Linear Circuits and Systems

Capacitors and Inductors– Part 3 of 4

Inductors

Course: Linear Circuits and Systems
Dr. Ahmed Dallal
Electrical and Computer Engineering
University of Pittsburgh

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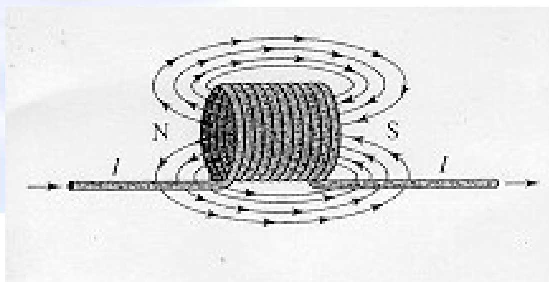
Inductance

- Electric current passing through a conductor will produce magnetic field or flux around it.
- If the wire conductor is wound around a core, magnetic filed /flux will resemble like permanent magnetic bar.



Inductance

- Inductance quantifies inductor' ability to store energy in a magnetic field when electrical current flows through it and is measured in Henry (H)
- The inductance of the coil, L, depends on permeability of core , μ, and physical construction (length l, area of cross-section A, and number of turn N)

$$L = \frac{\mu A N}{l}$$

Inductance

- Magnitude of flux produced depends on magnitude of current , I, and the inductance of the coil/inductor.

$$\phi = L\, I$$

Flux varies with time

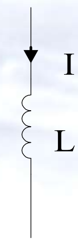
- If the current in the inductor is varied with time (t), flux ϕ will also varied with time. Variation of flux in the windings will induce voltage.

$$d\phi = L\, dI$$

Energy stored in inductor:

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

Power $p = iv = iL\frac{di}{dt}$



For duration of dt sec

$$dw = pdt = Li\frac{di}{dt}dt \quad = Lidi$$

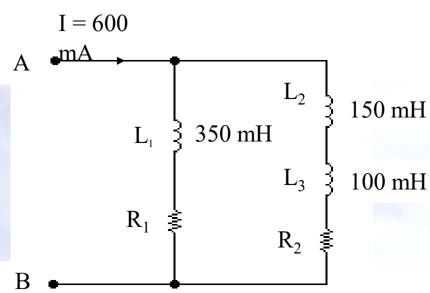
For current changes between i = 0 to i = I

$$W = L\int_0^I idi \quad = L\left[\frac{i^2}{2}\right]_0^I \quad = \frac{1}{2}LI^2$$

Inductor stores energy in the form of magnetic fields.

Example

By supplying a total of constant current at 600 mA, L_1 is found to store an energy of 28 mJ in its magnetic field. Calculate the total energy stored in L_2?



$W_1 = ½L_1I_1^2$

$I_1 = \sqrt{(2W_1/L_1)} = \sqrt{[(2 \times 28 \times 10^{-3})/(350 \times 10^{-3})]} = 400$ mA

$I_2 = I – I_1$ (Kirchoff's current law) = 600 – 400 = 200 mA

$W_2 = ½L_2I_2^2 = ½ \times 150 \times 10^{-3} \times (200 \times 10^{-3})^2 = 3$ mJ

Conclusion

Acknowledgement

This material is based upon work partially supported by the National Science Foundation under Grant# 2335802. Any opinions, findings, and conclusions, or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

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