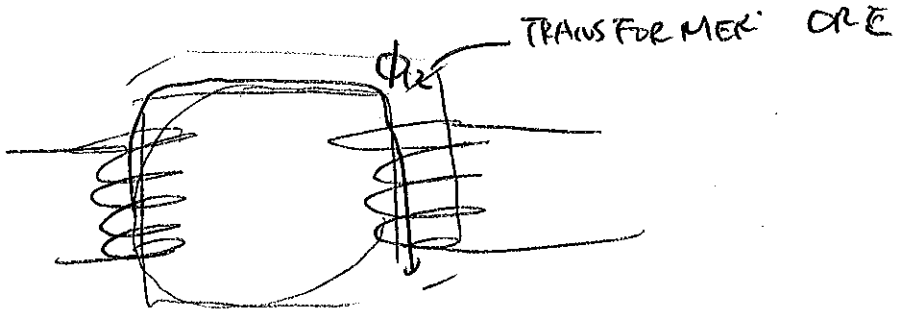
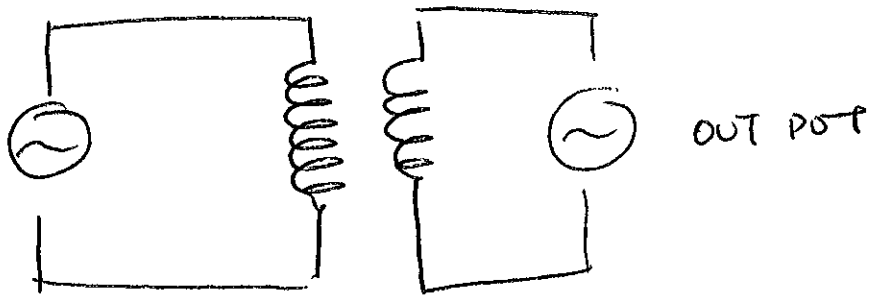
EXTRA

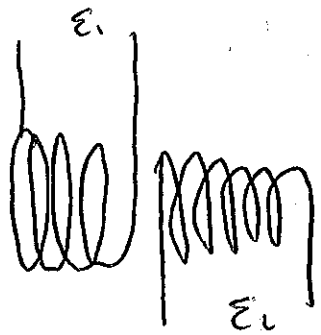
TRANSFORMERS





WEDNESDAY 4/7

MUTUAL INDUCTANCE



Φ_{12} : Φ FLUX IN COIL 2 BY COIL 1

$$\mathcal{E}_2 = -N_2 \frac{d\Phi_{12}}{dt} \Rightarrow \quad \Phi_{12} \sim I_1$$

$$\Phi_{12} = a I_1$$

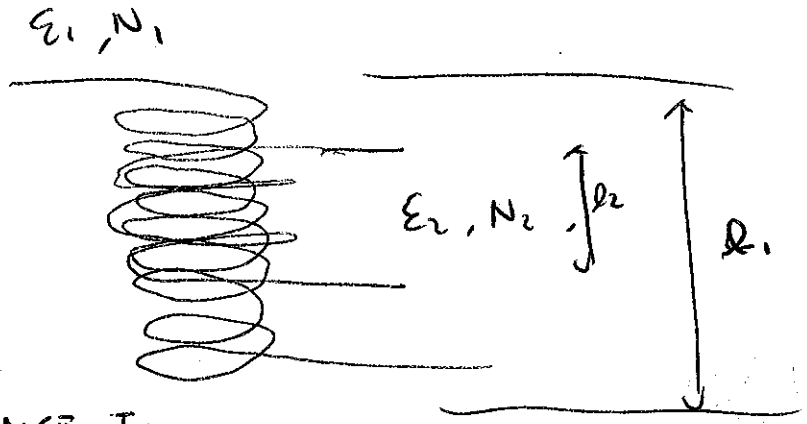
$$\mathcal{E}_2 = -N_2 \frac{d\Phi_2}{dt} = -N_2 a \frac{dI_1}{dt}$$

$$\mathcal{E}_2 = -M_{12} \frac{dI_1}{dt}$$

$$M_{12} = \frac{N_2 a \Phi_{12}}{I_2}$$

MUTUAL INDUCTANCE

EXAMPLE



CHANGE I_1

$$\mathcal{E}_2 \quad \frac{dI_1}{dt} \qquad \Phi_{12} = N_2 B_1 \pi R^2$$

$$= N_2 B_1 A$$

$$= N_2 \frac{N_1}{l_1} \mu_0 I_1 A$$

$$\mathcal{E}_2 = -\frac{d\Phi_{12}}{dt} = -\underbrace{\frac{N_2 N_1}{l_1} \mu A}_{M_{12}} \frac{dI_1}{dt}$$

CHANGE I_2

$$\frac{dI_2}{dt} \Rightarrow \Phi_{12} = \frac{N_1}{l_1} \cdot l_2 \cdot B_2 \pi R^2$$

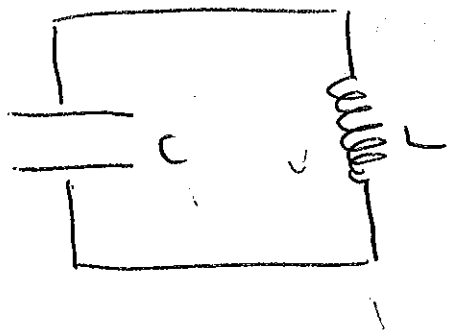
$$B_2 = \frac{N_2}{l_2} \mu_0 I_2$$

$$= \frac{N_2 N_2}{l_1} \mu_0 I_2 A$$

$$-\frac{d\Phi_{12}}{dt} = \frac{N_2 N_1}{l_2} \mu_0 A \frac{dI_{12}}{dt}$$

$M_{12} = M_{21}$

LC CIRCUIT



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

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

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

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

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

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

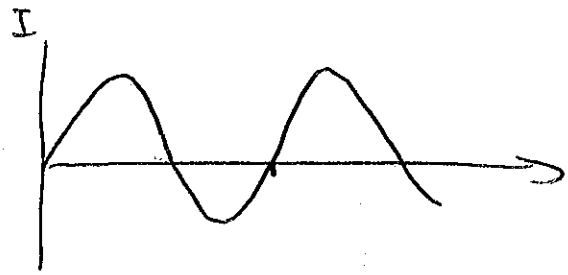
$$\omega = \frac{1}{\sqrt{LC}}$$

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

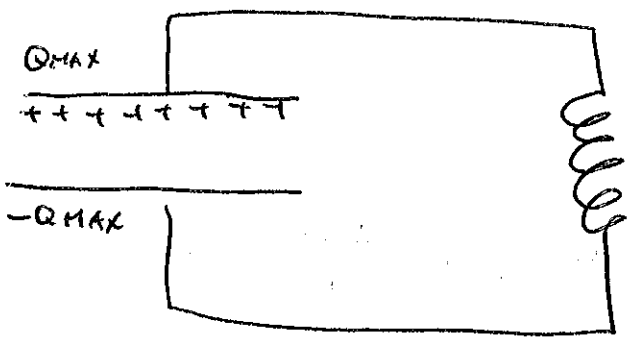
PHASE ϕ ? → INITIAL CONDITIONS

$t = 0 \quad I = 0$

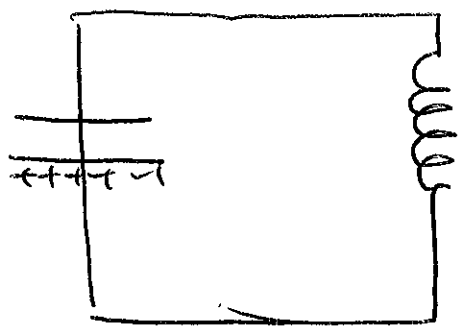
$\phi = 0$



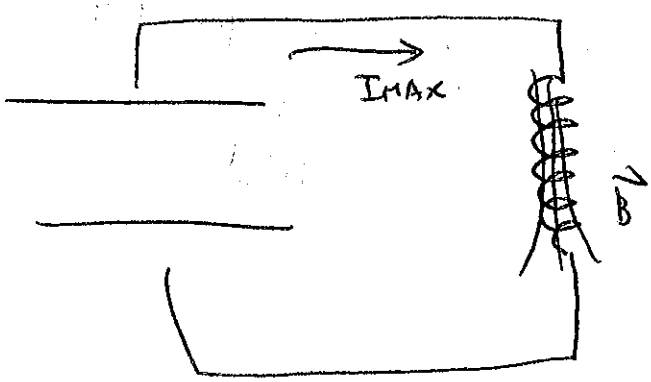
$t = 0$



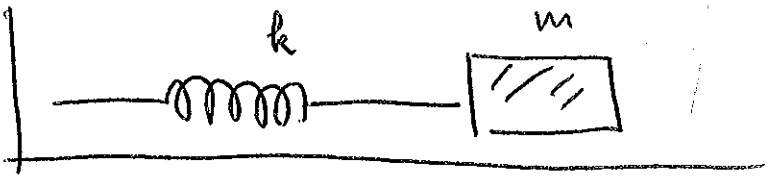
$t = T/2$



$t = T/4$



ANALOGOUS TO

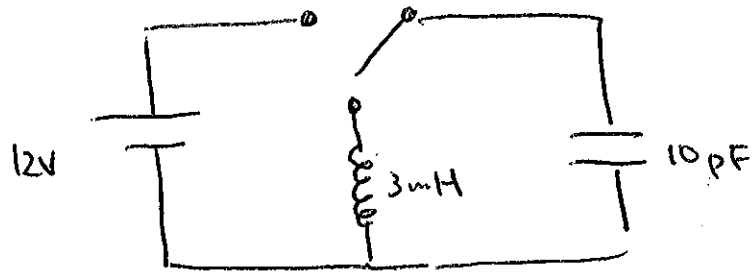


$$\frac{1}{2}kx^2 + \frac{1}{2}mv^2 = \text{CONSTANT}$$

HERE

$$\frac{Q^2}{2C} + \frac{1}{2}LI^2 = 0$$

$$\frac{Q^2}{2C} + \frac{1}{2}L\frac{d^2Q}{dt^2} = 0$$



a) FIND OSCILLATION FREQUENCY

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

$$2\pi f = \omega$$

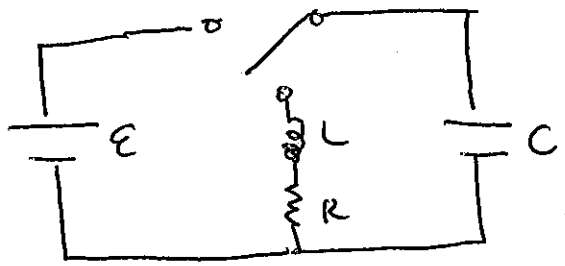
$$f = \frac{\omega}{2\pi} = \frac{1}{2\pi\sqrt{LC}}$$

b) MAXIMUM CURRENT + CHARGE?

$$Q_{MAX} = C\Delta V = 12 \times 10\,pF$$

$$I_{max} = \omega Q_{MAX} = \Rightarrow$$

RLC CIRCUIT



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

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

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

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

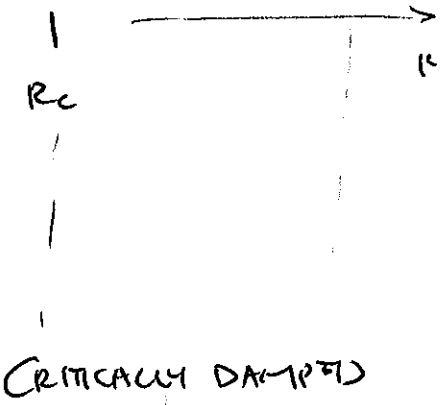
$$\omega_d = \left[\frac{1}{LC} - \left(\frac{R}{2L}\right)^2\right]^{1/2}$$

$$R_c = \sqrt{\frac{4L}{C}}$$

NO OSCILLATIONS OCCUR BEYOND THIS POINT

UNDER DAMPED

OVER DAMPED



CRITICALLY DAMPED