

Equation sheet

Integral Theorems:

$$\text{Gauss' Theorem: } \int_V \nabla \cdot \mathbf{A} \, dv = \oint_S \mathbf{A} \cdot d\mathbf{a}$$

$$\text{Stokes' Theorem: } \int_S (\nabla \times \mathbf{A}) \cdot d\mathbf{a} = \oint_{\Gamma} \mathbf{A} \cdot d\mathbf{l}$$

$$\text{Continuity equation: } \nabla \cdot \mathbf{J} + \frac{\partial \rho}{\partial t} = 0$$

Maxwell equations (integral):

$$\begin{aligned} \int \mathbf{D} \cdot d\mathbf{a} &= 4\pi Q & \int \mathbf{B} \cdot d\mathbf{a} &= 0 \\ \oint_{\Gamma} \mathbf{E} \cdot d\mathbf{l} &= -\frac{1}{c} \frac{\partial}{\partial t} \int_S \mathbf{B} \cdot d\mathbf{a} & \oint_{\Gamma} \mathbf{H} \cdot d\mathbf{l} &= \frac{4\pi}{c} \int_S \mathbf{J} \cdot d\mathbf{a} + \frac{1}{c} \frac{d}{dt} \int_S \mathbf{D} \cdot d\mathbf{a} \end{aligned}$$

Maxwell equations (differential):

$$\begin{aligned} \nabla \cdot \mathbf{D} &= 4\pi \rho_f & \nabla \cdot \mathbf{B} &= 0 \\ \nabla \times \mathbf{E} &= -\frac{1}{c} \frac{\partial \mathbf{B}}{\partial t} & \nabla \times \mathbf{H} - \frac{1}{c} \frac{\partial \mathbf{D}}{\partial t} &= \frac{4\pi}{c} \mathbf{J}_f \end{aligned}$$

$$\text{Potentials: } \mathbf{B} = \nabla \times \mathbf{A} \quad \mathbf{E} = -\nabla \phi - \frac{1}{c} \frac{\partial \mathbf{A}}{\partial t}$$

$$\text{Linear materials: } \mathbf{B} = \mu \mathbf{H}, \quad \mathbf{D} = \mathbf{E} + 4\pi \mathbf{P} = \mathbf{E} + 4\pi \chi_e \mathbf{E} = \epsilon \mathbf{E} = n^2 \mathbf{E}$$

$$\text{Energy density: } U = U_E + U_B = \frac{1}{4\pi} (\mathbf{E} \cdot \mathbf{D} + \mathbf{B} \cdot \mathbf{H})$$

$$\text{Time avg w/complex fields: } \langle U \rangle = \frac{1}{8\pi} (\mathbf{E} \cdot \mathbf{D}^* + \mathbf{B} \cdot \mathbf{H}^*)$$

$$\text{Poynting vector: } \mathbf{S} = \frac{c}{4\pi} \mathbf{E} \times \mathbf{H} \quad \text{Time avg using complex: } \langle \mathbf{S} \rangle = \frac{c}{8\pi} \mathbf{E} \times \mathbf{H}^*$$

$$\text{Larmor radiation, time avg radiated power: } \langle P \rangle = \frac{2}{3} \frac{e^2}{c^3} \langle a^2 \rangle$$

$$\text{Diffraction grating equation: } m\lambda = d(\sin \theta_d - \sin \theta_i).$$