UNIVERSITY OF PUERTO RICO
RIO PIEDRAS CAMPUS
COLLEGE OF NATURAL SCIENCES
DEPARTMENT OF PHYSICS
UNDERGRADUATE PROGRAM

Title: Electromagnetism I

Code: PHYS 4068

Number of Credits: 3

Prerequisites: MATH 3152, PHYS 3012-3014

Co-requisites: PHYS 4031

Description

This is the first part of the one-year course in Electromagnetism for Physics majors, which covers electrostatics and magnetostatics: Electrostatic potential, divergence and curl of electric fields, electric potential; Conductors, boundary-value problems and techniques for calculating potentials; Dipole and multipole expansion of the electric potential, the electrostatics of dielectric materials; Electric current, Ohm's law, continuity equation; Magnetic fields, the Lorentz force law, the Biot-Savart and Ampere's laws; The differential equations of magnetostatics, the vector potential, boundary-value problems; Magnetized media, the susceptibility and permeability, non-linear media and hysteresis.

Objectives

After completing this course the student will understand the basic concepts and fundamental principles of electrostatics, magnetostatics, and the interaction of currents and fields and will be able to apply these to actual physical situations and setup the corresponding mathematical problem. The student will also have practiced and mastered the application of mathematical techniques to solve such problems.

Course Content

Topic	Assigned time (hours)
1. A review of concepts in vector algebra and vector calculus.	3
2. The Divergence theorem, the Green's theorem, and the Stokes's theorem.	3
3. The Coulomb's Law and the concept of electric field.	3
4. Calculation of electric fields for simple charge distributions.	3
5. Divergence and curl of the electric field, the electrostatic potential.	3
6. Conductors, insulators and Gauss's Law. The electric	3

Dipole and multipole expansion of the electric potential.	
7. The Laplace and Poisson's equations.	3
8. Boundary value problems and the techniques for calculating potentials. Simple ideas about electrostatic images.	3
9. Capacitance, electrostatics in dielectric materials. Electrostatic energy.	3
10. Electric current and the current density. Continuity equation, Ohm's Law and electric power.	3
11. Concept of the magnetic induction field, Lorentz force, the Biot-Savart and Ampere's Laws.	3
12. The magnetic scalar potential (magnetostatics) and the magnetic vector potential.	3
13. Magnetic properties of materials.	3
14. Magnetized matter, magnetic susceptibility, permeability, and hysteresis.	3
15. Electromagnetic induction. The Faraday and Lenz's laws. Self and mutual inductances, magnetic energy.	3
Total hours	45 contact hours

Instructional Strategy

The main instructional tool in this class is lecturing. The students are trained to apply the concepts of electrostatics and magnetostatics to simple physical situations and setting up the problem mathematically, which is then solved using standard and elementary mathematical methods. A fair part of the lecturing effort is thus dedicated to the demonstration of solution of problems in electricity and magnetism. Homework assignments allow the students to use the relevant physics concepts as also practice problem solving techniques discussed in class. Solutions of homework problems are subsequently discussed in class, where the students are encouraged to present their work.

Minimum Require Facilities

Traditional lecture room.

Student Evaluation

Since the emphasis of this course is on problem solving techniques, the grades are mainly based on four exams where the student will work on problems similar to the ones encountered in class and in the homework problems, as well as on the performance in homework assignments. The students can also be asked to make a presentation in the class on a chosen topic using audiovisual aids if necessary, which may be counted as one of the exams.

Grading System

The overall score is determined by calculating the percentage of points obtained by the student. Grades are then assigned according to the standard curve: 100-90% = A, 89-80% = B, 79-70% = C, 69-60% = D, 59-0% = F.

Bibliography

1. Foundations of Electromagnetic Theory by John R. Reitz, Frederick J. Milford, and Robert W. Christy, 4th Edition, 1993, Addison-Wesley.
2. Introduction to Electrodynamics by David J. Griffiths, 3rd edition, 1999, Prentice Hall.
3. Classical Electromagnetism by Jerrold Franklin, 2005, Addison Wesley.

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