EMAG STUFF YOU NEED TO MEMORIZE (1)

- **Maxwell's equations**:

$$\nabla \cdot \mathbf{D} = \rho \quad \text{(Gauss's Law)}$$

$$\nabla \cdot \mathbf{B} = 0 \quad \text{(law of no magnetic monopoles)}$$

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t} \quad \text{(Faraday's Law)}$$

$$\nabla \times \mathbf{H} = \mathbf{J} + \frac{\partial \mathbf{D}}{\partial t} \quad \text{(Ampère's Law)}$$

- **Boundary conditions**:
  - ▷ Normal components:

$$B_{n2} = B_{n1}$$

$$D_{n2} - D_{n1} = \sigma = \text{surface charge density}$$

  - ▷ Tangential components:

$$E_{t2} = E_{t1}$$

$$H_{t2} - H_{t1} = K = \text{surface current density}$$

EMAG STUFF YOU NEED TO MEMORIZE (2)

- **Flux and current densities**:
  - ▷ Electric flux density:

$$\begin{aligned}\mathbf{D} &= \epsilon_0\mathbf{E} + \mathbf{P} \quad \text{(all materials)} \\ &= \epsilon\mathbf{E} \quad \text{(linear, isotropic materials)} \\ &= \boldsymbol{\epsilon}\mathbf{E} \quad \text{(linear, anisotropic materials)}\end{aligned}$$

  - ▷ Magnetic flux density:

$$\begin{aligned}\mathbf{B} &= \mu_0(\mathbf{H} + \mathbf{M}) \quad \text{(all materials)} \\ &= \mu\mathbf{H} \quad \text{(linear, isotropic materials)}\end{aligned}$$

  - ▷ Current density:

$$\mathbf{J} = \sigma\mathbf{E} \quad \text{(Ohm's Law)}$$

$$\nabla \cdot \mathbf{J} + \frac{\partial \rho}{\partial t} = 0 \quad \text{(conservation of electric charge)}$$

EMAG STUFF YOU NEED TO MEMORIZE (3)

- **Energy and power**:
  - ▷ Electric and magnetic energy densities (linear materials):

$$u_e = \tfrac{1}{2}\mathbf{E}\cdot\mathbf{D}, \quad u_m = \tfrac{1}{2}\mathbf{H}\cdot\mathbf{B}$$

  - ▷ Poynting vector (power density):

$$\mathbf{S} = \mathbf{E}\times\mathbf{H}$$

$$\nabla\cdot\mathbf{S} + \frac{\partial}{\partial t}(u_e + u_m) + \mathbf{J}\cdot\mathbf{E} = 0$$

  - ▷ Time average of a phasor product:
    If

$$F(t) = F_0\cos(\omega t + \phi) = \mathrm{Re}\,[\mathcal{F}] \quad \text{where} \quad \mathcal{F} = F_0\, e^{j(\omega t+\phi)}$$

then the time average of $[F(t)]^2$ is

$$\overline{[F(t)]^2} = \tfrac{1}{2}\mathcal{F}^*\mathcal{F}$$