Massachusetts Institute of Technology
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Currents, Magnetism and Relativity Formulae for Quiz #2

Ohm's Law: $\vec{J} = \sigma \vec{E}, V = IR$

Magnetic charges: $\vec{\nabla} \cdot \vec{B} = 0$

Biot-Savart's Law: $d\vec{B} = \frac{Id\vec{l} \times \hat{r}}{cr^2}$

Ampere's Law: $\oint_C \vec{B} \cdot d\vec{l} = \frac{4\pi}{c} I_{encl} = \frac{4\pi}{c} \int_S \vec{J} \cdot d\vec{a}$, $\vec{\nabla} \times \vec{B} = \frac{4\pi}{c} \vec{J}$

Faraday's Law: $\mathcal{E} = \oint_C \vec{E} \cdot d\vec{l} = -\frac{1}{c} \frac{d\Phi}{dt}$, $\vec{\nabla} \times \vec{E} = -\frac{1}{c} \frac{\partial \vec{B}}{\partial t}$

Mutual Inductance: $M_{12} = M_{21} = \frac{\Phi_{21}}{cI_1}, \mathcal{E}_{21} = -M_{21} \frac{dI_1}{dt}$

Self Inductance: $L = \frac{\Phi}{cI}, \mathcal{E} = -L \frac{dI}{dt}$

Magnetic Field Energy Density: $\frac{dU_B}{dv} = u_B = \frac{B^2}{8\pi}$

Relativistic Transformations:
All primed quantities measured in the frame F' which is moving in the positive x direction with velocity $u = \beta c$ as seen from F:

$$x' = \gamma(x - \beta ct) \quad p' = \gamma(p - \beta \frac{E}{c})$$
$$t' = \gamma(t - \beta \frac{x}{c}) \quad E' = \gamma(E - \beta cp)$$

$E'_x = E_x$	$E'_y = \gamma(E_y - \beta B_z)$	$E'_z = \gamma(E_z + \beta B_y)$
$B'_x = B_x$	$B'_y = \gamma(B_y + \beta E_z)$	$B'_z = \gamma(B_z - \beta E_y)$

Relativistic Mass, Energy: $m = \gamma m_0, E = mc^2$

Relativistic Doppler Effect: $f_o = [\frac{1-(u/c)}{1+(u/c)}]^{1/2} f_s$, u along the line joining o and s and u positive when s recedes from o.