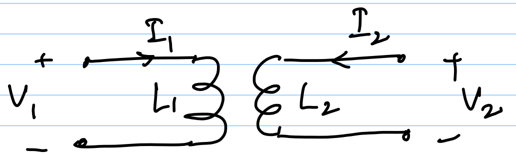
19/1/15

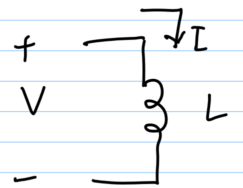
Lec 3

Mutual Inductor



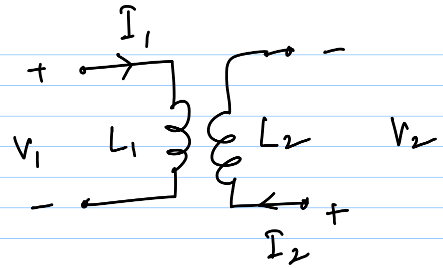
L = self inductance

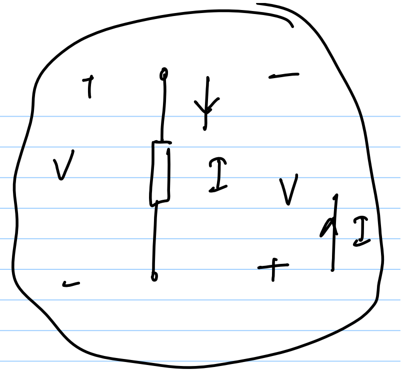
M = mutual inductance



$$V_1 = L_1 \frac{dI_1}{dt} + (M) \frac{dI_2}{dt}$$

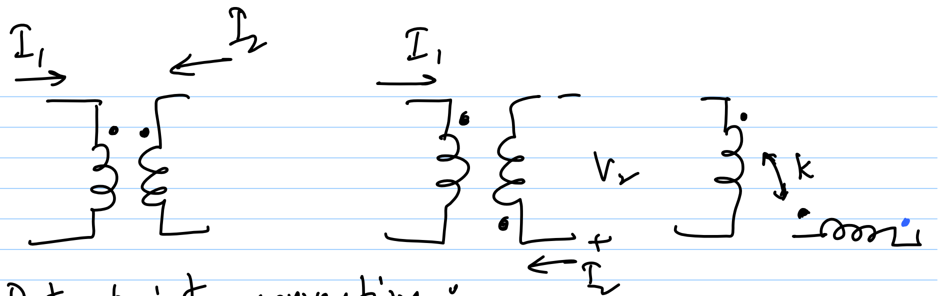
$$V_2 = (M) \frac{dI_1}{dt} + L_2 \frac{dI_2}{dt}$$





$$V_1 = L_1 \frac{dI_1}{dt} - M \frac{dI_2}{dt}$$

$$V_2 = -M \frac{dI_1}{dt} + L_2 \frac{dI_2}{dt}$$



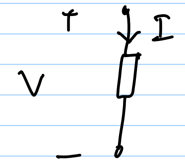
Dot point convention:

Currents entering dot points produce additive fluxes i.e. M is positive

$$M = k\sqrt{L_1 L_2} \quad ; \quad k = \text{coupling coefficient}$$

$$|k| \leq 1$$

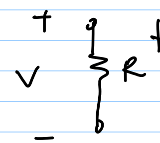
Passive sign convention



Power $P = V \cdot I$ dissipated inside the element (in Watts)

$P(t) = V(t)\, I(t)$

Passive – power is dissipated

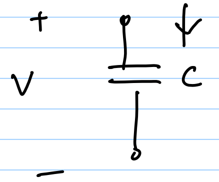


$I = V/R$

$P = VI = \frac{V^2}{R}$ or $I^2R > 0$

$\Rightarrow$ power is dissipated

Resistor = passive



$I = C \frac{dv}{dt}$ ⇒ Capacitor = passive

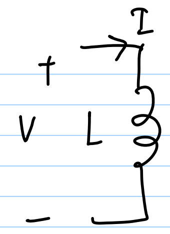
$P = VI = Cv \frac{dv}{dt}$

Energy (Joules)

$$E = \int_0^{T_0} P(t)\, dt = \int_0^{T_0} \left(Cv \frac{dv}{dt} \right) dt$$

$$= \frac{1}{2} C \left[v^2(T_0) - v^2(0) \right]$$

If $v(0) = 0 \Rightarrow E > 0$

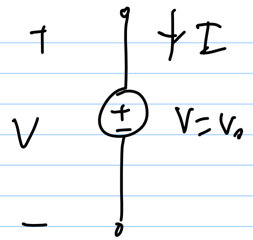


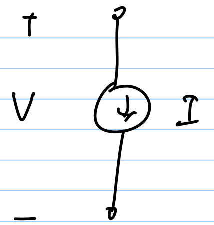
$$E = \frac{1}{2} L \left[I^2(T_0) - I^2(0) \right]$$

Inductor = passive

Passive : Electrical Energy is dissipated / in the element (or absorbed)

Active : Electrical energy is generated





$P = VI$

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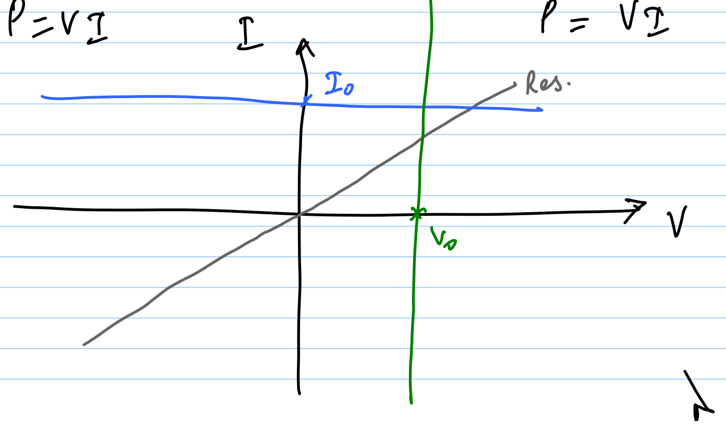

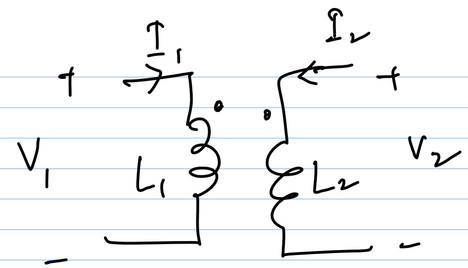

$P = V_1 I_1 + V_2 I_2$

$$E = \frac{1}{2} L_1 I_1^2 + \frac{1}{2} L_2 I_2^2 + M I_1 I_2 > 0$$

$$M = k\sqrt{L_1 L_2}$$

$$|k| \le 1$$