Mutual Induction

Φ_{12}: magnetic flux through each loop of coil 2 caused by current I_1 through coil 1

Φ_{21}: magnetic flux through each loop of coil 1 caused by current I_2 through coil 2

$$M_{12} = \frac{N_2 \Phi_{12}}{I_1} \quad \text{(mutual inductance)}$$

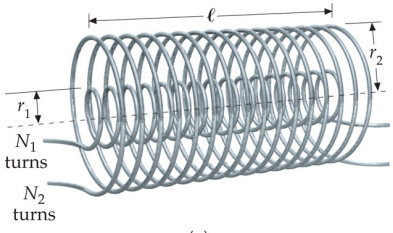
$$M_{21} = \frac{N_1 \Phi_{21}}{I_2} \quad \text{(mutual inductance)}$$

$$\mathcal{E}_2 = -M_{12} \frac{dI_1}{dt} \quad \text{(emf induced in coil 2 due to current in coil 1)}$$

$$\mathcal{E}_1 = -M_{21} \frac{dI_2}{dt} \quad \text{(emf induced in coil 2 due to current in coil 1)}$$

$$M_{12} = M_{21} = M \quad \text{(symmetry property)}$$

$$M = \mu_0 \frac{N_1}{\ell} \frac{N_2}{\ell} (\ell \pi r_1^2) \quad \text{(present configuration)}$$



(a)