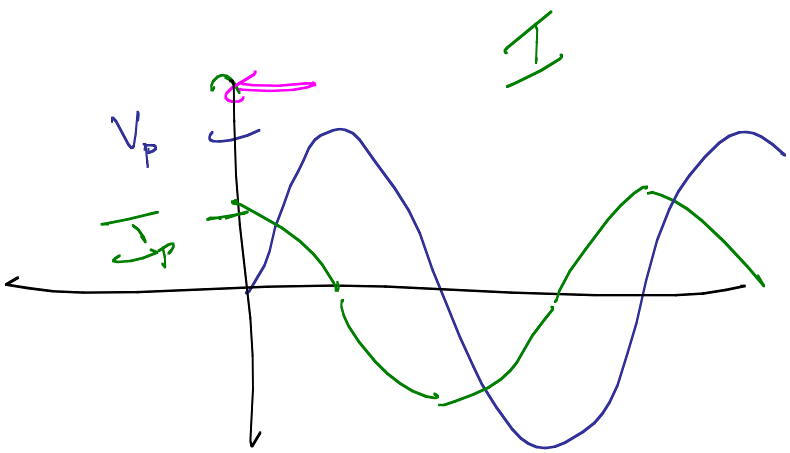
Phys 2120-4 10/26/12

Note Title 10/26/2012

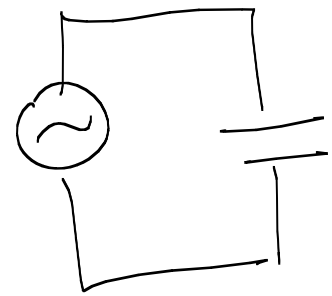
AC Circuit

$V_{rms} = \frac{V_p}{\sqrt{2}}$



Current leads voltage

$V(t) = V_p \sin\omega t$



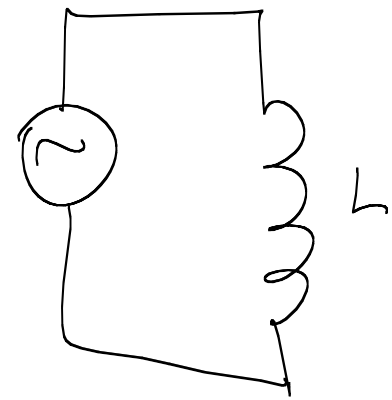
Frequency

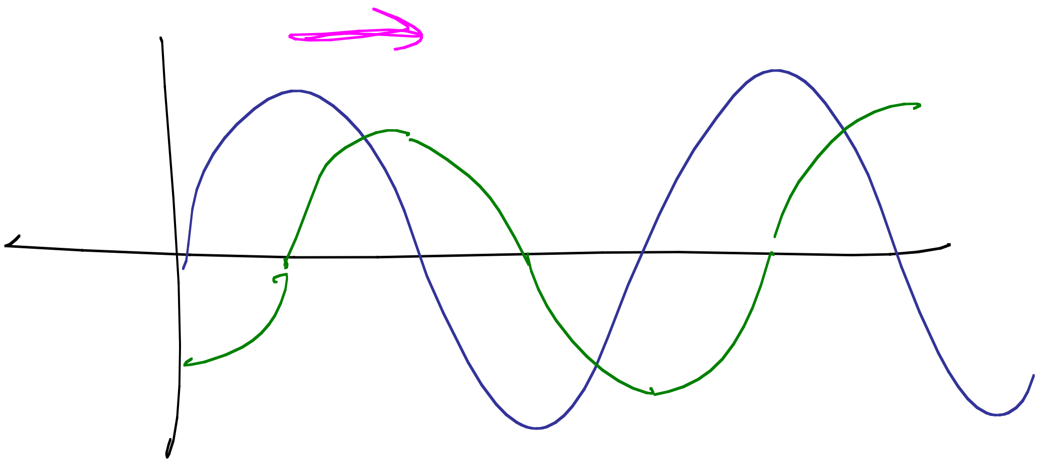
$I(t)$

$I_p = \frac{V_p}{X_c}$ $X_c = \frac{1}{\omega C}$

ohms

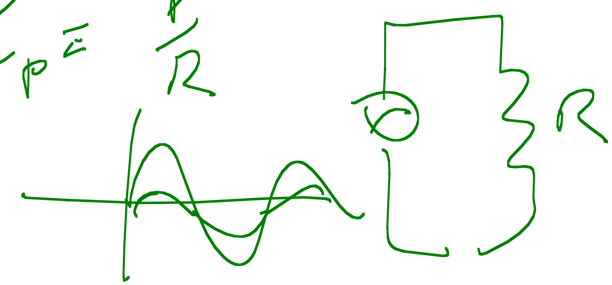
$$I_p = \frac{V_p}{X_L} \qquad X_L = \omega L$$





Current lags the voltage

$$I_p = \frac{V_p}{R}$$



28.13 Find the rms current in a 1.0 μF capacitor conn'd across 120-V rms 60 Hz AC power

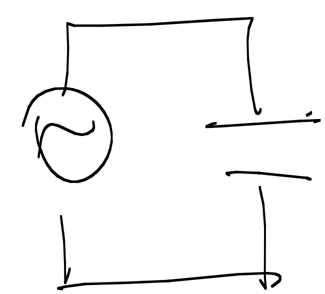
$V_p = \sqrt{2}\,(120\,V)$

$= \sim$

$\omega = 2\pi f = 377\ s^{-1}$

$X_c = \frac{1}{\omega C} = 2.65 \times 10^3$ Ohms

$I_{rms} = \frac{V_{rms}}{X_c} = \frac{120\ V}{2.65 \times 10^3\ \Omega} = 45\ mA$



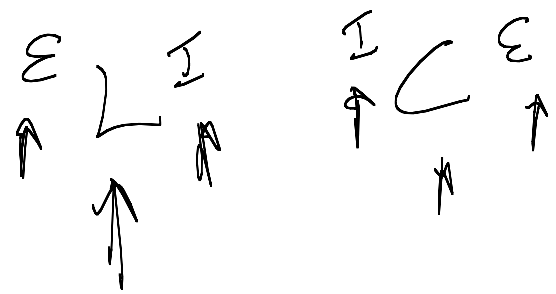
28.19 470 Ω Res, 10 μF capacitor, 750 mH inductor are each connected across 6.3 V rms 60 Hz AC power. Find the rms current

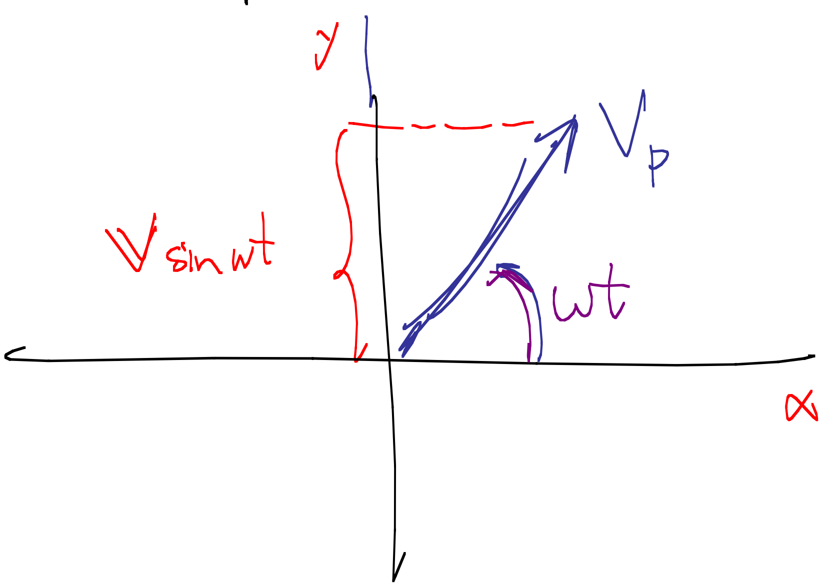
$\omega = 2\pi f$

a) R: $I_{rms} = \frac{V_{rms}}{R} = 13.\ mA$

C: $I_{rms} = \frac{V_{rms}}{1/\omega C} = \omega C V_{rms} = 24\ mA$

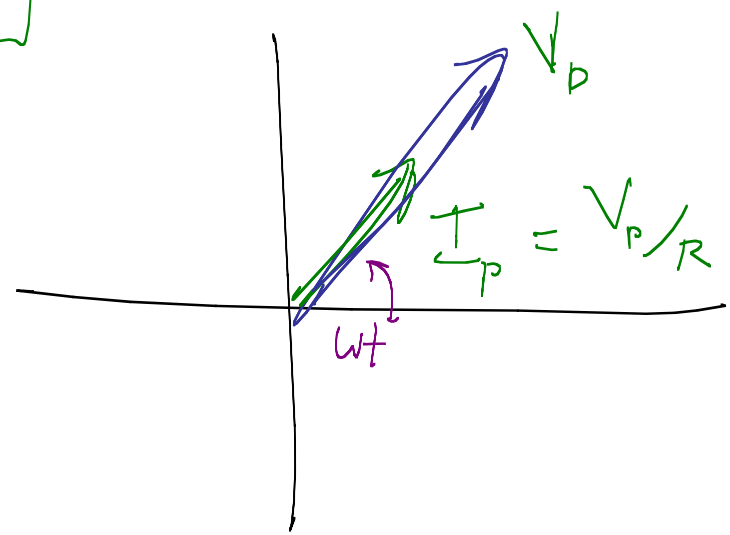
L = $I_{rms} = \frac{V_{rms}}{\omega L} = 22\ mA$



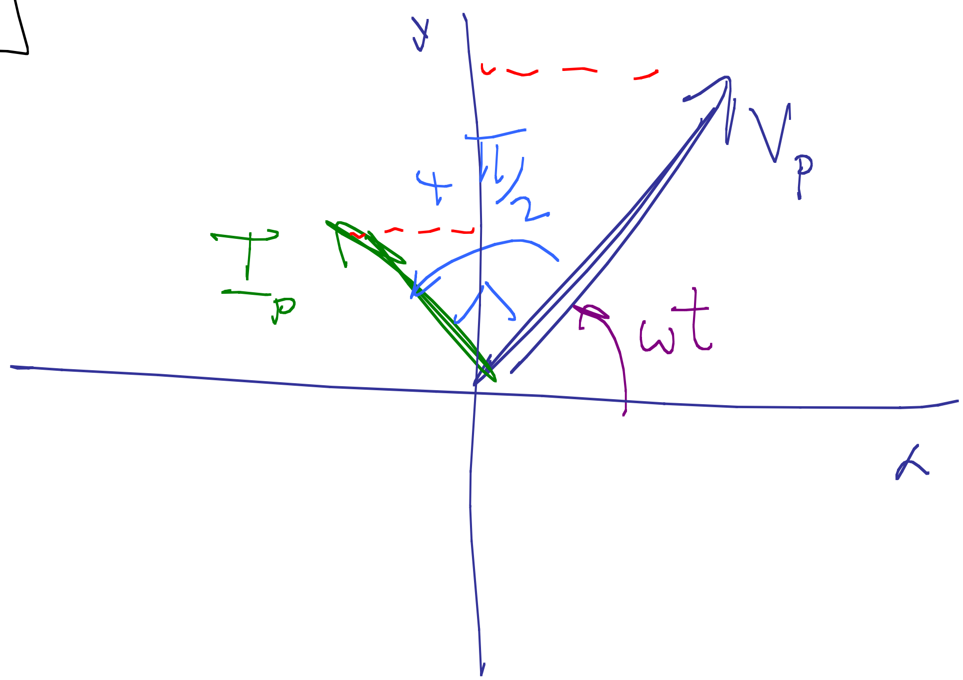


$$V = V_p \sin \omega t$$

R



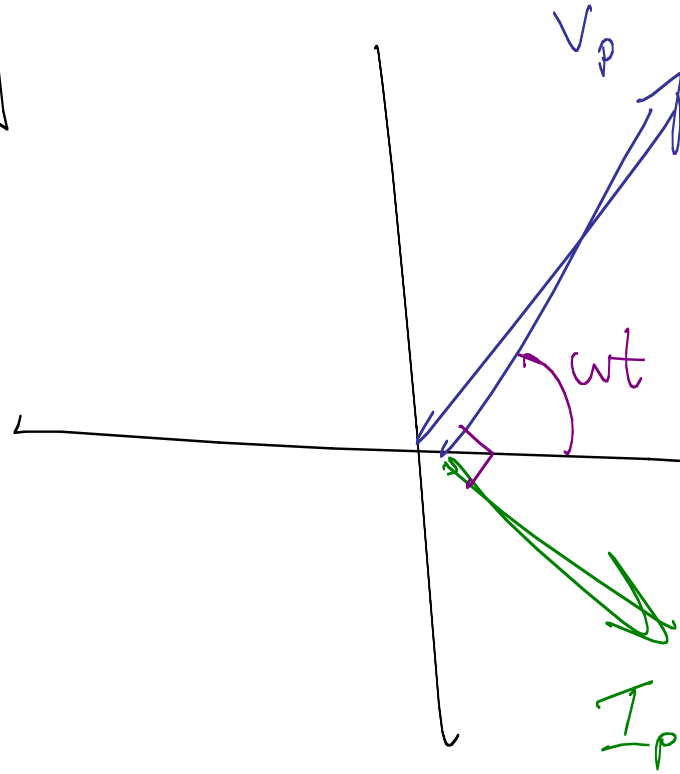
c)



$$I = \underbrace{\omega C V_p}_{I_p} \sin\left(\omega t + \frac{\pi}{2}\right)$$

$$I_p = \frac{V_p}{1/\omega C}$$

L



$$I = \underbrace{\frac{V_p}{\omega L}}_{I_p} \sin\left(\omega t - \frac{\pi}{2}\right)$$

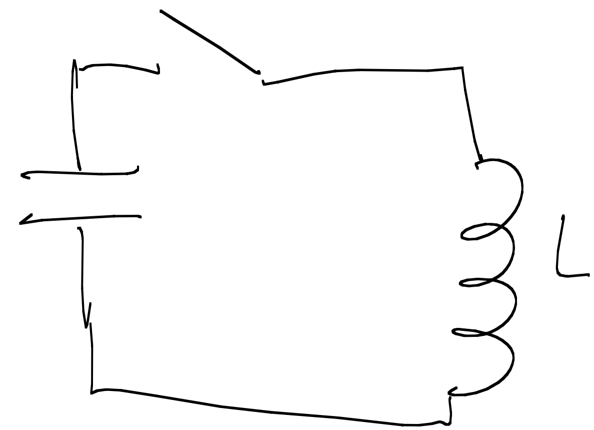
$$X_L = \omega L$$

C	L
$C = q/V$	$L = \Phi_B / I$
$I = C\, dV/dt$	$\mathcal{E} = -L\, dI/dt$

	C	L
$\omega \to 0$	Open	Short
$\omega \to \infty$	Short	Open

LC

charge up capacitor
to C



Close switch.

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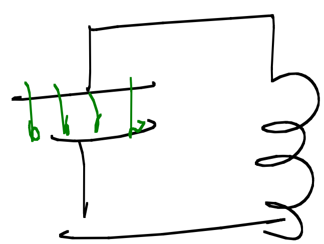
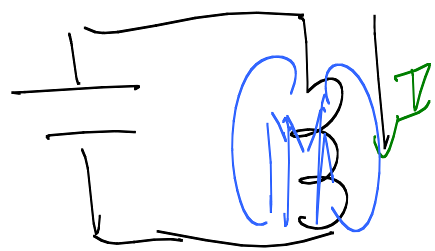


E in E field



E in B field

$\frac{1}{2}CV^2$

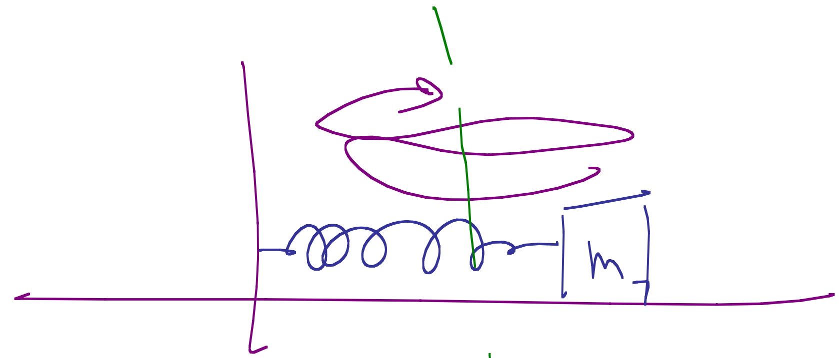
$\frac{1}{2}LI^2$

Energy goes between electric, magnetic

Capacitor corresps to spring

Inductor corresps to KE

Inertia.



$\frac{1}{2}mv^2 \quad \Big| \quad \frac{1}{2}kx^2$

Use Cons of E show something: LC circuit

$$U = U_B + U_E = \frac{1}{2}LI^2 + \frac{1}{2}CV^2 = \text{constant}$$

$V = q/C$

$I = dq/dt$

Take dU/dt

$$\frac{dU}{dt} = LI\frac{dI}{dt} + CV\frac{dV}{dt} = 0$$

$V = q/C$

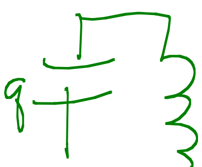
$$\frac{dV}{dt} = \frac{1}{C}\frac{dq}{dt} = \frac{1}{C} I$$

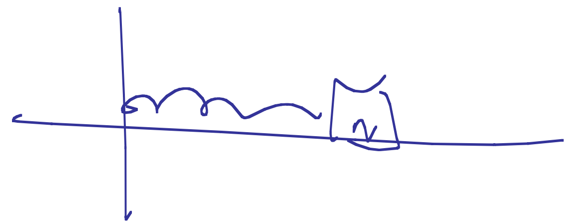
Can show $$L\frac{d^2q}{dt^2} + \frac{1}{C}q = 0$$

$$\frac{d^2q}{dt^2} = -\frac{1}{LC}q$$

$$\omega = \frac{1}{\sqrt{LC}} \qquad \omega^2$$

Ang. freq of osc's.

q 



$\omega = \sqrt{k/m}$

$$\frac{d^2x}{dt^2} = -\omega^2 x$$

$q(t) = q_p \cos \omega t$ $\qquad$ $\omega = \frac{1}{\sqrt{LC}}$ Resonant frequency

28.24 Find the resonant freq. of an LC circuit consisting of a 0.22 μF cap & a 1.7 mH inductor

$$\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{(1.7\times10^{-3})(0.22\times10^{-6})}} = 5.2\times10^{4}\ s^{-1}$$

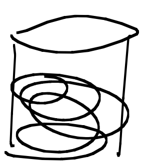
$f = \omega/2\pi$

$= 8.2$ kHz

28.25 An LC circuit with $C = 18\,mF$ undergoes osc's w/ period 2.4 s. Find inductance

$f = \frac{1}{2.4s} = 0.42\,Hz \qquad w = 2\pi f = 2.62\,s^{-1}$

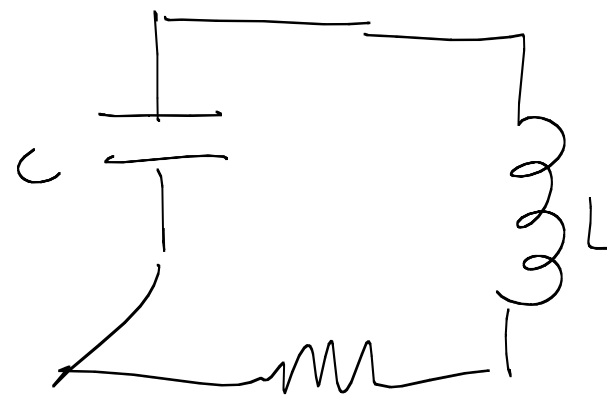
$w = \frac{1}{\sqrt{LC}} \qquad L = \frac{1}{w^2 C} = \underline{\underline{8.1\,H}}$



$f = \begin{cases} 550\,kHz \\ 1600\,kHz \end{cases}$

Rate Energy loss $-I^2R$

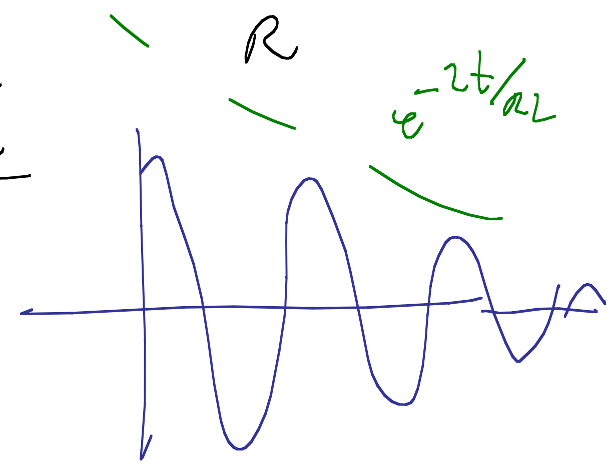
$$-I^2R = \frac{d}{dt}\left(\frac{1}{2}LI^2 + \frac{1}{2}CV^2\right)$$



Can show

$$L\frac{d^2q}{dt^2} + R\frac{dq}{dt} + \frac{q}{C} = 0 \qquad \omega = \frac{1}{\sqrt{LC}}$$

$$q(t) = q_0 e^{-Rt/2L} \cos\omega t$$

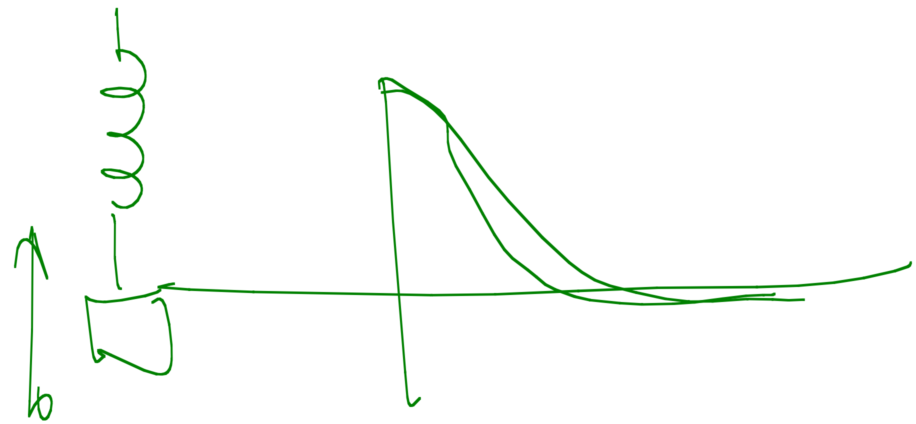


Damping

Time const $2L/R$

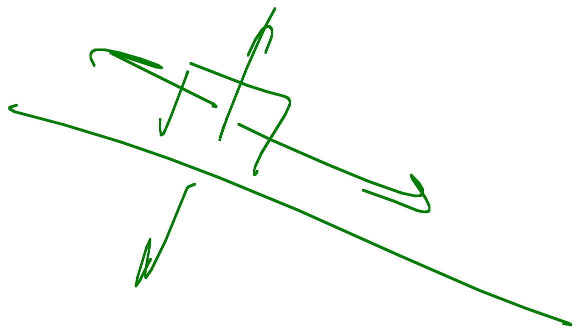
If $2L/R \simeq \sqrt{LC}$ or less critical damping

Analogy for pressing

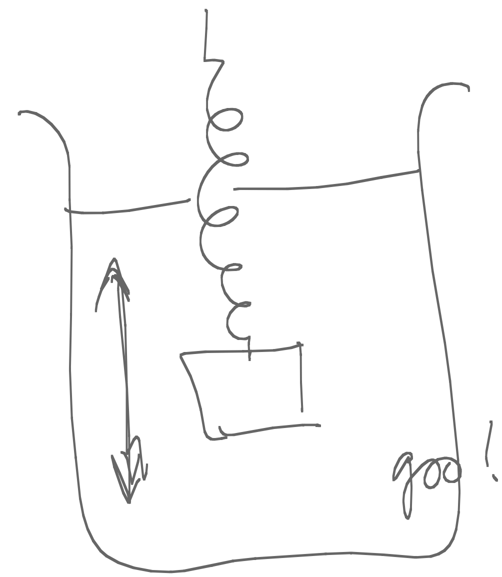


$R\frac{dq}{dt} \simeq Rv$

Friction. Velocity - dep. friction.



$R\frac{dq}{dt}$



Analogy RLC circuit

Mass, spring, goo.

$f_f = -bv$