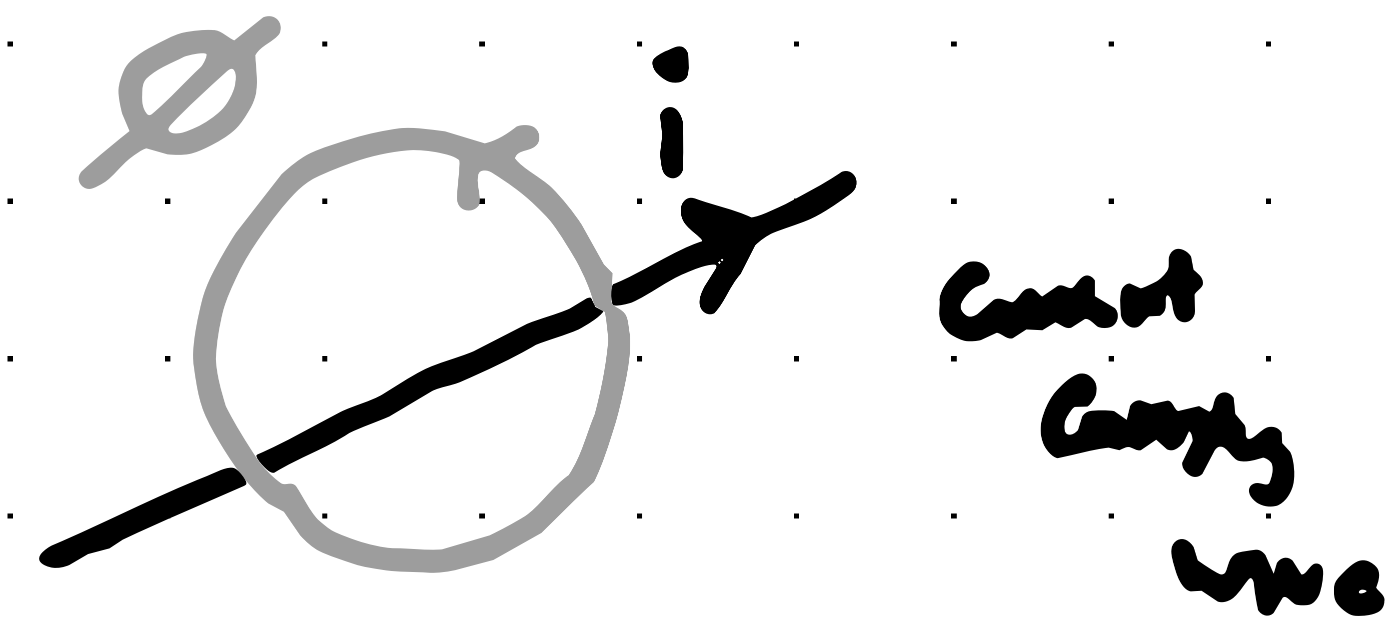
Lecture 15

ECED 2□□□

Chapter 6 Energy Storage Elements

1 The Inductor

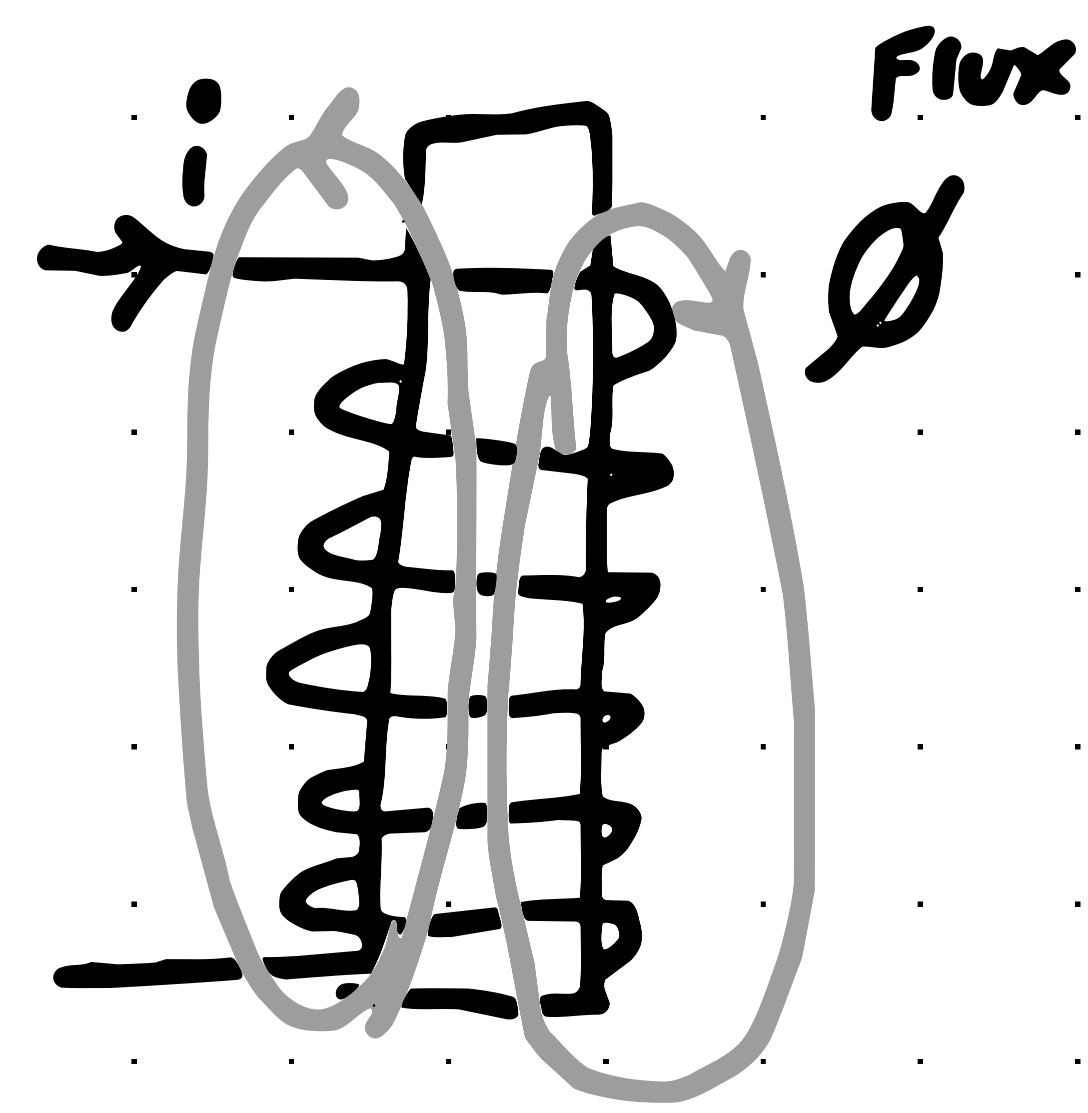


λ: Flux Linkage

$\lambda = N\phi$

ϕ — Magnetic Flux

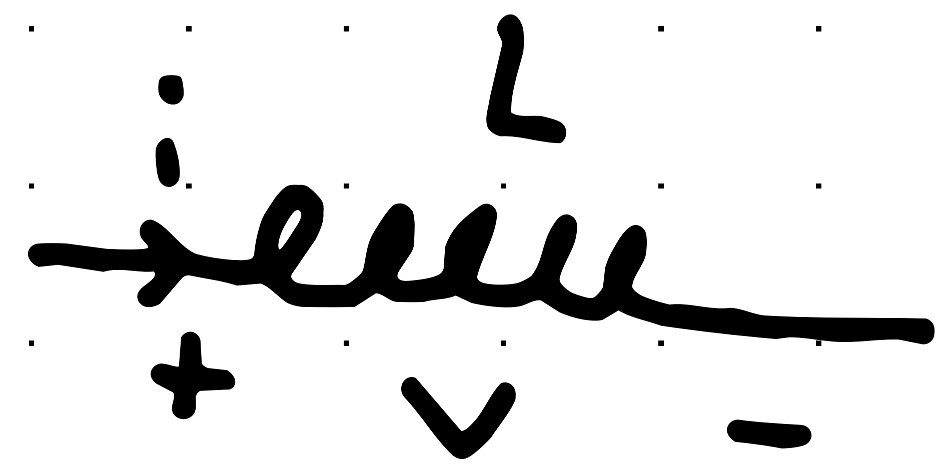
N — Number Of Loops



Inductance

$$L = \frac{\lambda}{i}$$

(Inductance)



(Wb/A) or
Henry (H)

Faraday's Law (One of the Maxwell Equations)

$$V = \frac{d\lambda}{dt} = \frac{d(Li)}{dt} = L\frac{di}{dt}$$

L will be constant for us, but it is variable generally. It relies on Magnetic Flux

$$V = L\frac{di}{dt}$$

For DC Circuits

- The inductor looks like a short circuit.

For the Current at any time

Since $v = L(di/dt)$, There is a proof to say

$$\boxed{i_{(t)} = \frac{1}{L}\int_{t_0}^{t} v_{(t)}\,dt + i_{(t_0)}}$$

Current at a time

Power

$$P = vi = \left(L\frac{di}{dt}\right)i = Li\frac{di}{dt}$$

$$\boxed{P = Li\frac{di}{dt}}$$

Energy

$$\boxed{W = \frac{1}{2}Li^2}, \quad W = \int Li\,di$$

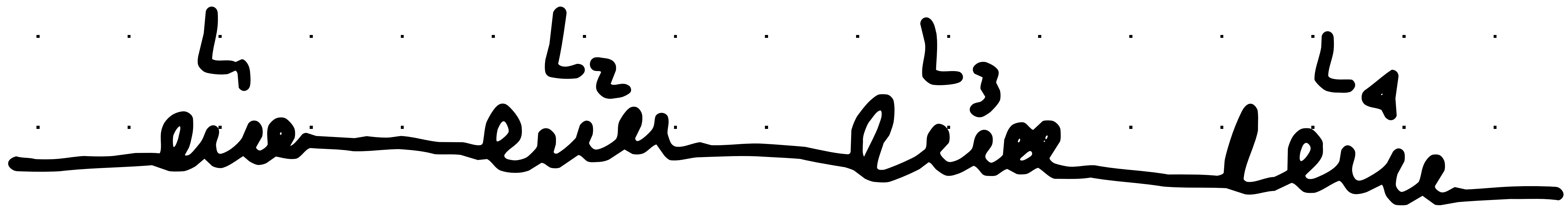
Summary

$$V_{(t)} = L\frac{di}{dt} \qquad i_{(t)} = \frac{1}{L}\int_{t_0}^{t} V_{(t)}\,dt + i_{(t_0)}$$

$$P = vi$$

$$W = \int L i \, di$$

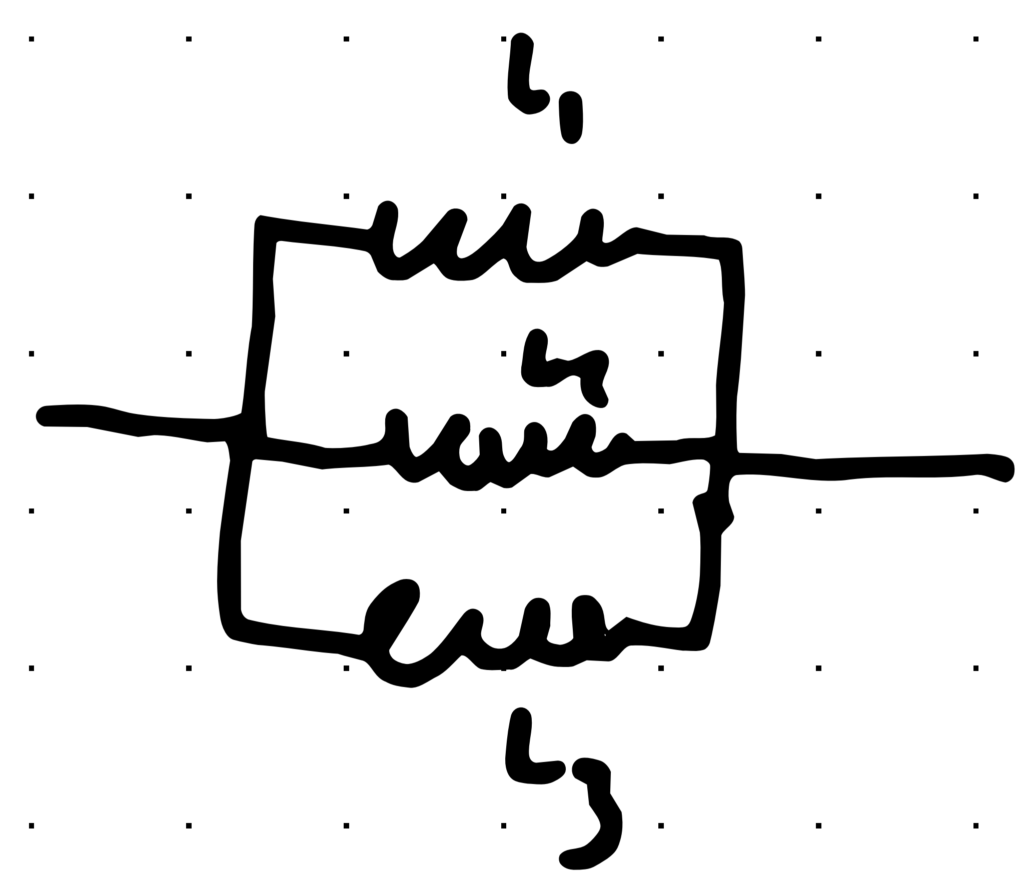
Inductors Connected in Series



$$L_{eq} = \sum L_i = L_1 + L_2 + L_3 + L_4$$

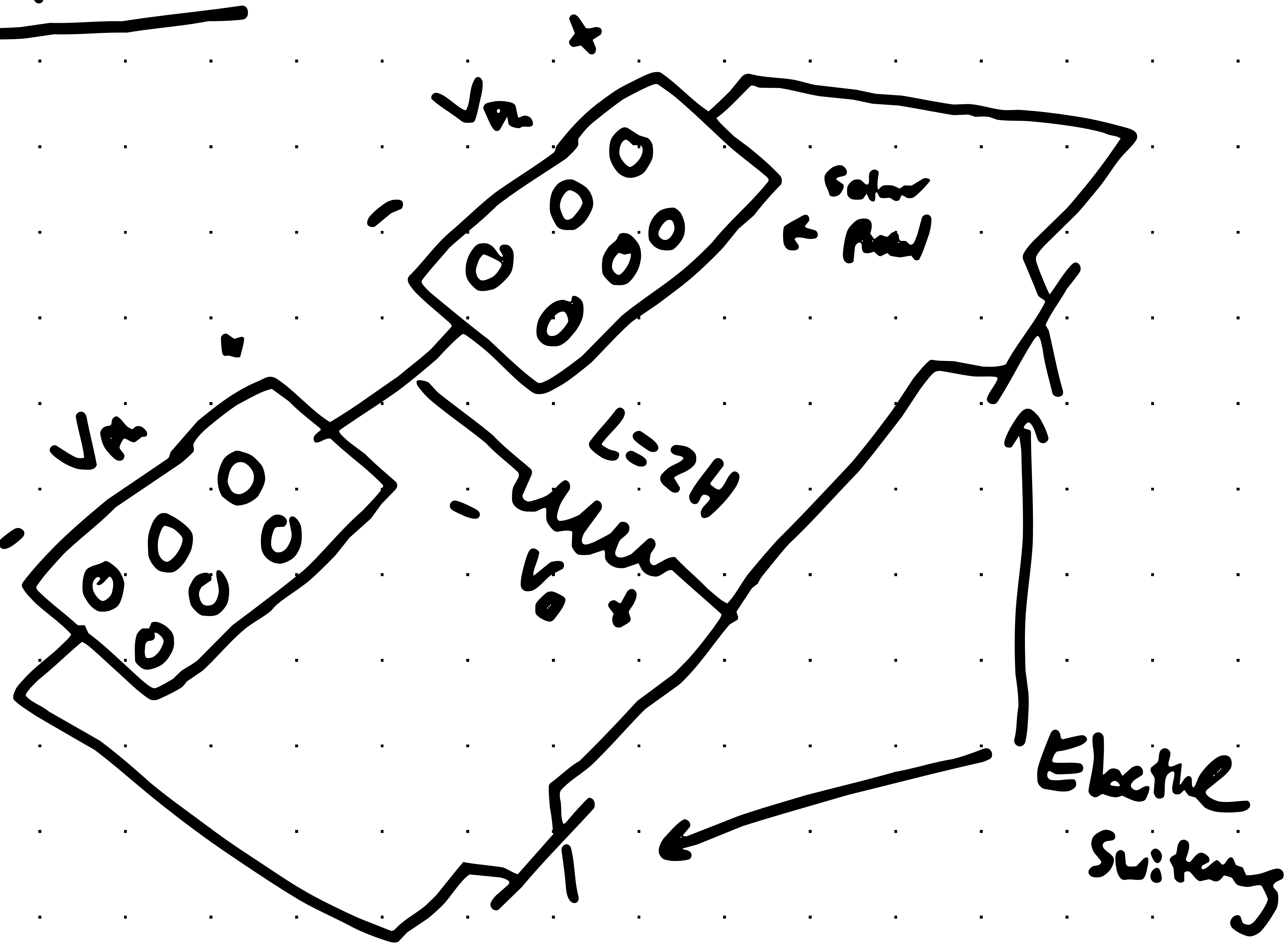
Inductors Connected in Parallel

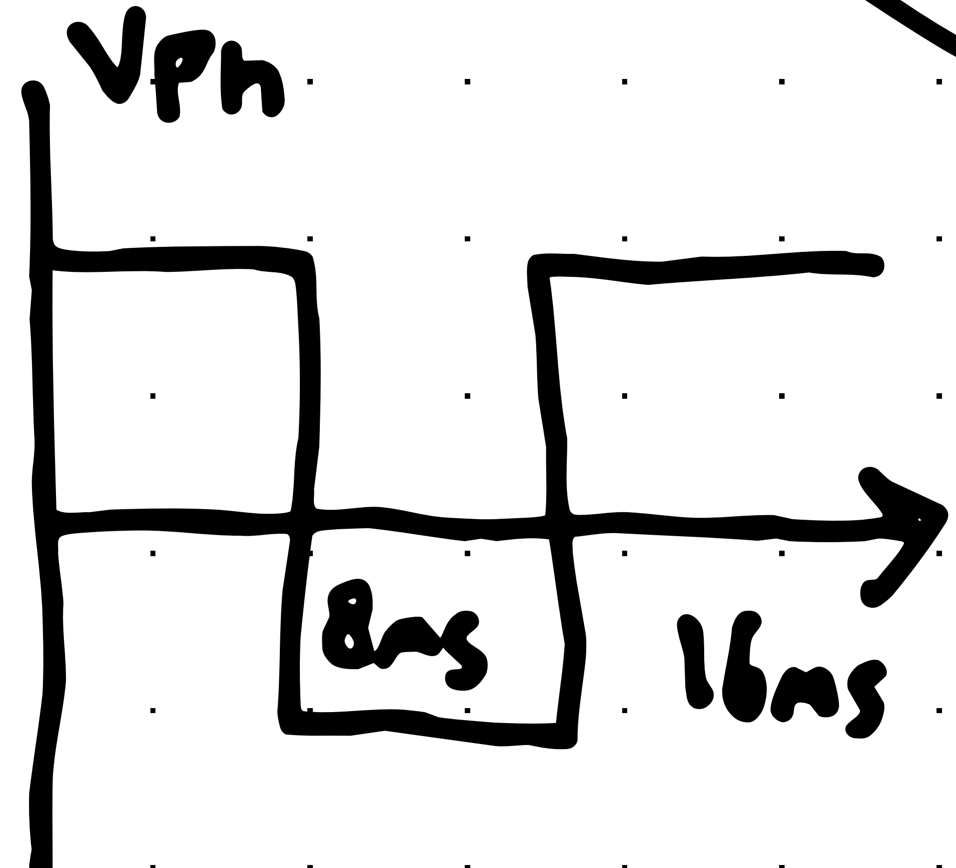
$$\frac{1}{L_{eq}} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} \dots$$



Example 1

(Conversion of photovoltaic to AC)





$-V_{ph}$ $\quad V_{ph} = 24V$

Find the current equations and draw the relation between i and t

$$i_{(t)} = \frac{1}{L}\int_{t_0}^{t} V_{(t)}\,dt + i_{(t_0)}$$

Solution

$$v_0 = \begin{cases} 24 & 0 \le t \le 8ms \\ -24 & 8 < t < 16ms \end{cases}$$

$$= \frac{1}{2}\int_0^t 24\,dt + i_0 = \frac{1}{2}(24)t\Big|_0^t + (-48mA) =$$

$$\boxed{i_{(t)} = 12t - 48mA \qquad 0 < t \le 8ms}$$

For $8 < t \leq 16ms$ $V_0 = -24v$

$$i_{(t)} = \frac{1}{L} \int_{t_0}^{t} V_{(t)} \, dt + i_{(t_0)}$$

-24 $t_0 = 8ms$

$$I_{(t)} = \frac{1}{2} = \int_{8ms}^{t} -24 \, dt + 48mA$$

(You'll Need this from the other equation!)

$$= \frac{1}{2} [-12t + 48mA]$$