MUTUAL INDUCTANCE

Often the magnetic flux through a circuit can vary due to the current changing in a nearby circuit. The EMF induced in a circuit this way is called ***mutual inductance*** because it is due to the interaction between the two coils.

Consider two closely wound coils of wire as shown below:

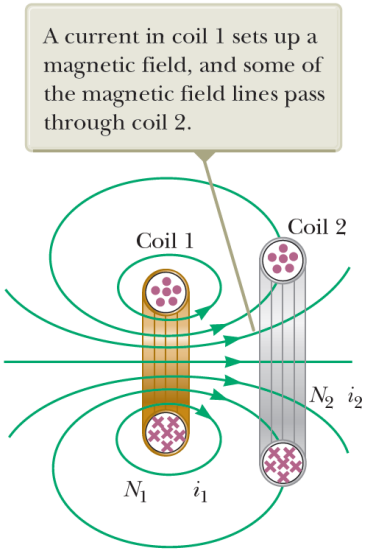

Figure 32.8 A cross-sectional view of two adjacent coils.

The flux through coil 2 is proportional to the current i_1 in coil 1:

$$N_2\Phi_B \propto i_1$$

(1) $N_2\Phi_{21} = M_{21}i_1$

$$\boxed{M_{21} = \frac{N_2\Phi_{21}}{i_1}}$$ Mutual Inductance

Differentiating Eq. (1):

$$N_2\frac{d\Phi_{21}}{dt} = M_{21}\frac{di_1}{dt}$$

$$\boxed{\varepsilon_2 = -M_{21}\frac{di_1}{dt}}$$ Induced EMF in coil 2 due current changing in coil 1

If we now consider the current i_2 in the second oil changing with time:

$$M_{12} = \frac{N_1 \Phi_{12}}{i_2}$$

$$\varepsilon_1 = -M_{12} \frac{di_2}{dt}$$

Although, not obvious:

$$M_{21} = M_{12}$$

The mutual inductance depends on the physical arrangement of both coils regardless of which one is causing the flux to change.