# 7.1: Background Material

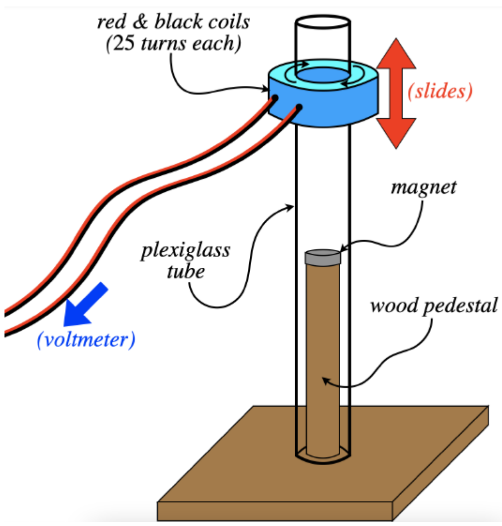
## Text References

- Faraday's Law
- Magnetic Field of a Loop

## Faraday's Law with a Coil and a Magnet

In the first part of the lab, we slide a coil of wire past a permanent magnet (whose field is oriented perpendicular to the surface of the coil). The magnetic field is not uniform, which means that the strength of the flux of the field through the coil changes as the coil gets closer to or more distant from the magnet. Thus moving the coil in such a situation should induce an emf in the coil. This coil can then act like a battery, "pushing" current out from whichever coil lead becomes the higher potential (determined by Lenz's law).

**Figure 7.1.1 – Experimental Apparatus, Part 1**

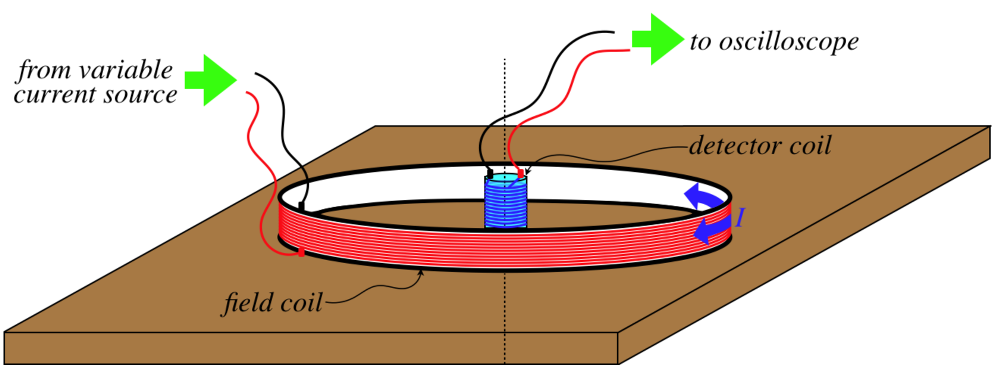



## Faraday's Law with Two Coils

If we arrange two conducting coils coaxially, and run a current through one of them, it will produce a magnetic field that passes through the other. If we vary this current over time, then the magnetic flux through the second coil will change with time, inducing an emf in the second coil according to Faraday's law. This lab explores this very scenario. A computer generates a sinusoidal current through one coil, and the second coil is connected to an oscilloscope that measures the emf induced. With the current varying periodically, the flux (and therefore the emf) varies periodically as well, making the oscilloscope the perfect device to measure the time dependence of the emf.

Here is the experimental setup:

**Figure 7.1.2 – Experimental Apparatus, Part 2**



The analysis of this experiment (i.e. "solving the physics problem") consists of three steps:

1. Determine the magnetic field $B(t)$ in the region of space where the detector coil is located, in terms of the current $I(t)$ flowing through the field coil. In this case the "region of space" is the center of the field coil, and the radius of the detector coil is sufficiently small that the field is reasonably uniform across its area, simplifying the next step...
2. Compute the flux of magnetic field $\Phi(t)$ through the detector coil.
3. Derive the induced emf $\mathcal{E}(t)$ in the detector coil from Faraday's law.