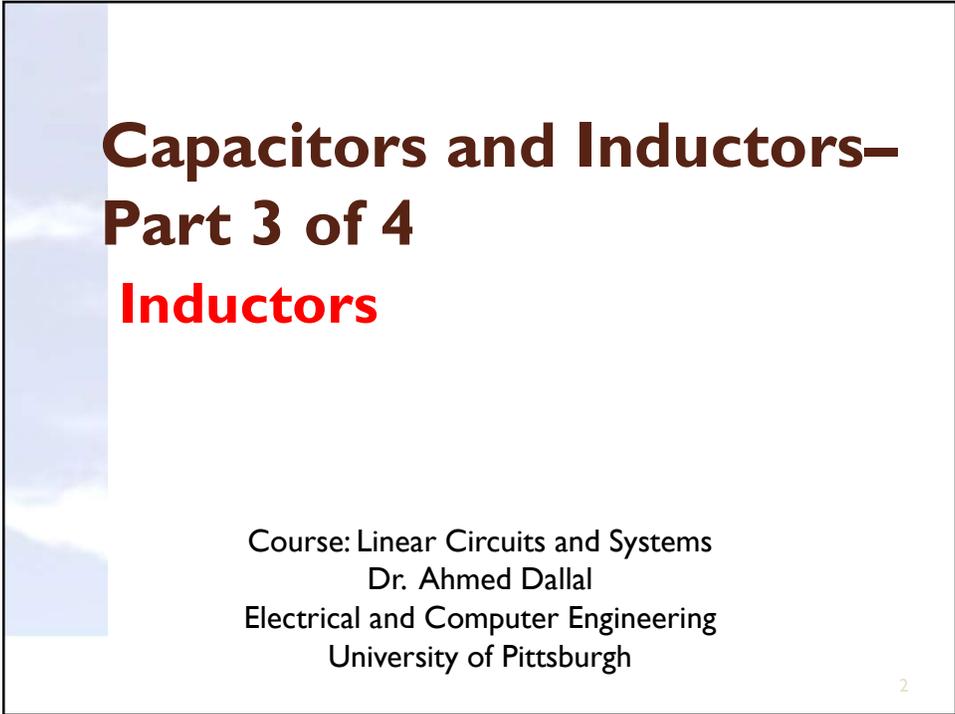


- Linear Circuits and Systems



Capacitors and Inductors— Part 3 of 4

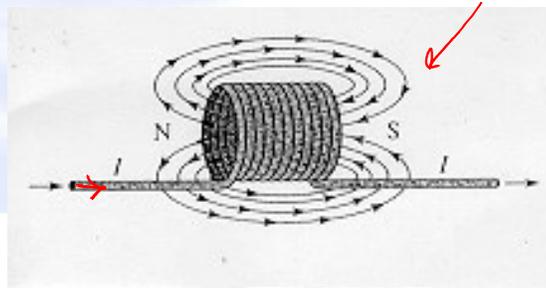
Inductors

Course: Linear Circuits and Systems
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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 field /flux will resemble like permanent magnetic bar.



Inductance

- Inductance quantifies inductor's 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)

$$\rightarrow L = \frac{\mu AN}{l}$$

Inductance

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

$$\boxed{\phi = LI}$$


A hand-drawn diagram of an inductor, represented by a series of loops, with an arrow indicating current I flowing into it and the letter L below it representing inductance.

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.

$$\boxed{\frac{d\phi}{dt} = L \frac{dI}{dt}}$$

$$I = \frac{1}{L} \int v dt \quad \leftarrow \quad V = L \frac{dI}{dt}$$

Energy stored in inductor:

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

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

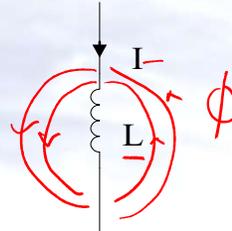
For duration of dt sec

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

For current changes between $i = 0$ to $i = I$

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

Inductor stores energy in the form of magnetic fields.

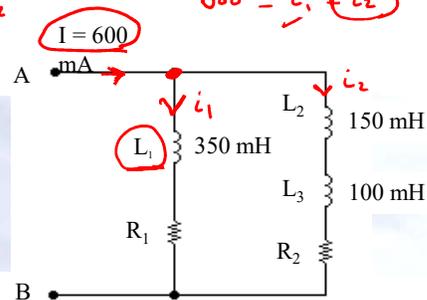


Example

$$W_2 = \frac{1}{2} L_2 i_2^2$$

$$600 = i_1 + i_2$$

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 ?



$$\rightarrow W_1 = \frac{1}{2} L_1 i_1^2 \leftarrow$$

$$\rightarrow i_1 = \sqrt{\frac{2W_1}{L_1}} = \sqrt{\frac{2 \times 28 \times 10^{-3}}{350 \times 10^{-3}}} = 400 \text{ mA}$$

$$\rightarrow i_2 = I - i_1 \text{ (Kirchoff's current law)} = 600 - 400 = 200 \text{ mA}$$

$$W_2 = \frac{1}{2} L_2 i_2^2 = \frac{1}{2} \times 150 \times 10^{-3} \times (200 \times 10^{-3})^2 = 3 \text{ mJ}$$

Conclusion

$$\Phi = L i$$

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

$$W = \frac{1}{2} L i^2$$



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THE END