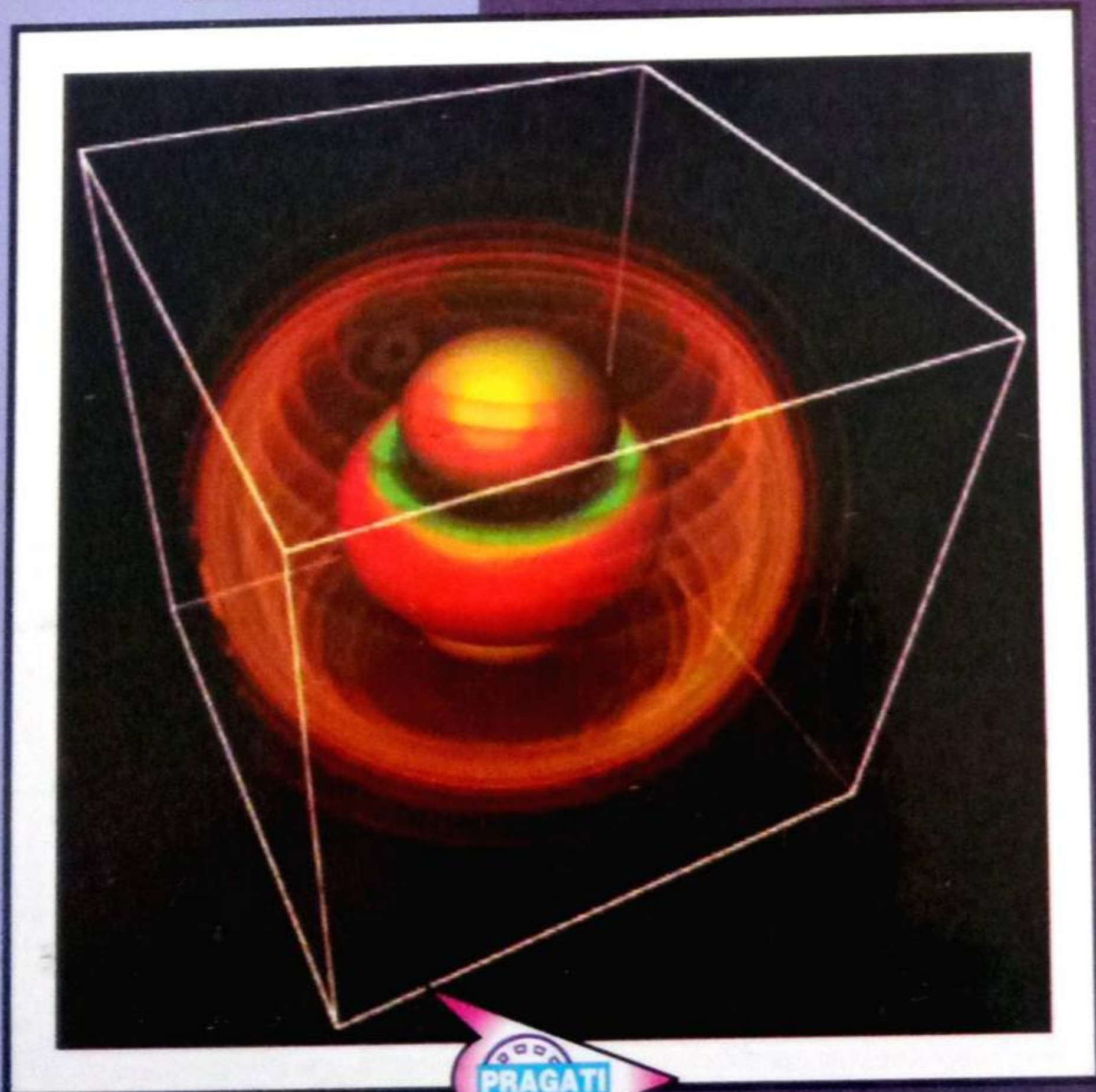




**GUPTA ■ KUMAR ■ SINGH**

# **ELECTRODYNAMICS**



*A Pragati Edition*

# Contents

---

## 1. ELECTROSTATICS

---

3-43

- The Electric charge 3
- Charge density 3
- Coulomb's law 4
- Electric field strength 5
- Electrostatic potential 10
- Potential of a charge distribution 13
- Electric field and potential of a dipole 13
- Electric dipole interactions 16
- Electric quadrupole and multipoles 18
- Multipole expansion of potential 20
- Gauss' Law 27
- Application of Gauss's Law 28
- Green's theorem : Calculation of field from the charge distribution 32
- Solved Problems 34
- Exercises 40

## 2. ELECTROSTATIC FIELD IN DIELECTRICS

---

44-70

- Dielectric polarization 44
- Relative Permittivity (Dielectric constant) and Displacement Vector 46
- External field of a dielectric medium 47
- The electric field in a material medium 49
- Relation between  $\mathbf{D}$ ,  $\mathbf{E}$  and  $\mathbf{P}$  52
- Point charge in dielectric fluid 55
- Potential and field due to a polarised sphere 56
- Molecular field in a dielectric (*Claussius-Mossotti relation*) 61
- Polarization of polar molecules 64
- Debye's modification of Claussius-Mossotti relation : (*Study of molecular structure*) 64
- Exercises 68

## 3. FORCE AND ENERGY RELATIONS IN ELECTROSTATIC FIELDS

---

71-87

- Electrostatic energy and energy density in free space and in dielectric 71
- Thermodynamic interpretation of electrostatic energy 75
- Concept of free energy and Thomson's theorem 76
- Volume forces in the electrostatic field 79
- Maxwell stress tensor 83
- Solved Problems 85
- Exercises 86

**4. POTENTIAL PROBLEMS**

- Uniqueness theorem 88  
 Green's reciprocation theorem 88  
 Solution by Green's function 89  
 The method of electrical image 91  
 Point charge near an infinite grounded conducting plane 91  
 Dielectric slab of infinite face in front of a point charge 95  
 Spherical conductor near point charge 98  
 Solution of problems by fictitious charge method 109  
 Poisson and Laplace equations in cartesian coordinates 112  
 Solution of Laplace equation 116  
 Solution of Laplace equation for electrostatic problems 123  
 Potential at any point between the plates of a parallel plate condenser 123  
 Potential between two grounded semi-infinite parallel electrodes terminated by a plane electrode at potential  $\phi_0$  126  
 Potential between two grounded parallel electrodes terminated on two opposite sides by plates at potentials  $\phi_1$  and  $\phi_2$  128  
 Potential within a conducting box 130  
 Spherical condenser 132  
 Conducting sphere in a uniform electrostatic field 133  
 Dielectric sphere in a uniform electrostatic field 137  
 Uniformly charged ring 140  
 Potential at a point due to a charged disc 140  
 Potential at a point due to cylindrical shell 142  
 Potential between coaxial conducting cylinders 143  
 Conducting cylinder in a uniform field 145  
 Solved Problems 145  
 Exercises 149

**5. MAGNETOSTATICS**

152-196

- Current density 152  
 Magnetic induction 153  
 Force on a current element : Ampere's Force law 153  
 Magnetic interaction of steady line currents : Biot and Savart law :  
     Magnetic induction 154  
 Divergence of magnetic induction, **B** 164  
 The magnetic vector potential, **A** 165  
 The divergence of vector potential, **A** 167  
 The curl of magnetic induction, **B** 168  
 Magnetic scalar potential 170  
 Magnetisation, **M** 179  
 Currents in a material media 181  
 Magnetic intensity 182