

Induced emk

$$\mathcal{E} = \oint (\mathbf{E} + \mathbf{v} \times \mathbf{B}) \cdot d\mathbf{l}$$

$$\mathcal{E} = -\frac{d\Phi}{dt}$$

$$\mathcal{E} = -\frac{d\Lambda}{dt} \quad (\text{coil with multiple turns})$$

Maxwell's equations

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$$

$$\nabla \times \mathbf{H} = \mathbf{J} + \frac{\partial \mathbf{D}}{\partial t}$$

$$\nabla \cdot \mathbf{D} = \rho$$

$$\nabla \cdot \mathbf{B} = 0$$

The Conservation Equation

$$\nabla \cdot \mathbf{J} + \frac{\partial \rho}{\partial t} = 0$$

Potentials

$$V(\mathbf{r}, t) = \frac{1}{4\pi\epsilon_0} \int \frac{\rho(\mathbf{r}', t - \frac{R}{c})}{R} dv' = \frac{1}{4\pi\epsilon_0} \int \frac{\rho_{ret}}{R} dv'$$

$$\mathbf{A}(\mathbf{r}, t) = \frac{\mu_0}{4\pi} \int \frac{\mathbf{J}(\mathbf{r}', t - \frac{R}{c})}{R} dv' = \frac{\mu_0}{4\pi} \int \frac{\mathbf{J}_{ret}}{R} dv'$$

$$\mathbf{B} = \nabla \times \mathbf{A}$$

$$\mathbf{E} = -\nabla V - \frac{\partial \mathbf{A}}{\partial t}$$

Magnetic Flow Density

$$\mathbf{B}(\mathbf{r}, t) = \frac{\mu_0}{4\pi} \int \frac{\mathbf{J}_{ret} \times \mathbf{e}_R}{R^2} dv' + \frac{\mu_0}{4\pi c} \int \frac{\mathbf{J}'_{ret} \times \mathbf{e}_R}{R} dv'$$

Filamentous Antenna

$$\mathbf{B} = \frac{\mu_0}{4\pi} \int \frac{i(z, t - R/c) d\mathbf{l} \times \mathbf{e}_R}{R^2} + \frac{\mu_0}{4\pi c} \int \frac{i(z, t - R/c) d\mathbf{l} \times \mathbf{e}_R}{R}$$

Oscillating Electric Dipole

$$\mathbf{B} = \frac{\mu_0}{4\pi} \frac{\mathbf{p}'(t - R/c) \times \mathbf{e}_R}{R^2} + \frac{\mu_0}{4\pi c} \frac{\mathbf{p}''(t - R/c) \times \mathbf{e}_R}{R}$$

Oscillating Magnetic Dipole

$$\mathbf{B} = -\frac{\mu_0}{4\pi} \frac{\mathbf{m}'(t - R/c) \times \mathbf{e}_R}{R^2} - \frac{\mu_0}{4\pi c} \frac{\mathbf{m}''(t - R/c) \times \mathbf{e}_R}{R}$$

Pointing's Vector

$$\mathbf{P}_S(\mathbf{r}, t) = \mathbf{E}(\mathbf{r}, t) \times \mathbf{H}(\mathbf{r}, t)$$