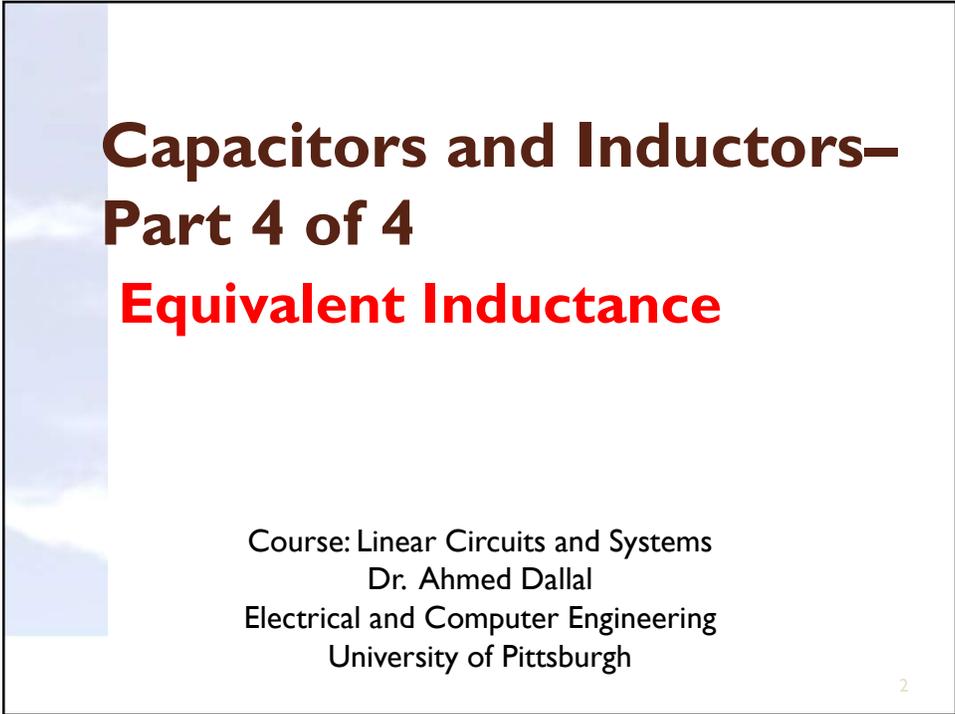


- Linear Circuits and Systems



Capacitors and Inductors— Part 4 of 4

Equivalent Inductance

Course: Linear Circuits and Systems
Dr. Ahmed Dallal
Electrical and Computer Engineering
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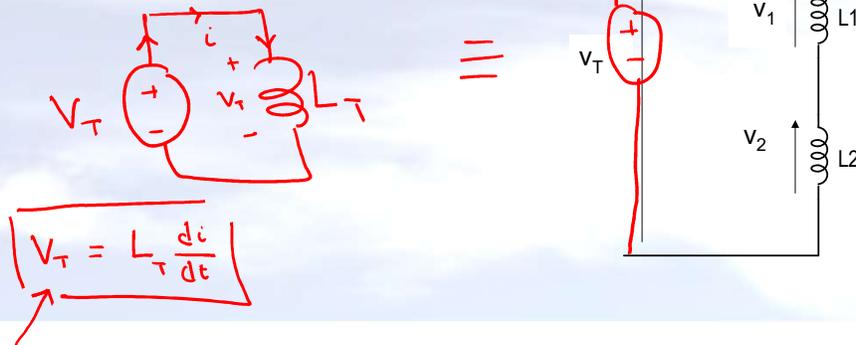
Reminder: Voltage-current relationship

Inductor is a dynamic element whose voltage current relationship is given as:

$$\longrightarrow v = L \frac{di}{dt} \quad \longrightarrow \quad i = \frac{1}{L} \int v dt$$

Inductors in series

- What is the equivalent inductance of two inductors in series?



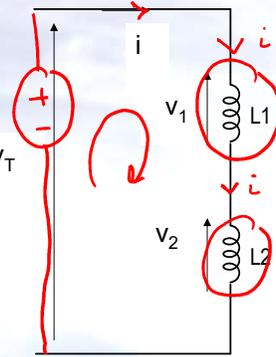
Inductors in series

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

$$\rightarrow v_T = v_1 + v_2$$

$$\boxed{L_T \frac{di}{dt}} = L_1 \frac{di}{dt} + L_2 \frac{di}{dt} = \underline{(L_1 + L_2)} \frac{di}{dt} v_T$$

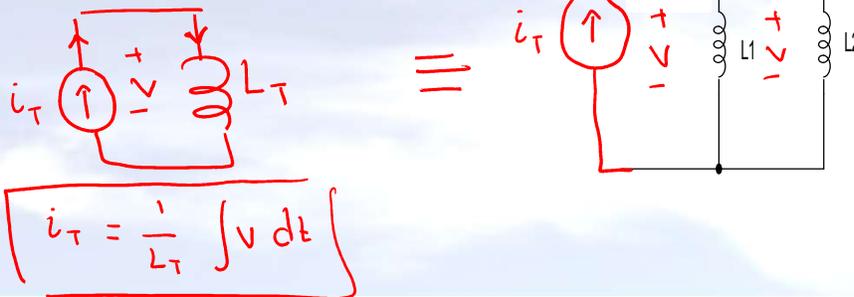
$$\rightarrow L_T = \underline{L_1 + L_2}$$



In general $L_T = \underline{L_1 + L_2 + \dots + L_n}$

Inductors in parallel

- What is the equivalent inductance of two inductors in parallel?

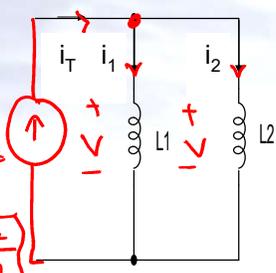


Inductors in parallel

$$i = \frac{1}{L} \int v dt$$

$$i_T = i_1 + i_2$$

$$\frac{1}{L_T} \int v dt = \frac{1}{L_1} \int v dt + \frac{1}{L_2} \int v dt = \left(\frac{1}{L_1} + \frac{1}{L_2} \right) \int v dt$$

$$\frac{1}{L_T} = \frac{1}{L_1} + \frac{1}{L_2} \Rightarrow L_T = \frac{L_1 L_2}{L_1 + L_2}$$


In general

$$\frac{1}{L_T} = \frac{1}{L_1} + \frac{1}{L_2} + \dots + \frac{1}{L_n}$$

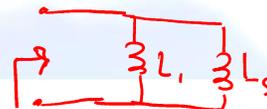
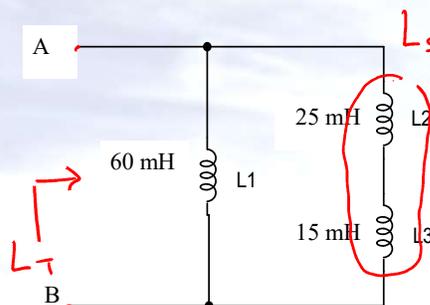
Example

Effective inductance between A and B is:

$$\rightarrow L_s = L_2 + L_3 = 25 + 15 = 40 \text{ mH}$$

$$L_t = \frac{(L_1 \times L_s)}{(L_1 + L_s)}$$

$$= \frac{(60 \times 40)}{(60 + 40)} = 24 \text{ mH}$$



Conclusion

Series $L_T = L_1 + L_2 + \dots$

Parallel : $\frac{1}{L_T} = \frac{1}{L_1} + \frac{1}{L_2} + \dots \leftarrow$

2 inductors
in parallel $L_T = \frac{L_1 L_2}{L_1 + L_2}$

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THE END