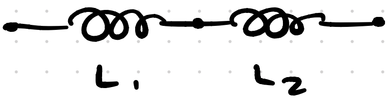
INDUCTORS IN SERIES & PARALLEL*

- TLDR : INDUCTORS COMBINE IN SERIES AND PARALLEL JUST LIKE RESISTORS:

SERIES



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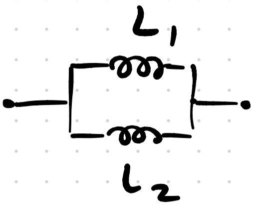
$$L = L_1 + L_2$$

PARALLEL



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$$L = \left(\frac{1}{L_1} + \frac{1}{L_2}\right)^{-1}$$

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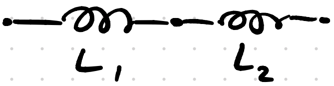
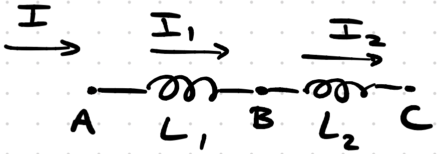
* THE INDUCTORS ARE ASSUMED TO BE FAR ENOUGH APART THAT THEIR MUTUAL INDUCTANCE (M) IS NEGLIGIBLE.

ARGUMENT:

Series:



- IF WE SEND IN A CURRENT CHANGING @ A RATE $\frac{\Delta I}{\Delta t}$, WHAT IS THE VOLTAGE DROP OVER THE SERIES COMBINATION?



- KCL: $I_1 = I_2 = I$

$$\longrightarrow \boxed{\frac{\Delta I_1}{\Delta t} = \frac{\Delta I_2}{\Delta t} = \frac{\Delta I}{\Delta t}} \quad Ⓐ$$

- KVL: $V_{A \to C} = V_{A \to B \to C}$

$$\longrightarrow V = V_1 + V_2$$

$$= L_1 \frac{\Delta I_1}{\Delta t} + L_2 \frac{\Delta I_2}{\Delta t}$$

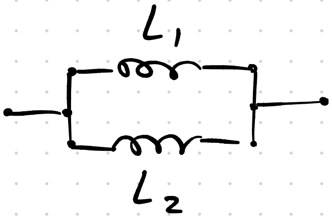
(TRUE FOR ANY INDUCTOR)

$$= L_1 \frac{\Delta I}{\Delta t} + L_2 \frac{\Delta I}{\Delta t} \quad [\text{VIA Ⓐ}]$$

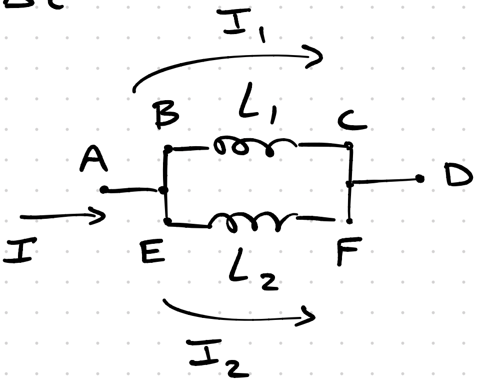
$$= (L_1 + L_2) \frac{\Delta I}{\Delta t}$$

$$\longrightarrow \underline{L = L_1 + L_2}$$

PARALLEL



- IF WE MEASURE A VOLTAGE V ACROSS THE PARALLEL COMBO, WHAT CAN WE DEDUCE ABOUT THE RATE OF CHANGE $\frac{\Delta I}{\Delta t}$ OF CURRENT THRU THE COMBO?



- KVL:

$$V_{A\to B} = V_{A\to C\to D\to B}$$
$$= V_{A\to E\to F\to B}$$

$$\longrightarrow V = V_1 = V_2$$
$$= L_1 \frac{\Delta I_1}{\Delta t} = L_2 \frac{\Delta I_2}{\Delta t} \longrightarrow \boxed{\begin{aligned} \frac{\Delta I_1}{\Delta t} &= V/L_1 \\ \frac{\Delta I_2}{\Delta t} &= V/L_2 \end{aligned}}$$

- KCL:

$$I = I_1 + I_2$$

$$\longrightarrow \frac{\Delta I}{\Delta t} = \frac{\Delta I_1}{\Delta t} + \frac{\Delta I_2}{\Delta t} = \frac{V}{L_1} + \frac{V}{L_2} = V\left(\frac{1}{L_1} + \frac{1}{L_2}\right)$$

$$\longrightarrow V = \left(\frac{1}{L_1} + \frac{1}{L_2}\right)^{-1} \frac{\Delta I}{\Delta t} \longrightarrow \underline{L = \left(\frac{1}{L_1} + \frac{1}{L_2}\right)^{-1}}$$

CONCEPTUALLY:

SERIES

- THE SAME CURRENT GOES THRU EACH, SO EMFS ADD.

PARALLEL

- CURRENT SPLITS, SO EMF ACROSS EITHER IS LESS THAN IF ENTIRE CURRENT WENT THRU ONE OR THE OTHER.