Look at $I(t)$

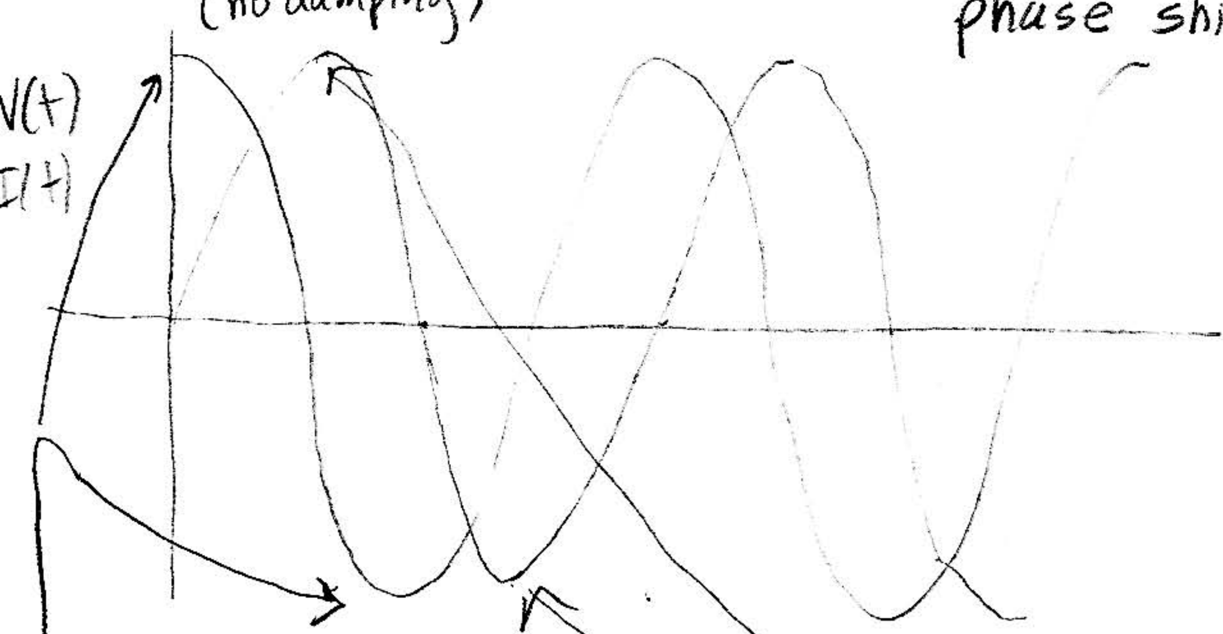
$$I(t) = -C\frac{dV}{dt}$$

$$= -C\frac{d}{dt}\Big(\underbrace{Ae^{-\frac{R}{2L}t}\cos(\omega t)}_{\text{two terms!}}\Big)$$

$$= -CA\Big[-\frac{R}{2L}e^{-\frac{R}{2L}t}\cos(\omega t)$$
$$-\omega e^{-\frac{R}{2L}t}\sin(\omega t)\Big]$$

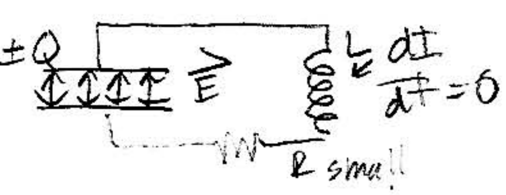
$$= AC\omega e^{-\frac{R}{2L}t}\Big[\sin(\omega t) + \underbrace{\frac{R}{2L\omega}}_{\text{phase shift!}}\cos(\omega t)\Big]$$

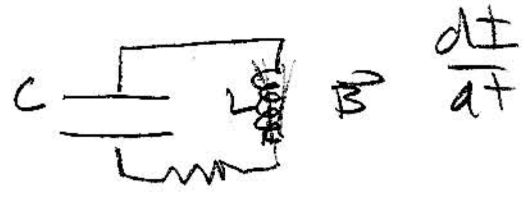
(no damping)



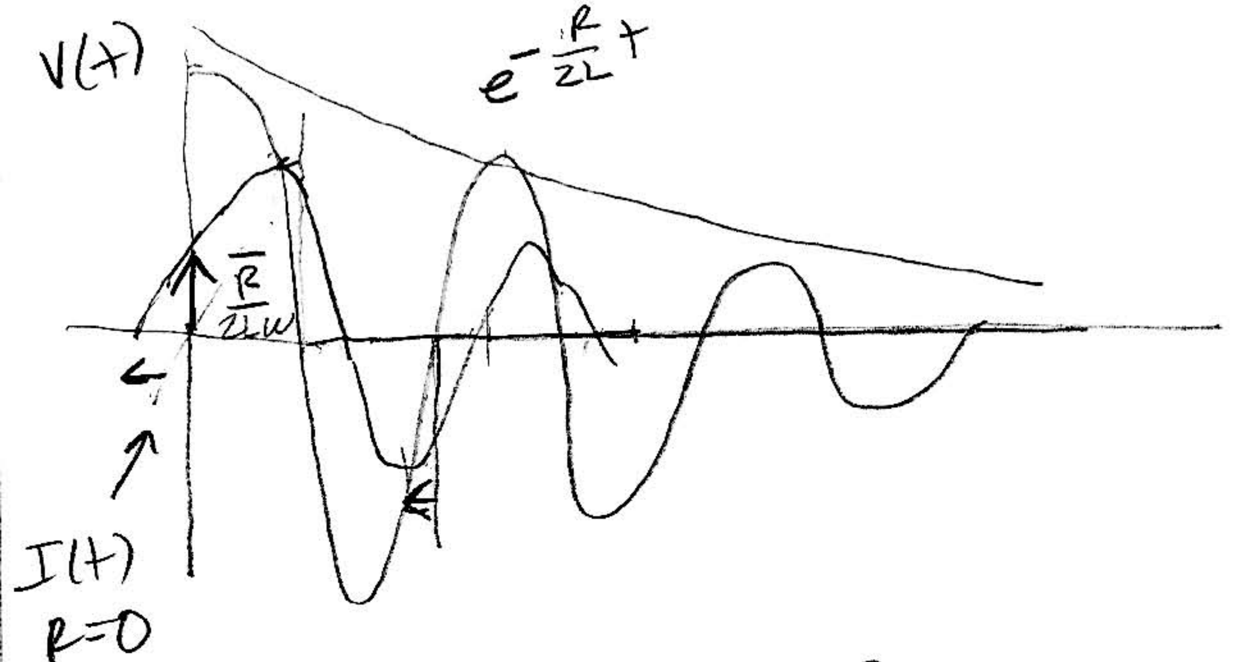
Energy in C

Energy in L





Impact of R:



$I(t)$ acquires $\frac{R}{2L\omega}\cos(\omega t)$

Shifts $I(t)$ left from undamped.

Q: look at energy,

$\propto I^2$ or V^2

$\propto e^{-\frac{R}{L}t}$

$t_{1/e}$ is: $\frac{R}{L}t_{1/e} = 1$

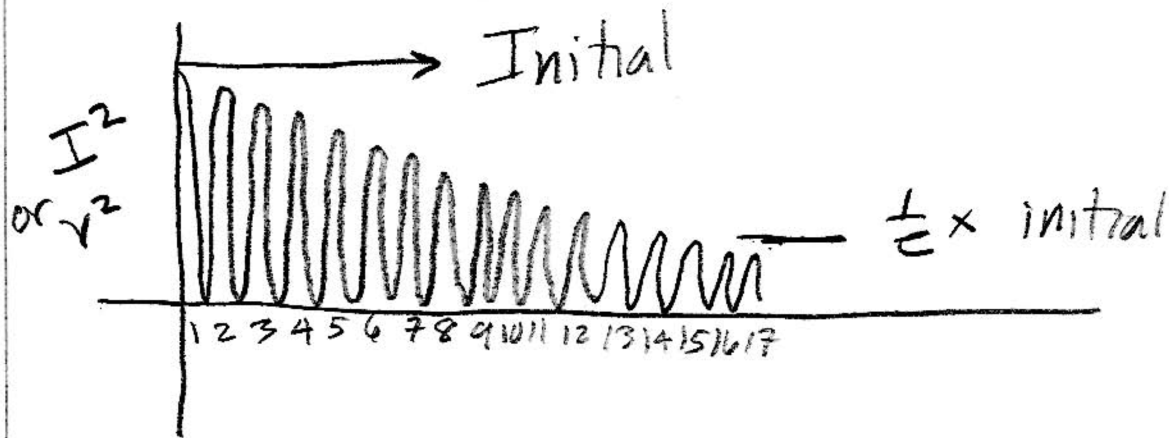
$$t_{1/e} = \frac{L}{R}$$

How many radians is $\omega t_{1/e}$?

That is defined as Q

$$Q = \frac{\omega L}{R} \qquad \text{as } R \to 0,\ Q \to \infty$$

Visually:

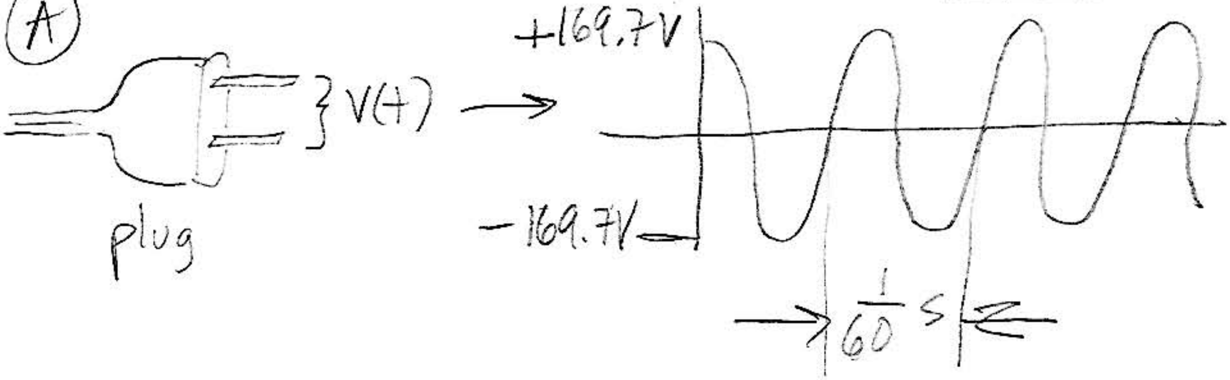


$$\underbrace{2\pi}_{\simeq 6} \times 17 = Q$$

$$Q \simeq 100$$

Driving with a Sinusoidal Voltage

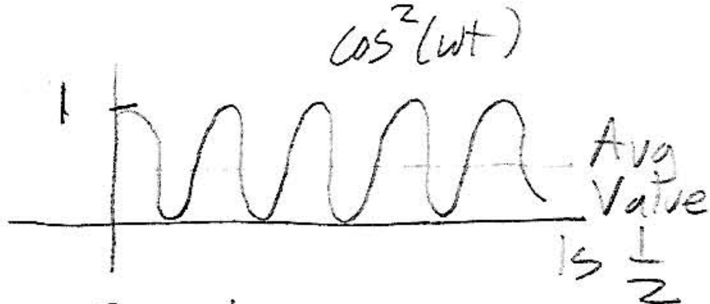
(A)



$$V(t) = V_0 \cos(\omega t) \qquad V_0 = 169.7\ \text{V}$$

$$\omega = 2\pi f = \frac{2\pi}{T} = 60\cdot 2\pi$$
$$= 377\ \text{rad/s}$$

"120 V" is the "rms"



$$V^2(t) = V_0^2 \cos^2(\omega t)$$

$$\langle V^2(t) \rangle = V_0^2 \times \frac{1}{2}$$

$$\boxed{\langle V^2(t) \rangle^{1/2} = \frac{V_0}{\sqrt{2}} = 120\ \text{V}}$$

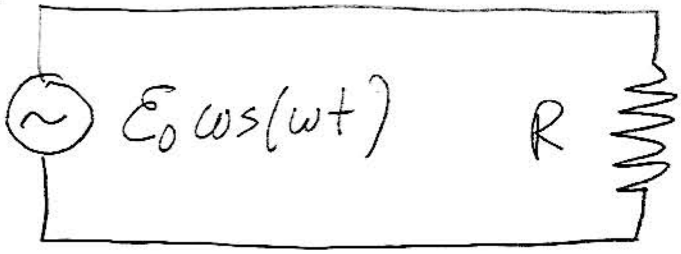
Europe: $f = 1/50$ s (not 1/60)

$$V_0 = 311.1\ \text{V}$$

(B) Capturing Radio waves!

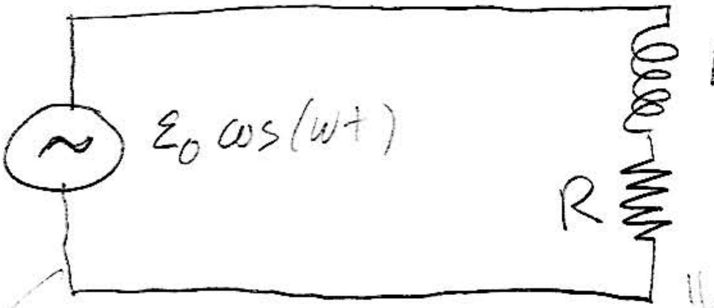
$f \sim 10^6$ 1/s (AM)

$\sim 10^8$ 1/s (FM)

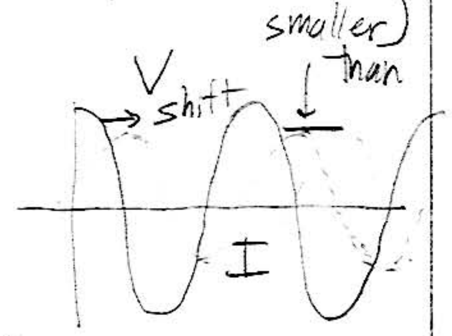


$$I = \frac{\mathcal{E}_0}{R}\cos(\omega t)$$

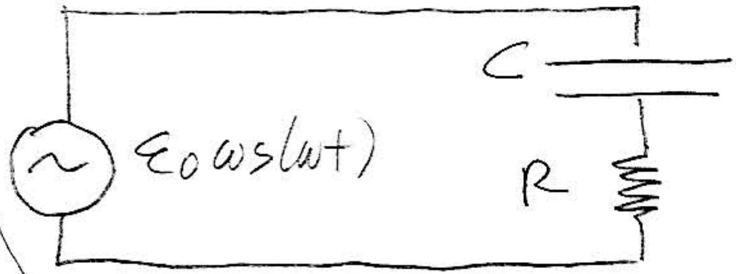
easy

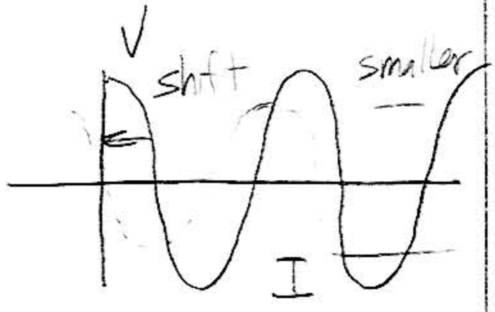


I:



"sluggish"





$$\mathcal{E}_0 \cos(\omega t) - L\frac{dI}{dt} = RI$$

$$\underbrace{Re}_{\text{drop}}\left[\mathcal{E}_0 e^{i\omega t} - L\frac{dI}{dt}\right] = Re\left[RI\right]$$

$$I = I_0 e^{i\omega t} \qquad \frac{dI}{dt} = i\omega I_0 e^{i\omega t}$$

$$\mathcal{E}_0 \cancel{e^{i\omega t}} - i\omega L I_0 \cancel{e^{i\omega t}} = R I_0 \cancel{e^{i\omega t}}$$

$$\mathcal{E}_0 = (R + i\omega L) I_0$$

$$\boxed{I_0 = \frac{\mathcal{E}_0}{R + i\omega L}}$$