

SEMESTER - III PHYS-231: ELECTRICITY AND MAGNETISM

Chapter 1

1. Define line, surface and volume integrals
2. Define gradient, divergence and curl in Cartesian coordinate system. Explain their physical significance
3. Show that $\nabla \times (\nabla F) = 0$ where F is a scalar field (Curl of the gradient of a scalar field is zero)
4. State and explain Gauss' divergence theorem
5. State and explain Stoke's theorem
6. Define scalar and vector triple product of two vectors
7. What are scalar and vector **fields** ?
8. Show that $\nabla(\nabla \times \vec{V}) = 0$ where \vec{V} is a vector field
9. Show that $\nabla \cdot (\nabla \times \vec{V}) = 0$ where \vec{V} is a vector field (Divergence of curl of a vector field is zero)
10. If \vec{F} is a conservative field, show that $\nabla \times \vec{F} = 0$
11. What is Laplacian ?
12. Explain how to relate surface integral and volume integral

Chapter 2

1. Explain the concept of electric flux
2. State and prove Gauss' law in electrostatics
3. Obtain integral and differential forms of Gauss' law
4. Apply Gauss's law for evaluating the electric field intensity due to
 - (a) point charge
 - (b) infinite line of charge
5. Apply Gauss's law for evaluating the electric field intensity due to
 - (a) uniformly charged spherical shell
 - (b) uniformly charged solid sphere (non-conducting)
6. Apply Gauss's law for evaluating the electric field intensity due to
 - (a) plane charged sheet
 - (b) charged conductor
7. What is electrostatic shielding ?
8. Obtain Coulomb's law from Gauss's law

9. Derive an expression for the energy stored in unit volume of an electric field
10. Differentiate between potential and potential difference ? How are these related to work done ?
11. What are equipotential surfaces ?
12. Show that potential at a point

$$V_{point} = \int_{\infty}^{point} \vec{E} \cdot d\vec{l}$$

13. Obtain an expression for electric potential due to
 - (a) a point charge
 - (b) an electric dipole
14. Obtain an expression for electric potential due to
 - (a) uniformly charged conducting spherical shell
 - (b) uniformly charged conducting solid sphere
15. Derive a relation connecting electric field and electric potential
16. Show that

$$E = -\nabla V$$

17. State Laplace's equation and Poisson's equation. What is the importance of these equations ? State and explain uniqueness theorems
18. The electric field E is zero at a point. Is the electric potential V necessarily zero at that point ? Give examples
19. Explain how to calculate electric field from potential
20. Define capacitance. Derive an expression for capacitance of
 - (a) an isolated spherical conductor
 - (b) Parallel plate capacitor
21. Define capacitance. Derive an expression for capacitance of
 - (a) spherical capacitor
 - (b) cylindrical condenser
22. Explain how the capacitance of a parallel plate capacitor will modify, when a dielectric slab is inserted between the plates of the capacitor
23. Obtain an expression for the energy stored per unit volume (energy density) in an electrostatic field
24. Derive an expression for the combined capacitance of three parallel plate capacitors connected in (i) series (ii) parallel
25. What is a dielectric material ? Differentiate between polar and non-polar materials with examples

26. Define the terms and obtain relations connecting them
 - (a) Dielectric constant
 - (b) Electric polarisation
 - (c) Polarizability
 - (d) Electric displacement vector
 - (e) Electric susceptibility
27. What is a linear dielectric medium ? Differentiate between free charges and bound charges
28. Obtain the form of Gauss's theorem in dielectrics

Chapter 3

1. What is meant by magnetostatics ?
2. State and explain Biot-Savart law. Use it to find the magnetic flux density due to a current carrying straight conductor
3. State and explain Biot-Savart law. Use it to find the magnetic flux density due to a current carrying coil
4. State and explain Biot-Savart law. Use it to find the magnetic flux density due to a current carrying solenoid
5. What is Lorentz force equation ?
6. State and explain Ampere's circuital law and deduce the corresponding Maxwell equation from it
7. Obtain divergence and curl of **magnetic field** in magnetostatics
8. Define the term magnetic vector potential
9. Define the term current density. Relate it with **H** and **A**
10. State and explain Gauss' law in magnetism ? How is it related to the concept of magnetic dipole
11. Discuss the Ampere Circuital law with its limitations
12. Explain the difference between magnetic induction \vec{B} , magnetizing field \vec{H} and intensity of magnetisation \vec{M} . Obtain the relation connecting them
13. Define the terms permeability of free space, permeability of a medium, relative permeability and magnetic susceptibility. Derive a relation connecting them
14. Discuss the behaviour of a material when placed in an external magnetic field and hence classify materials in to diamagnetic, paramagnetic and ferromagnetic. Discuss their properties with examples
15. What are magnetic domains ?
16. What is Curie temperature ?
17. Discuss the nature of susceptibility and its temperature dependence of diamagnetic, paramagnetic and ferromagnetic materials

18. Write a short note on hysteresis loop in magnetism and explain the terms retentivity and coercivity
19. Compare electrostatics and magnetostatics using basic equations and expressions in each of them
20. Diamagnetism is universal phenomenon. Explain why?

Chapter 4

1. State and explain Faraday's laws of electromagnetic induction ?
2. Obtain integral and differential form of Faraday's laws of electromagnetic induction
3. Write down the Maxwell's equations corresponding to the Faraday's laws of electromagnetic induction
4. State Lenz's law
5. What is self induction ? Define the term self-inductance
6. What is mutual induction ? Define the term mutual-inductance
7. Obtain an expression for the self-inductance of a long air-cored solenoid
8. Obtain expressions for effective inductance when two coils are connected in series and in parallel
9. Derive an expression for energy stored in a magnetic field
10. Derive an expression for mutual inductance between two co-axial solenoids
11. What is coefficient of coupling ?
12. What are eddy currents? Give their practical applications
13. Explain the concept of displacement current and show how it led to a modification of Ampere's law
14. What is Poynting vector ? State and explain Poynting's theorem
15. Derive an expression for energy density in electromagnetic field
16. Discuss the **propagation of electromagnetic wave through a homogeneous, isotropic dielectric medium (non-conducting isotropic medium)**
17. Explain the transverse nature of electromagnetic waves
18. **What are the Maxwell's equations in electrodynamics ? Explain**

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