Massachusetts Institute of Technology
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Circuits and Waves Formulae for Quiz #3

Impedance: $V = ZI, Z_R = R, Z_C = -\frac{i}{\omega C}, Z_L = i\omega L$

Admittance: $Y = 1/Z$

Complex notation: $e^{i\theta} = cos\theta + isin\theta, z = \alpha + ib = |z|e^{i\theta}, |z| = \sqrt{\alpha^2 + b^2}, tan\theta = b/\alpha$

Displacement: current $I_d = \frac{1}{4\pi}\frac{d\Phi_E}{dt}$, density $\vec{J}_D = \frac{1}{4\pi}\frac{\partial \vec{E}}{\partial t}$

Maxwell's equations: $\vec{\nabla} \cdot \vec{E} = 4\pi\rho, \vec{\nabla} \cdot \vec{B} = 0, \vec{\nabla} \times \vec{E} = -\frac{1}{c}\frac{\partial \vec{B}}{\partial t}, \vec{\nabla} \times \vec{B} = \frac{4\pi}{c}\vec{J} + \frac{1}{c}\frac{\partial \vec{E}}{\partial t}$

Electromagnetic waves: $\vec{E} = \vec{E}_0 f(\vec{k}\vec{r} - \omega t), \vec{B} = \vec{B}_0 f(\vec{k}\vec{r} - \omega t), k = 2\pi/\lambda, \omega = 2\pi/T, c = \omega/k, \hat{k} = \vec{E} \times \vec{B}$

Wave "mechanics": Poynting vector $\vec{S} = \frac{c}{4\pi}\vec{E} \times \vec{B}$, momentum density $\vec{g} = \frac{1}{4\pi c}\vec{E} \times \vec{B}$, energy density $u_T = \frac{E^2}{8\pi} + \frac{B^2}{8\pi}$, radiation pressure $\frac{F}{A} = u_T$

Waveguides: $\frac{\partial I}{\partial x} = -C_0\frac{\partial V}{\partial t}, \frac{\partial V}{\partial x} = -L_0\frac{\partial I}{\partial t}, \frac{\partial^2 I}{\partial^2 x} - L_0 C_0 \frac{\partial^2 I}{\partial^2 t} = 0, \frac{\partial^2 V}{\partial^2 x} - L_0 C_0 \frac{\partial^2 V}{\partial^2 t} = 0$