Anekant Education Society's

TULJARAM CHATURCHAND COLLEGE OF

ARTS, SCIENCE AND COMMERCE, BARAMATI

(Autonomous Status)

(Affiliated to Savitribai Phule Pune University, Pune)

DEPARTMENT OF PHYSICS

M.Sc.-I SEM-II PHY4201 :Electrodynamics

Question Bank

Q.1 Answer in one sentence

1. Define the terms monopole,Dipole,Quadrupole and Octopole.
2. How the potential V in multiple expansion varies with r in monopole,Dipole,Quadrupole and Octopole?
3. State the Farady's law of induction for moving medium.
4. What do you mean by Maxwell's Displacement Current ?
5. Write the Maxwell's equaition in differential form.
6. Write the Maxwell's equaition in integral form.
7. What is linear Quadrupole?
8. Write the boundary condition at interface of electric field
9. Write the boundary condition at interface of magnetic field
10. Write the boundary condition at interface of diectric.
11. State Poynting theorem
12. Write an expression for energy stored in electric and magnetic fields?
13. Write an expression for skin depth in case of good conductor.
14. Write an expression for skin depth in case of poor conductor.
15. Define electromagnetic wave .
16. Electromagnetic waves are transverse in nature.Comment?
17. Write three fundamental laws of geometrical optics
18. How you can differentiate between TE and TM waves?
19. What is Hertz Potential ?
20. Write the condition of Lorentz Gauge and Coulomb Gauge
21. Express d'Alembertian operator.
22. Draw the Minkowski's space-time diagram.
23. What is four vector potential?

24. Write two postulates of special theory of relativity
25. Write equations for Galilean transformation?
26. Write equations for Lorentz transformation?

Q 2 Short notes

1. Magnetic interaction between two current loops
2. Four vector potential
3. Multiple moments
4. Minkowski's space-time diagram
5. Hertz potential $\vec{z}$
6. Lorentz force on a charged particle
7. Boundary conditions on $\vec{E}$ and $\vec{B}$,$\vec{D}$ and $\vec{H}$at the interface between two media
8. Momentum space
9. Differntial and integral forms of Maxwell's Equaition
10. Poynting's Theorem
11. Skin depth and Skin effect
12. Law of relativistic addition of velocities
13. Momentum space
14. Boundary conditions on $\vec{E}$
15. Boundary conditions on$\vec{B}$
16. Boundary conditions on$\vec{D}$
17. Radiation from a dipole
18. Galilean Transformation
19. Lorentz transformation
20. Gauge transformation
21. Faraday's law stationary media
22. Faraday's law moving media

Q.3 Short Answer Quetions

1. Find the ratio of skin depth in copper at 1 KHz to 100 MHz.
2. State and prove the boundary conditions at the interface of electric field medium.
3. Show that standing wave f(z,t)=A Sinkz Cos ωt satisfies the wave equaition $\frac{\partial^2 F}{\partial^2 t} = \frac{1}{v^2}\frac{\partial^2 F}{\partial t^2}$ where $v = \frac{\omega}{k}$
4. For plane electromagnetic waves propagating in $\vec{k}$ direction we have that $\vec{B} = \frac{\vec{K}\times\vec{E}}{\omega}$ show that $\vec{E} = -\frac{\omega}{k^2}\left(\vec{k}X\vec{B}\right)$
5. Whether the following potential is in the coulomb gauge or ? in the Lorentz gauge?
$$V(\vec{r},t) = 0\vec{A}(\vec{r},t) = \frac{1}{4\Pi\varepsilon o}\cdot\frac{qt}{r^2}\hat{r}$$
6. Show that C^2E^2-B^2 is invariant under Lorentz transformations.
7. Derive Faraday's law of induction for moving medium.
8. Find the velocity at which the mass of the particle is double its rest mass.Given c=3 x 10^8 m/s.
9. Show that ratio electrostatic and magnetostatic energy densities is equal to unity.
10. Prove the relativistic addition theorem for velocities and show that any velocity added relationstically to 'c'gives the resultant velocity 'c'.
11. Obtain an expression for Fresnel's equaition if the electric field vectors are perpendicular to the plane of incidence.
12. An electron is moving at a speed of 1.8 X 10^8 m/s .Find the ratio of its effective mass to its rest mass.
13. Find the rest mass of electron in eV if its rest mass is 9.11 X 10^{-31} kg.
14. Two identical bodies move towards each other ,the speed of each being 0.9c .Find their speed relative to each other.
15. Write the expressions for Lorentz ad Coulombs gauges.Hence explain the two conditions.
16. Describe the magnetic interaction between two current loops.

17. State and prove the boundary conditions at the interface of dielectric

18. State and prove the boundary conditions at the interface of magnetic medium.
19. Calculate the frequency at which the skin-depth in sea water is 1 meter.
    Given: $□_0 = 4\pi \times 10^{-7} \frac{Wb}{A-m}$ $and\ \sigma = 4.3 \frac{mho}{m}$
20. Explain the Ampere's circuital law and Maxwell's fourth equaition of electromagnetic field.
21. Using Maxwell's equaition :$\vec{\nabla} x\vec{E} = -\frac{\partial B}{\partial t}$,prove that $\nabla.\overrightarrow{B} = 0$
22. Uniform electric and magnetic fields $\vec{E} = E\hat{z}$and $\vec{B} = B\hat{x}$are present everywhere .If at t=0 ,particle of charge q and mass m starts at the origin with velocity $v(0) = \left(\frac{E_0}{2B_0}\right)\hat{y}$,Find the equation of trajectory of the particle.

23. Find the fields corresponding to

$$v(\vec{r}, t) = 0 \quad \vec{A}(\vec{r}, t) = \frac{1}{4\Pi\ \varepsilon_0} \frac{qt}{r^2}\hat{r}$$

Q.4 Long answer questions

1. Starting with Maxwell's equations,derive inhomogenous wave equations in terms of scalar potential $\phi$and vector potential $\vec{A}$
2. Derive an expression for potential at a point due to small linear quadrupole.
3. State Maxwell's equations in vacuum.Assuming that □ =0 $\vec{J}$=0.determine whether the given pair of $\vec{E}$ and $\vec{H}$satisfy Maxwell's equaitions.$\vec{E}$=$\hat{x}\, cos(2\pi z)\, cos(6\pi \times 10^8 t)$; $\vec{H}$ =$\hat{y}\frac{1}{6\Pi}\sin(2\pi z)\sin(6\pi \times 10^8 t)$
4. Show that combined space time interval $x^2+y^2+z^2-c^2t^2$ is Lorentz invariant.
5. Derive an expression for electromagnetic field tensor $F_{\mu\gamma}$.
6. State and prove Poynting's Theorem.
7. Starting from Maxwells's equaition ,establish the equaition of continuity.
8. Explain the term Multipole moments.Derive an expression for potential at a distant point using multipole expansion for a localized charge distribution in free space.

9. Show that Maxwell's equaition in a charge free region leads to $\nabla^2\vec{E} = \mu\varepsilon\frac{\partial^2\vec{E}}{\partial t^2} + \mu\sigma\frac{\partial\vec{E}}{\partial t}$ and $\nabla^2\vec{B} = \mu\varepsilon\frac{\partial^2\vec{B}}{\partial t^2} + \mu\sigma\frac{\partial\vec{B}}{\partial t}$

10. Prove that $\frac{\vec{E}.\partial D}{\partial t} = \frac{1}{2}\frac{\partial}{\partial t}(\vec{E}.\vec{D})$ and $\frac{\vec{H}.\partial B}{\partial t} = \frac{1}{2}\frac{\partial}{\partial t}(\vec{H}.\vec{B})$

11. The magnetic field intensity $\vec{B}$ at a point is given by:

    $\vec{B} = \left(\frac{\mu_0}{4\Pi}\right)\int\frac{\vec{J}X\vec{r}}{r^3}\,d\tau$ show that $\vec{\nabla}x\vec{B} = \mu_0\vec{J}$.

12. Derive the Lorentz relativistic transformation equaitions

13. Obtain Faraday's law of induction in differential form for a stationary medium and show how it can be modified if the medium is moving with velocity.

14. Suppose V=0 and $\vec{A} = A_0\,sin(kx - \omega t)\,\hat{y}$ where $A_0, k\ and\ \omega$ are constants .Find and check that they satisfy Maxwell's equaition in vacuum.

15. Determie $\vec{E}$and $\vec{B}$ for TE waves propagating in the yz-plane between two parallel perfectly conducting plates at y=0 and y=a.

16. Determie $\vec{E}$and $\vec{B}$ for TM waves propagating in the yz-plane between two parallel perfectly conducting plates at y=0 and y=a.

17. State Maxwell's equations in vacuum.Assuming that ρ =0 $\vec{J}$=0.determine whether the given pair of $\vec{E}$ and $\vec{H}$satisfy Maxwell's equaitions.$\vec{E}=\hat{x}\,z^2\sin\omega t$; $\vec{H} = -\hat{y}\frac{\varepsilon_0\omega}{3}z^3\cos\omega t$

18. State Maxwell's equations in vacuum.Assuming that ρ =0 $\vec{J}$=0.determine whether the given pair of $\vec{E}$ and $\vec{H}$satisfy Maxwell's equaitions.$\vec{E}=\hat{x}\ \ (t - z\sqrt{\varepsilon_0\mu_0})$, $\vec{H} = \hat{y}\,(t - z\sqrt{\varepsilon_0\mu_0})\sqrt{\frac{\varepsilon_0}{\mu_0}}$

19. Determine the limiting values of the width 'a' of a waveguide of square cross section that will transmit a wave of length λ in the TE_{10} mode but not in the TE_{11} or TM_{11} modes

20. Consider a rectangular waveguide with dimensions 2.28 cm x 1.01 cm.What TE modes will propagate in this waveguide ,if the driving frequency is 1.0 x 10^{10} Hz?

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