

Inductance

- _____ is process where _____ is induced by changing magnetic _____

Mutual Inductance

- Mutual inductance is _____ of one _____ to _____ like a transformer
 - Change in _____ usually by changing _____ since they are solid pieces
 - Can be reduced by _____ coils

$$emf_2 = -M \frac{\Delta I_1}{\Delta t}$$

- Where M = mutual inductance, (Unit: H (henry)), I = current, t = time, emf = induced emf

Self-inductance

- A changing _____ in a coil causes a changing _____ in _____ of coil
- Changing B-field causes _____ emf in the _____ coil
- Resists _____ in _____ in the device

$$emf = -L \frac{\Delta I}{\Delta t}$$

- Where L = self-inductance, (Unit: H (henry))

- Self-Inductance

$$L = N \frac{\Delta \Phi}{\Delta I}$$

- For _____

$$L = \frac{\mu_0 N^2 A}{\ell}$$

- Where L = inductance, $\mu_0 = 4\pi \times 10^{-7}$ Tm/A, N = number of loops, A = cross-sectional area, ℓ = length of solenoid

The 4.00 A current through a 7.50 mH inductor is switched off in 8.33 ms. What is the emf induced opposing this?

Energy stored in an inductor

$$E_{ind} = \frac{1}{2} LI^2$$

- Where, E_{ind} = energy, L = inductance, I = current

Homework

1. How would you place two identical flat coils in contact so that they had the greatest mutual inductance? The least?
2. How would you shape a given length of wire to give it the greatest self-inductance? The least?
3. Two coils are placed close together in a physics lab to demonstrate Faraday's law of induction. A current of 5.00 A in one is switched off in 1.00 ms, inducing a 9.00 V emf in the other. What is their mutual inductance? (OpenStax 23.55) **1.80 mH**
4. If two coils placed next to one another have a mutual inductance of 5.00 mH, what voltage is induced in one when the 2.00 A current in the other is switched off in 30.0 ms? (OpenStax 23.56) **0.333 V**
5. A device is turned on and 3.00 A flows through it 0.100 ms later. What is the self-inductance of the device if an induced 150 V emf opposes this? (OpenStax 23.58) **5.00 mH**
6. Camera flashes charge a capacitor to high voltage by switching the current through an inductor on and off rapidly. In what time must the 0.100 A current through a 2.00 mH inductor be switched on or off to induce a 500 V emf? (OpenStax 23.60) **4.00×10^{-7} s**
7. A large research solenoid has a self-inductance of 25.0 H. (a) What induced emf opposes shutting it off when 100 A of current through it is switched off in 80.0 ms? (b) How much energy is stored in the inductor at full current? (c) At what rate in watts must energy be dissipated to switch the current off in 80.0 ms? (d) In view of the answer to the last part, is it surprising that shutting it down this quickly is difficult? (OpenStax 23.61) **31.3 kV, 1.25×10^5 J, 1.56 MW, no**
8. (a) Calculate the self-inductance of a 50.0 cm long, 10.0 cm diameter solenoid having 1000 loops. (b) How much energy is stored in this inductor when 20.0 A of current flows through it? (c) How fast can it be turned off if the induced emf cannot exceed 3.00 V? (OpenStax 23.62) **19.7 mH, 3.95 J, 0.132 s**
9. A precision laboratory resistor is made of a coil of wire 1.50 cm in diameter and 4.00 cm long, and it has 500 turns. (a) What is its self-inductance? (b) What average emf is induced if the 12.0 A current through it is turned on in 5.00 ms (one-fourth of a cycle for 50 Hz AC)? (c) What is its inductance if it is shortened to half its length and counterwound (two layers of 250 turns in opposite directions)? (OpenStax 23.63) **1.39 mH, -3.33 V, 0**
10. The heating coils in a hair dryer are 0.800 cm in diameter, have a combined length of 1.00 m, and a total of 400 turns. (a) What is their total self-inductance assuming they act like a single solenoid? (b) How much energy is stored in them when 6.00 A flows? (c) What average emf opposes shutting them off if this is done in 5.00 ms (one-fourth of a cycle for 50 Hz AC)? (OpenStax 23.64) **1.01×10^{-5} H, 1.82×10^{-4} J, 12.12 mV**