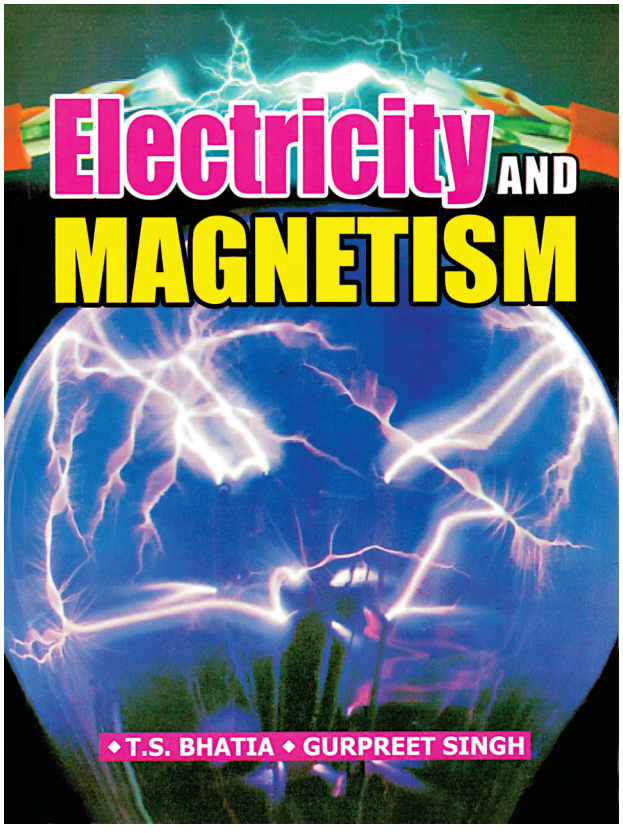
Book Review



ELECTRICITY AND MAGNETISM by T.S. Bhatia and Gurpreet Singh Published by Vishal Publishing Company (Jalandhar), Pages 472, Paperback Rs 375 (Punjab and Delhi; Rs 390 in other states of India; Rs. 800 for International edition).

"Electricity and Magnetism" by T.S. Bhatia and Gurpreet Singh, is is a first year (freshman year) text book in accordance with the prescribed syllabi of Guru Nanak Dev University (Amritsar), Punjab University (at Patiala and at Chandigarh). It also has a solution bank for the problems at the end of the book.

After the syllabi of the three Universities the contents show the sections of each chapter. Important equations in each chapter are numbered.

In the first chapter, vector algebra and calculus and coordinate systems are presented. A generalized approach is used in coordinate systems by using scale factors (they use these scale factors for grad, div or curl in the following chapter). Vector multiple products have been worked out in great details (here the use of Kronecker delta and the Levi-Civita symbols could also have been introduced for dot and cross products). The derivative of a vector assumes that the unit vectors do not change and could be done in a more generalized format leading the student seamlessly to rotating frames.

The second chapter is on Gauss and Stokes theorems (vector volume and surface integral). A minor error appears on page 87 where the Green's theorem is referred to as Grevi's theorem.

The third chapter on electric charge and field in SI units. Vectorial derivation of electric field due to dipole was shown, while field for a line-charge, uniformly charged ring, and uniformly charged hemispherical surface was shown. The relation to electrostatic units is shown. Occasionally an alternate set of units like F/m ($C^2N^{-1}m^{-2}$ for ε) or V/m ($NC^{-1}m$ for E) is helpful for students in finding a lateral connection between quantities.

The fourth chapter is on Gauss's law and its applications. Here the force on surface charge is shown. The chapter might have used the electric field at a small hole in a hollow charged metallic conductor to demonstrate the Gauss's law. This chapter could also show the force per area between two charged infinite plates as a consequence of Gauss's law.

The fifth chapter is on electric potential in terms of line integrals (path integrals on specified curves in vectorial electric field whose functional form is given is often require a few worked out examples). Apart from the electric potential for various situations, an excellent part of this chapter is that potential due to multipoles (dipole and quadrupole only) are also derived. Electric potential energy of an uniformly charged sphere is also worked out (it is tempting to show the relation between the mass of an electron and the one obtained from this self energy (divided by c^2). Image charge method for plane (point charge in front a conducting plane) and sphere (point charge in front of conducting sphere) is also presented in this chapter.

The sixth chapter is on electric current and comes in the correct logical sequence as one can relate the knowledge gained so far, coupled with the concept of drift motion (and mobility) to arrive at resistance and Ohms law. The Drude-Lorentz theory is presented in this chapter. This is followed by the Lorentz transform of the electric field (velocity, momentum and force) and the appearance of the Lorentz force (leading to the magnetic effect of current). This chapter is very informative.

The seventh chapter deals with electric fields in matter, electric polarization, polarization surface charge, effect of dielectric electric susceptibility (polarizability) and energy density in dielectric medium.

In the eighth chapter we go back to magnetic effects of current, vector potential for current distributions, surface current density and Hall effect. Here the Lorentz transform of the magnetic field is also discussed. This chapter, as well, would be very useful to students.

The ninth chapter discusses magnetic properties of matter. Here the equivalent surface current due to a magnetic field, leading to the appearance of magnetic susceptibility is simply beautiful. That would seamlessly introduce students to these magnetic properties of materials. Magnetic field due to and the magnetic moment of current loops and forces on them in magnetic fields are discussed here. Here Bohr magnetron is introduced. The presentation of electron spin magnetic moment however seems to indicate that the magnetic moment of the electron is due to actual rotation (mechanical spin) of a distribution of charges, when in fact such a picture would require the surface velocity of the electron to exceed the speed of light. Such an interpretation might have been better avoided. Diamagnetism and paramagnetism and Langevin's theory of diamagnetism and paramagnetic susceptibility (upto the Curie's law) are also presented here. The domain theory of ferromagnetism and magnetic hysterisis is presented here followed by a comparison of units (Gaussian, cgs and SI).

The tenth chapter is on electromagnetic induction, from Faraday's law, Lenz's law to self and mutual inductance. This is followed by index and a solution bank.

This text book is excellent for first year students. However, the level of material provided varied though out (from an elementary treatment of the first few chapters to the detailed equations of Lorentz transform). One beautiful feature is the seamless nature of introduction of concepts as a continuation of ideas already developed in earlier chapters. I often felt that the appearance of obsolete system of units (Gaussian, cgs-esu and cgs-emu) actually confused students. Electricity and magnetism already has a bit too many quantities and learning all of them in SI makes life much easier to students. The set of obsolete units are mostly for historical reasons, and does not help much in problem solving. The concept of magnetic spin as presented in the book may also be revised. The set of problems are very instructive and students will gain a lot from them. ❐

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