Introduction to Electromagnetism

Overview

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Maxwell's Equations

$$\nabla \times \mathbf{E} + \frac{\partial \mathbf{B}}{\partial t} = 0$$

Faraday's law

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

Ampère's law

"Displacement current"

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

Gauss's law

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

No free magnetic monopole (?)

$$\mathbf{D} = \varepsilon \mathbf{E} = \varepsilon_o \mathbf{E} + \mathbf{P}$$

$$\mathbf{H} = \frac{\mathbf{B}}{\mu} = \frac{\mathbf{B}}{\mu_o} - \mathbf{M}$$

Constitutive relations

Findings of 19th century!!

Syllabus

- Course book:
  - Field and Wave Electromagnetics by D. K. Cheng, 2nd ed., Addison-Wesley, 1989.
- What you have learnt (I presume):
  - Engineering mathematics I & II, Circuit theory I
- What you will be learning:
  - Chap. 1. The Electromagnetic Model
  - Chap. 2. Vector Analysis
  - Chap. 3. Static Electric Fields
  - Chap. 4. Solution of Electrostatic Problems
  - Chap. 5. Steady Electric Currents
  - Chap. 6. Static Magnetic Fields

  Static

  Time-varying
  - Chap. 7. Time-Varying Fields and Maxwell's Equations
- Assessment:
  - Attendance and participation (5%), assignment (10%), practice (25%) exam 1 (20%), exam 2 (15%), exam 3 (25%)

Conclusions

- "Introduction to Electromagnetism": easy or difficult?
  - Only 4 independent equations!
  - *Even easier for static fields!*
- A lot of exciting things to do if you've made it through!
  - Electronics (Wired/Wireless communications, high-speed circuits, etc.)
  - Photonics (Optical communications, lasers, sensors, display, bio-medicine, energy, nano/meta material, etc.)
  - High-energy physics, atomic physics, particle accelerator, etc.)