$

$\omega t = \theta$

$$I_{AV} = \frac{1}{T}\int_0^T i\,dt = \frac{1}{\pi}\int_0^{\pi} i\,dt = \frac{1}{\pi}\int_0^{\pi} i_m \sin\theta\,d\theta$$
$$= \frac{I_m}{\pi}\left[-\cos\theta\right]_0^{\pi}$$
$$= \frac{I_m}{\pi}\left[1+1\right]$$
$$= \frac{2}{\pi} I_m$$

		I_{AV}	I_{rms} (eff)
1		$\frac{2}{\pi} I_m$	$\frac{I_m}{\sqrt{2}}$
2		$\frac{2}{\pi} I_m$ $\downarrow \times 1/2$	$\frac{I_m}{\sqrt{2}}$ $\downarrow \times 1/2$
3		$\frac{1}{\pi} I_m$	$\frac{I_m}{2\sqrt{2}}$
4		I_m $\downarrow \times 1/2$	I_m $\downarrow \times 1/\sqrt{2}$
5		$\frac{I_m}{2}$	$\frac{I_m}{\sqrt{2}}$
6		$\frac{I_m}{2}$	$\frac{I_m}{\sqrt{3}}$
7		$\frac{I_m}{2}$	$\frac{I_m}{\sqrt{3}}$
8		$\frac{2}{3} I_m$	$\frac{\sqrt{5}}{3} I_m$

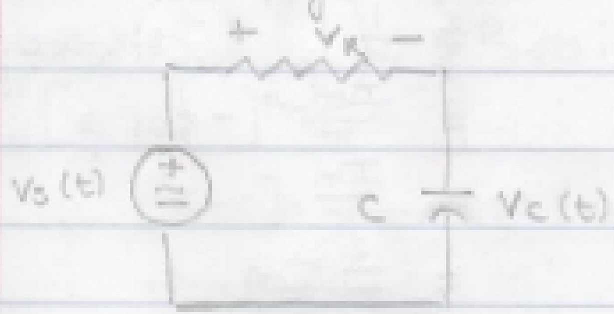
- The Form Factor, $K_f = \frac{I_{rms}}{I_{AV}} = \frac{\frac{I_m}{\sqrt{2}}}{\frac{2}{\pi} I_m} \approx 1.109$

- The Crest Factor, $C = \frac{I_m}{I_{rms}} = \frac{I_m}{\frac{I_m}{\sqrt{2}}} \approx \sqrt{2} = 1.414$

* Phasors and Complex Numbers

Solving AC circuits:

· Node Voltage Method



* Complex Numbers

$\sqrt{-1} = i = \underset{\sim}{j}$ → used instead of i

$x = \underset{\sim}{A} \pm j\underset{\sim}{B}$ → Rectangular Form

↳ Real → Imaginary

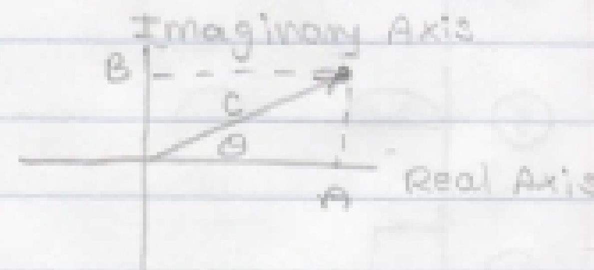
$C = \sqrt{A^2 + B^2}$

$\theta = \tan^{-1}(B/A)$

$x = Ce^{j\theta} = C\angle\theta$ → Polar Form

$-180° < \theta < 180°$ or $-\pi < \theta < \pi$

$x = C\cos\theta + jC\sin\theta$ → Back to rectangular form



$\boxed{\text{Ex.}}$ $i = 10 + j20$

$i = \sqrt{10^2 + 20^2} \angle \tan^{-1}(20/10)$

$= 22.36 \angle 63.4°$

$\boxed{\text{Ex.}}$ $i = 10\angle 5°$

$i = 10\cos(5°) + j10\sin(5°)$

$= 9.96 + j0.87$

* can add, subtract, multiply, and divide complex numbers

* Complex Conjugate

 - Reflect about the real axis
 - change sign of angle/ imaginary form