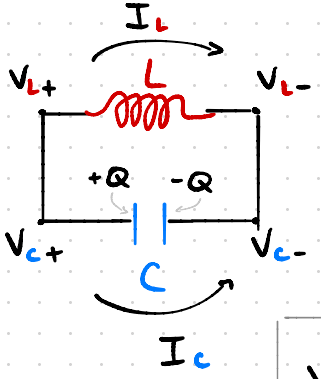
LC CIRCUITS

- LC "OSCILLATOR":



KVL:

$$V_L = V_{L+} - V_{L-} = V_{C+} - V_{C-} = V_C$$

KCL:

$$I_L = -I_C$$

$$V_L = L\frac{\Delta I_L}{\Delta t}, \quad V_C = \frac{Q}{C}, \quad I_C = \frac{\Delta Q}{\Delta t}$$

- COMBINING:

$$L\frac{\Delta I_C}{\Delta t} = -\frac{Q}{C}$$

- ANALOGY: $\longrightarrow$ $L\frac{\Delta I_C}{\Delta t} = -\frac{Q}{C}$ (LC OSCILLATOR) $\sim$ $ma = -kx$ (HOOKE'S LAW)

$Q \sim x$

(CHARGE) (POSITION)

$I_C = \frac{\Delta Q}{\Delta t} \sim v = \frac{\Delta x}{\Delta t}$

(CURRENT) (VELOCITY)

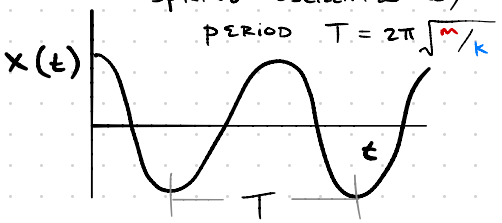
$\frac{\Delta I_C}{\Delta t} \sim a = \frac{\Delta v}{\Delta t}$

(ACCELERATION)

COMPARING ABOVE:

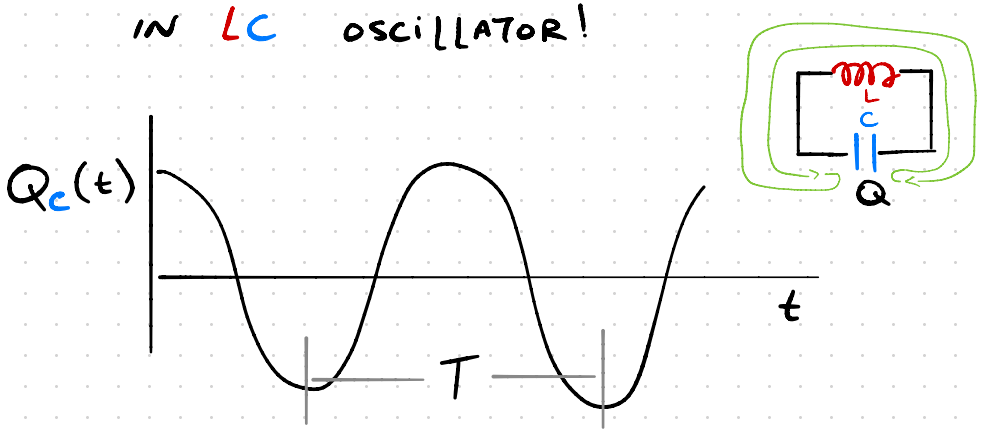
$L \sim m, \quad \frac{1}{C} \sim k$

SPRING OSCILLATES W/ PERIOD $T = 2\pi\sqrt{m/k}$



- By analogy:

  Charge oscillates back and forth between two ends of capacitor in LC oscillator!



For spring:

$$T = 2\pi\sqrt{m/k}$$

Substituting $m \to L$, $k \to 1/C$:

$$T = 2\pi\sqrt{L/(1/C)} = 2\pi\sqrt{LC}$$

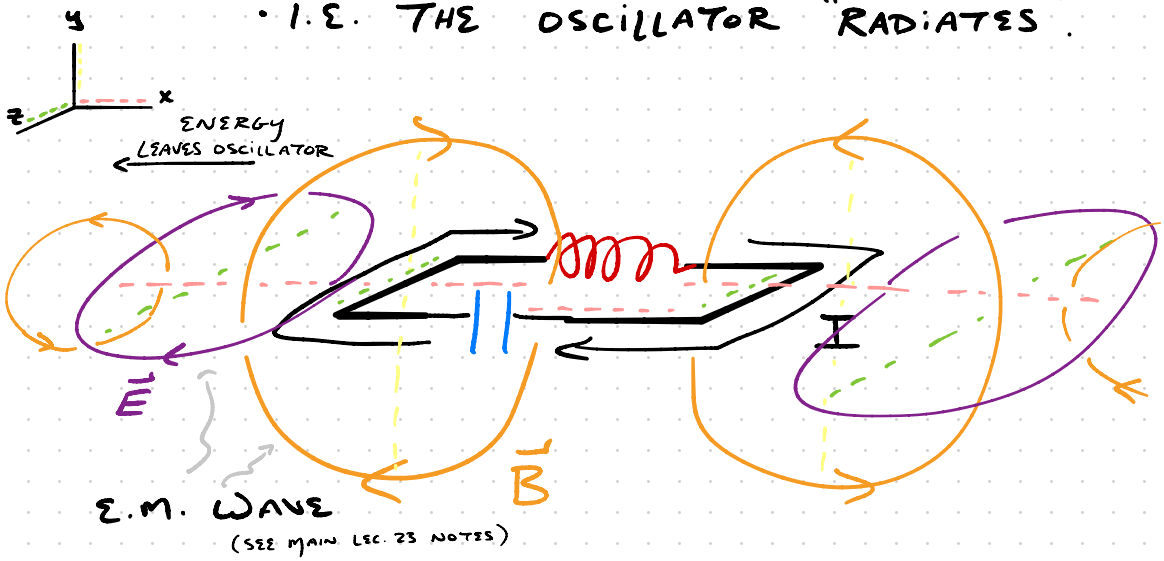
(period of oscillation in LC oscillator)

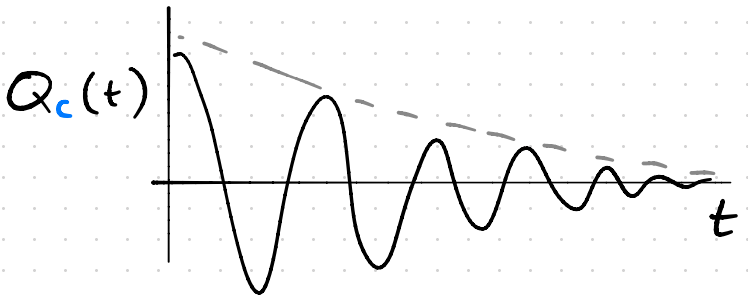
$$f = \frac{1}{T} = \frac{1}{2\pi}\cdot\frac{1}{\sqrt{LC}}$$

("resonant frequency")

GENERATION OF E.M. WAVES

- OSCILLATION OF CHARGE IN L.C. OSCILLATOR PRODUCES E.M. WAVES!
- I.E. THE OSCILLATOR "RADIATES".





- ENERGY $E = \frac{1}{2}\frac{Q^2}{C}$ INITIALLY STORED ON CAPACITOR IS CONVERTED INTO E.M. WAVES!