FDITE212 Advanced classical electrodynamics

Description:

Advanced electrodynamics is a fascinating field that delves into the behavior of electric and magnetic fields, especially in complex scenarios.

It provides a deeper understanding of the forces and fields that are fundamental to both everyday technology and cutting-edge scientific research.

Some examples: Advanced knowledge of electrodynamics is crucial for modern technologies, including telecommunications, medical imaging (like MRI), and even understanding the universe through astrophysics.

Topics:

1. **Electrostatics in Vacuum**
   Coulomb's law, Electric Field, Gauss's law, Poisson and Laplace Equations, Green theorem
2. **Boundary value problems in electrostatics**
   Method of Images, point charge near grounded conducting sphere and near charged insulated conducting sphere, conducting sphere in uniform Electric-field, Green function for sphere, general solution for electrostatic Potential
3. **Mathematical physics of electrostatics and special functions**
   Laplace Eqn in Spherical coordinates, Legendre Equation and Polynomials, problems with azimuthal symmetry, Associate Legendre functions and Spherical harmonics and their addition theory, Bessel Functions and solving electrostatic problems in cylindrical coordinates, Expansion of Green Function in Spherical Coordinates, Expansion of Green Function in cylindrical Coordinates
4. **Multipoles and Dielectrics**
   Multipole expansion, expansion of the energy and charge distribution in external electrostatic field, Electrostatic of ponderable media, the dielectric problem, molecular polarizability, electric susceptibility and its Model, electrostatic energy in dielectric media
5. **Magnetostatics, Faraday's law and Quasi-static Fields**
   Biot-Savart law, differential equations of magnetostatics and Amper's Law, Vector potential, Magnetic Fields of a localized current distribution, magnetic moment, Force and torque, Macroscopic Equations and boundary conditions, methods for solving magnetostatic problems, and boundary value problems, uniformly magnetized sphere, magnetic shielding, Faraday's law of induction, Energy in the magnetic field, self- and mutual- inductances, quasi-static magnetic fields
6. **Maxwell Eqs and Macroscopic electromagnetism, conservation laws**
   Maxwell's displacement current, Maxwell Equations, Victor and scaler potentials, Gauge transformation, Lorenz Gauge, Coulomb Gauge, Green Functions for the wave equation,

Retarded solutions for the Fields, Derivation of the Equations of Macroscopic electromagnetism, Poynting Theorem and conservation of energy and momentum for particles in electromagnetic fields, Linear Dissipative Media with losses, harmonic Fields, Definitions of Impedance and Admittance, Transformation properties of electromagnetic fields

7. **Thermodynamics of the Electric, magnetic and electromagnetic fields**
   Thermodynamic relations for dielectrics, total free energy of a dielectric, thermodynamic inequalities, thermoelectric phenomena, thermos-galvanic phenomena, thermoelectric relations in magnetic fields, total free energy of a magnetic substance

References

1. Classical Electrodynamics (J. D. Jackson, J Wiley& Sons, Inc 1999)
2. Electrodynamics of Continuous media (L. Landau and E. Lifshitz, Pergamon Press 1984)
3. Statistical Physics (part 1) (L. Landau and E. Lifshitz, Pergamon Press 1980