Introduction to Electromagnetism

Overview

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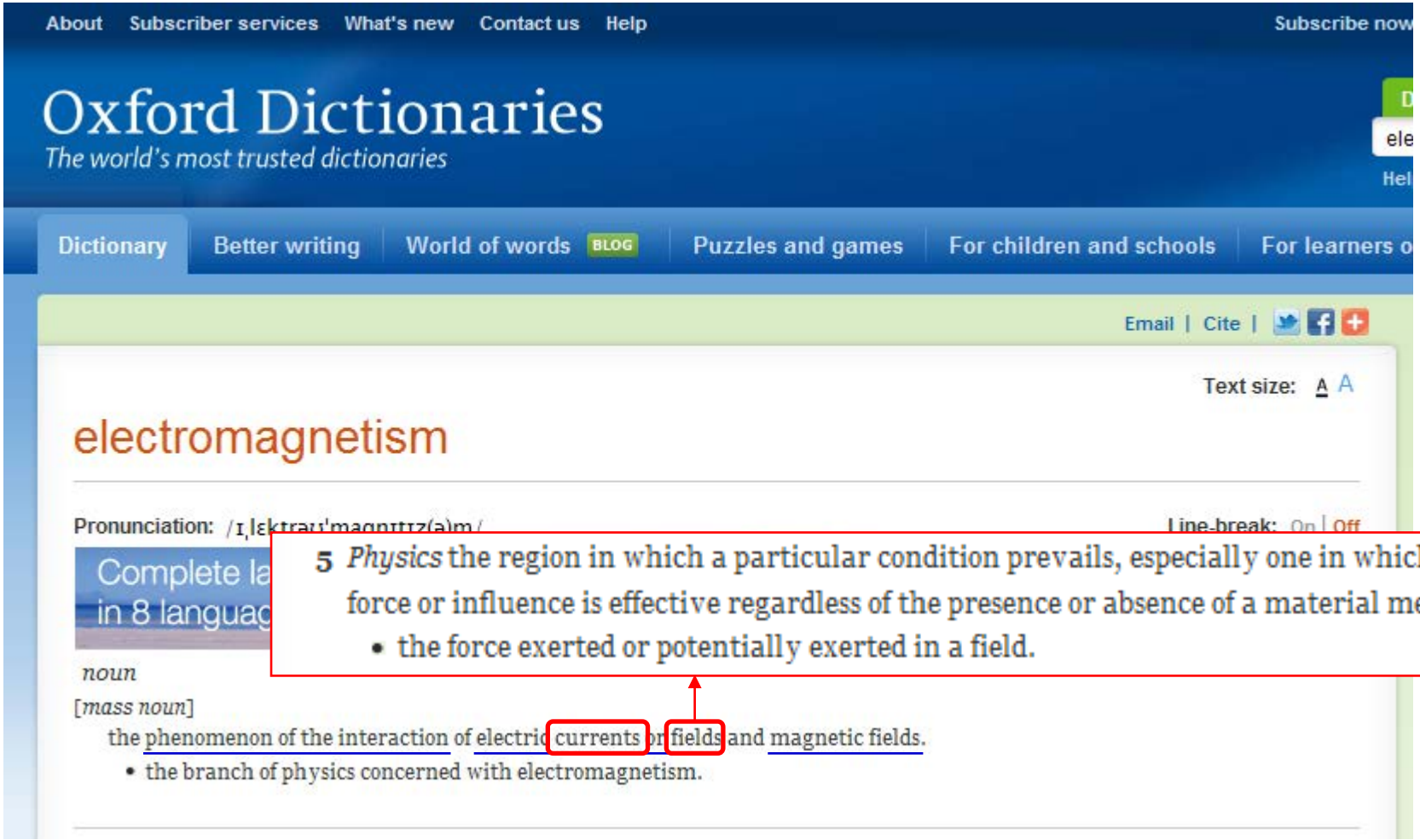
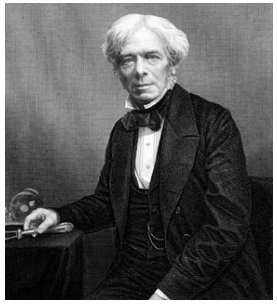
Electromagnetism



Maxwell's Equations



Michael Faraday
(1791–1867)

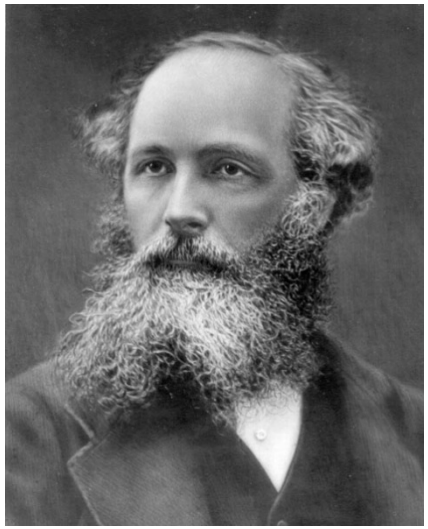
$$\nabla \times \mathbf{E} + \frac{\partial \mathbf{B}}{\partial t} = 0$$

Faraday's law

"Displacement current"

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

Ampère's law



James Clerk Maxwell
(1831–1879)

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

Gauss's law

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

No free magnetic monopole (?)

Andre Marie Ampere
(1775 - 1835)

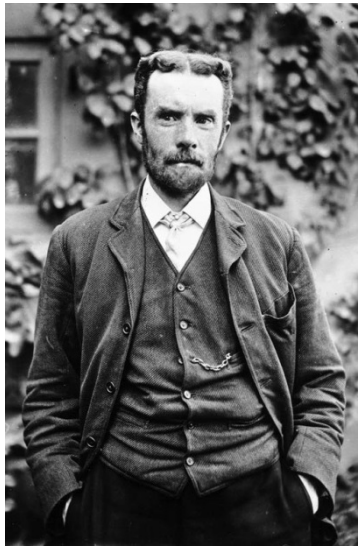
$$\mathbf{D} = \varepsilon \mathbf{E} = \varepsilon_0 \mathbf{E} + \mathbf{P}$$

$$\mathbf{H} = \frac{1}{\mu}\mathbf{B} = \frac{1}{\mu_0}\mathbf{B} - \mathbf{M}$$

Constitutive relations

Carl Friedrich Gauss
(1777 - 1855)

Findings of 19th century!!



Oliver Heaviside
(1850–1925)

James Clerk Maxwell

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

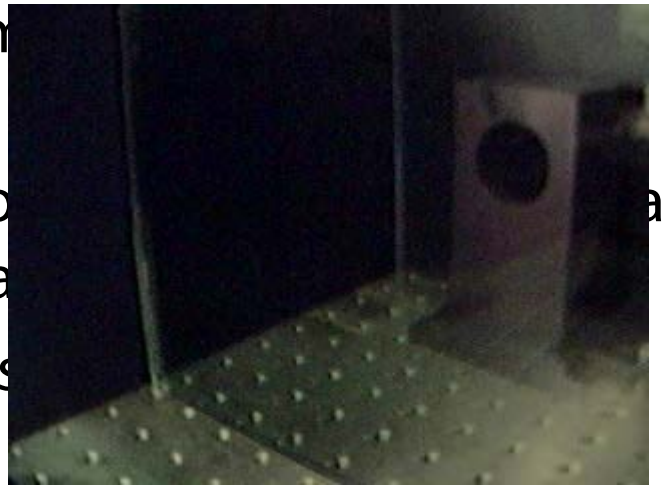
  Time-varying
  - Chap. 7. Time-Varying Fields and Maxwell's Equations
- Assessment:
  - Participation/quiz (10%), assignment (25%), practice (25%) exam 1 (15%), exam 2 (8%), exam 3 (17%)

Lightening: A Good Example!

http://en.wikipedia.org/wiki/File:Lightning_over_Oradea_Romania_3.jpg

Conclusions

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



High-power fibre laser demo