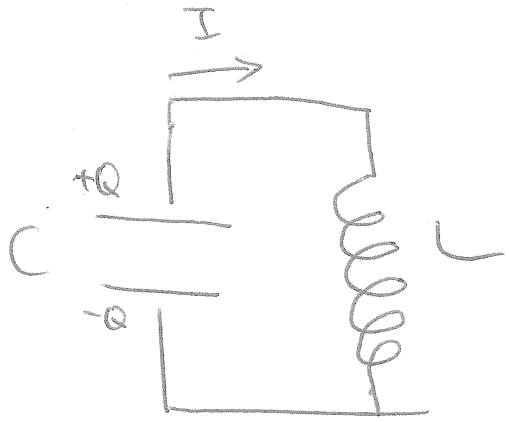


$$\frac{Q}{C} - L\frac{dI}{dt} = 0$$

$$I = -\frac{dQ}{dt}$$

$$\frac{Q}{C} + L\frac{d^2Q}{dt^2} = 0$$

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

$$Q = Q_{MAX}\cos(\omega t + \phi)$$

INITIALIZATION

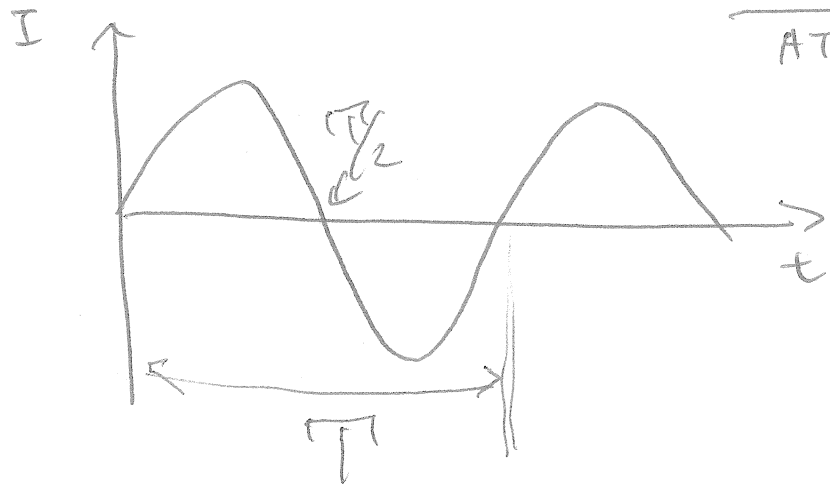
$$\omega = \frac{1}{\sqrt{LC}}$$

$$I = -\frac{dQ}{dt} = -\left(-\omega Q_{MAX}\sin(\omega t + \phi)\right)$$

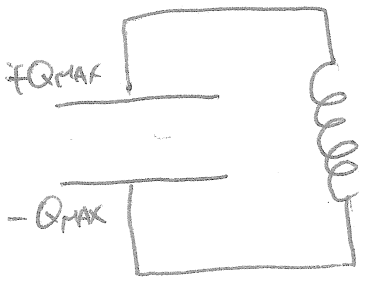
$$= \omega Q_{MAX}\sin(\omega t + \phi)$$

AT $t=0$ $\quad I=0$

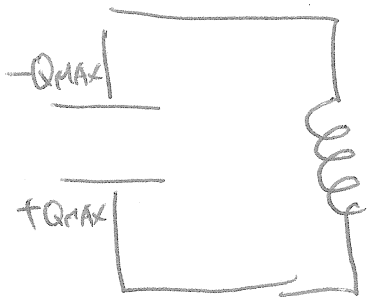
$$\phi = 0$$



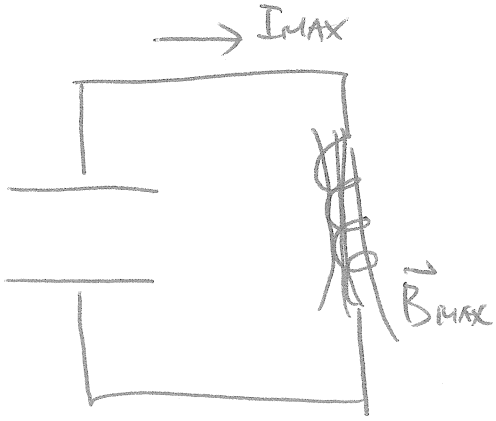
At $t = 0$



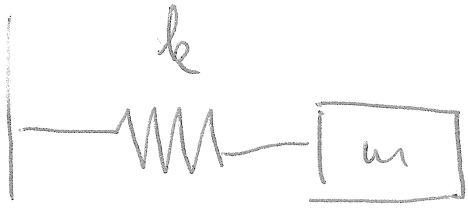
At $t = T/2$



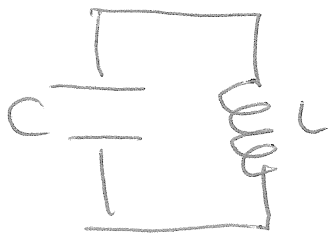
At $t = T/4$ $\quad I(T/4) = I_{MAX} = \omega Q_{MAX}$



ANALOGOUS TO



$$\frac{1}{2} k x^2 + \frac{1}{2} m v^2 = \text{CONSTANT}$$

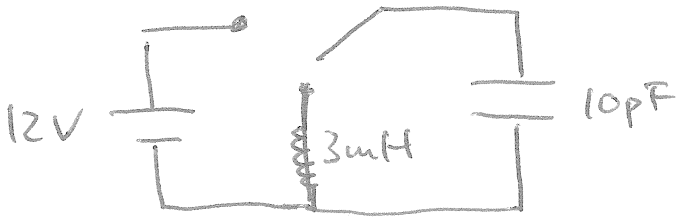


$$\frac{1}{2} C V^2 + \frac{1}{2} L I^2 = \text{CONSTANT}$$

$$Q = CV$$

$$\frac{1}{2} \frac{Q^2}{C} + \frac{1}{2} L I^2 = \text{CONSTANT}$$

EXAMPLE



a) FIND OSCILLATION FREQUENCY

$$f = \frac{1}{T} \qquad T = \frac{2\pi}{\omega}$$

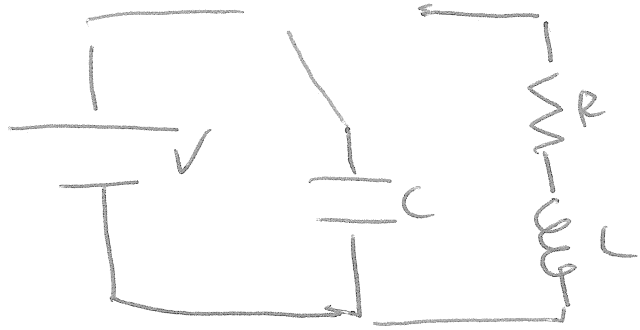
$$2\pi f = \omega$$

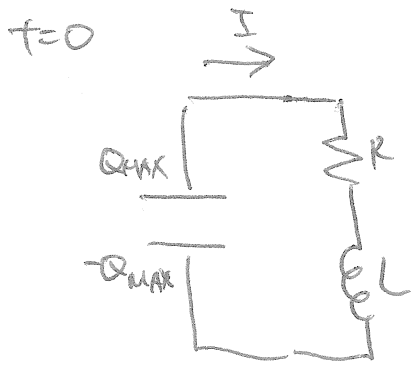
$$f = \frac{\omega}{2\pi} = \frac{1}{2\pi\sqrt{LC}}$$

b) MAXIMUM CURRENT AND CHARGE.

$$Q_{MAX} = C V = 12V \times 10pF = 120pC$$

$$I_{MAX} = \omega Q_{MAX} \Rightarrow \text{CAN BE CALCULATED}$$





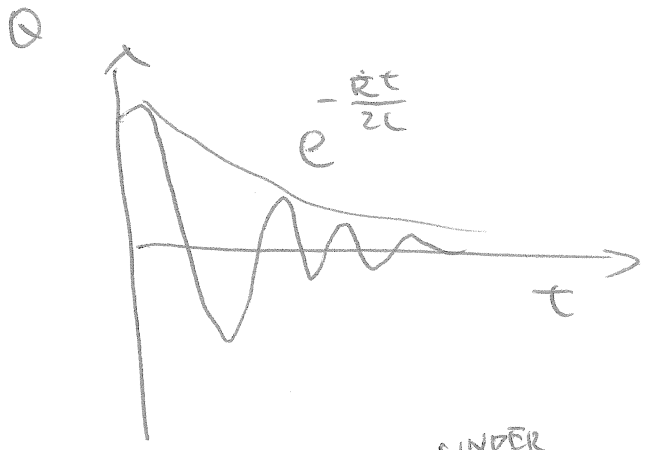
$$\frac{Q}{C} - IR - L\frac{dI}{dt} = 0$$

$$I = -\frac{dQ}{dt}$$

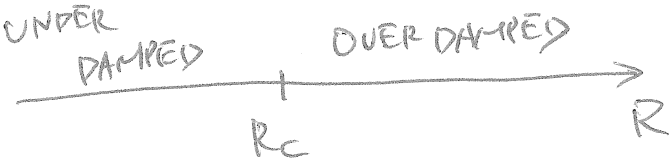
$$\boxed{\frac{Q}{C} + R\frac{dQ}{dt} + L\frac{d^2Q}{dt^2} = 0}$$

$$Q(t) = Q_{MAX}\, e^{-\frac{Rt}{2L}} \cos(\omega t)$$

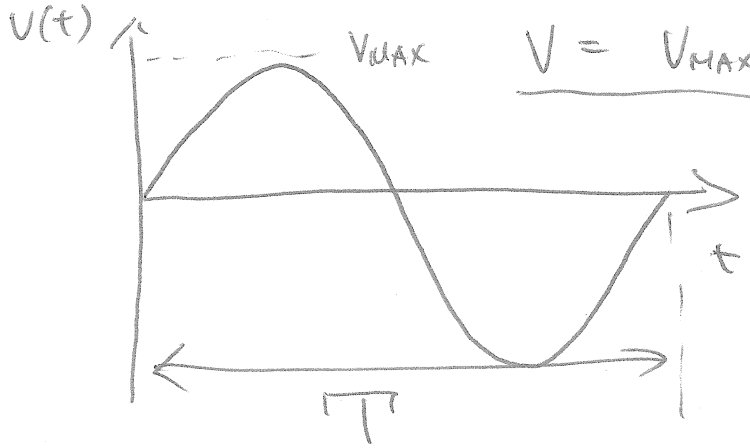
$$\omega = \left[\frac{1}{LC} - \left(\frac{R}{2L}\right)^2\right]^{1/2}$$



$$R_c = \sqrt{\frac{4L}{C}}$$ NO OSCILLATION OCCURS



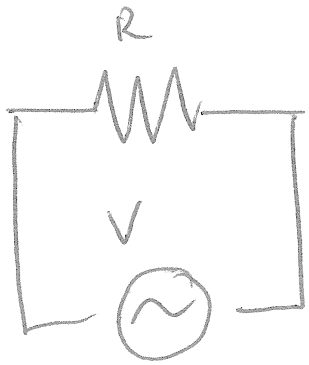
AC CIRCUITS



$V = V_{MAX} \sin \omega t$

$T = \frac{2\pi}{\omega}$

EXAMPLE



GIVEN $V(t) = V_{MAX} \sin \omega t$

WHAT IS $I(t)$?

$V - IR = 0$

$V = IR$

$I = \frac{V}{R} = \frac{V_{MAX} \sin \omega t}{R}$

ROOT MEAN SQUARE (RMS)

$I_{RMS} = \sqrt{(I^2(t))_{AVERAGE}}$

$I(t) = I_{MAX} \sin \omega t$

$I_{MAX} = \frac{V_{MAX}}{R}$ IN THIS CASE

$I^2(t) = I_{MAX}^2 \sin^2 \omega t$

$(\sin^2 \omega t)_{AVERAGE} = \frac{1}{T} \int_0^T \sin^2(\omega t) = \frac{1}{T}\left[\frac{t}{2} - \frac{\sin(2\omega t)}{4\omega}\right]_0^T = \frac{1}{2}$

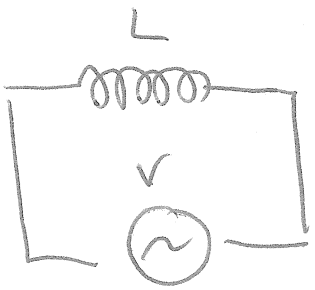
$$I_{RMS} = \frac{I_{MAX}}{\sqrt{2}}$$

EXAMPLE

$V(t) = 200 \sin(\omega t)$

WHAT IS THE RMS VOLTAGE?

$$\Delta V_{RMS} = \frac{200}{\sqrt{2}} = 141\,V$$



$V(t) = V_{MAX} \cos(\omega t)$

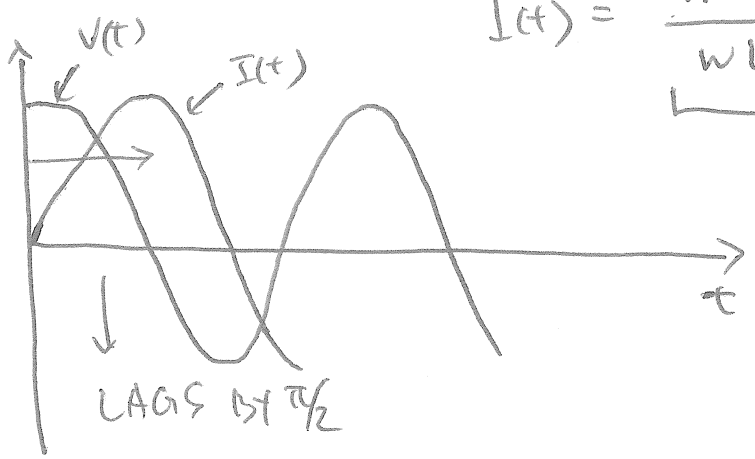
$$V(t) - L\frac{dI}{dt} = 0$$

$$V(t) = L\frac{dI}{dt}$$

$$\frac{dI}{dt} = \frac{V(t)}{L} = \frac{V_{MAX}\cos(\omega t)}{L}$$

$$I(t) = \frac{V_{MAX}}{\omega L}\sin(\omega t)$$

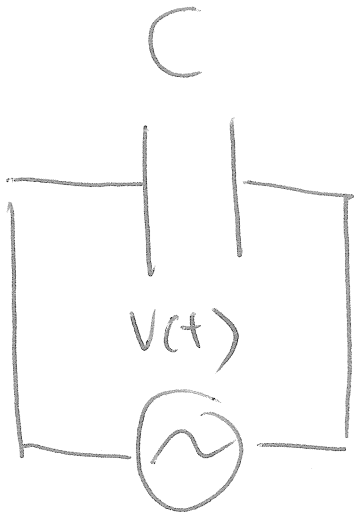
$\left[\frac{V}{\omega L}\right]$



$$I_{MAX} = \frac{V_{MAX}}{\omega L}$$

X_L : REACTANCE OF INDUCTOR

$$\boxed{X_L = \omega L}$$



~~V(t) = Q~~

$$V(t) - \frac{Q}{C} = 0$$

$$V(t) = V_{MAX}\cos(\omega t)$$

$$Q(t) = CV(t)$$

$$= CV_{MAX}\cos\omega t$$

$$I = \frac{dQ}{dt} = -\omega C V_{MAX}\sin(\omega t)$$

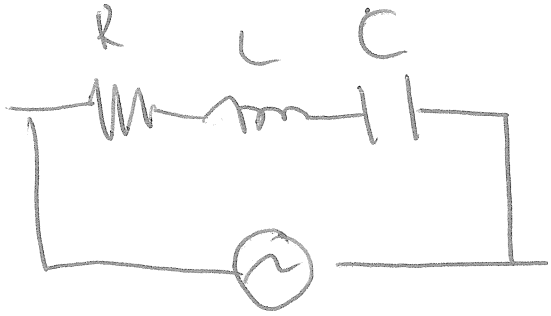
$$\sin(\omega t) = -\cos(\omega t + \pi/2)$$

$$= +\omega C V_{MAX}\cos(\omega t + \pi/2)$$

CURRENT LEADS VOLTAGE

$$I_{MAX} = \omega C V_{MAX}$$

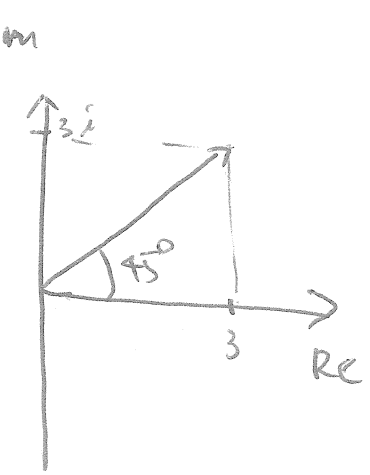
$$X_C = \frac{1}{\omega C}$$



~~V = IR~~

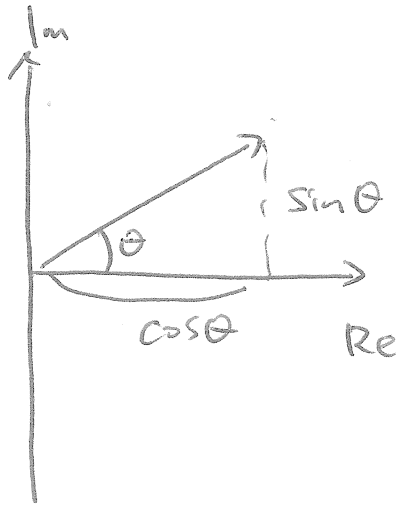
$$V(t) - IR - L\frac{dI}{dt} - \frac{Q}{C} = 0$$

$i = \sqrt{-1}$



COMPLEX NUMBER

$3 + 3i$



$\text{Cos}\theta + i\,\text{Sin}\theta$

EULER RELATIONSHIP

$$e^{i\theta} = \text{Cos}\theta + i\,\text{Sin}\theta$$

$$\text{Cos}\,\omega t = \text{Re}\left[e^{i\omega t} \right]$$

$$= \underline{\text{Re}}\left[\text{Cos}\,\omega t + i\,\text{Sin}\,\omega t \right]$$

$$V(t) = V_M \text{Cos}\,\omega t \rightarrow = V_M e^{i\omega t}$$

$$I(t) = I_M e^{i(\omega t - \phi)}$$

$$\frac{V(t)}{I(t)} = \frac{V_M e^{i\omega t}}{I_M e^{i(\omega t - \phi)}} = \frac{V_M}{I_M} e^{i\phi}$$

$\underline{\phi = 0}$