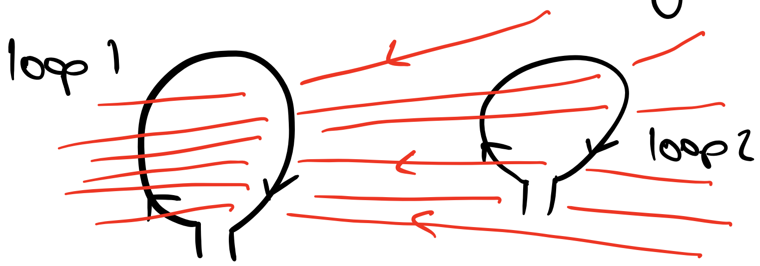
Mutual Inductance

If we have two coils near each other then a current through one can induce flux through the other.



For a given current in loop 1, I_1, we get a certain flux through loop 2, Φ_2. We define the constant of proportionality M_{12} to be $\Phi_2 = M_{12} I_1$. Also $\Phi_1 = M_{21} I_2$.

It happens that $M = M_{12} = M_{21}$. No proof shown. We call this mutual inductance. Units - henry.

Course Summary

Lorentz: $$\underline{F} = q(\underline{E} + \underline{v} \times \underline{B})$$

Force on Wire: $$\underline{F} = \int_0^L nqv \, d\underline{l} \times \underline{B}$$

Magnetic Dipole Moment: $$\underline{\mu} = I\underline{A}$$

Torque: $$\underline{\Gamma} = \underline{\mu} \times \underline{B}$$

Biot-Savart: $$d\underline{B} = \frac{\mu_0}{4\pi} I \frac{d\underline{l} \times \hat{r}}{|\underline{r}|^2}$$

Maxwell's Equations

$$\oiint \underline{E} \cdot d\underline{S} = \frac{Q_{enc}}{\epsilon_0} \qquad \nabla \cdot \underline{E} = \frac{\rho}{\epsilon_0}$$

$$\oiint \underline{B} \cdot d\underline{S} = 0 \qquad \nabla \cdot \underline{B} = 0$$

$$\oint \underline{E} \cdot d\underline{l} = -\iint \frac{\partial \underline{B}}{\partial t} \cdot d\underline{S} \qquad \nabla \times \underline{E} = -\frac{\partial \underline{B}}{\partial t}$$

$$\oint \underline{B} \cdot d\underline{l} = \mu_0 \iint \left(\underline{j} \cdot d\underline{S} + \epsilon_0 \frac{\partial \underline{E}}{\partial t} \cdot d\underline{S} \right) \qquad \nabla \times \underline{B} = \mu_0 I_{enc} + \mu_0 \epsilon_0 \frac{\partial E}{\partial t}$$