GOVERNMENT ZIRTIRI RESIDENTIAL SCIENCE COLLEGE

Subject: Physics

Paper name: Electromagnetic Theory

Paper No: Phy/VI/CC/17

Semester: VI

A. Multiple choice questions [25 (5 from each unit)]

1. If ε is the permittivity of a dielectric medium, then the refractive index will be ($\varepsilon_r = dielectric\ constant, \varepsilon_o = permittvity\ of\ free\ space$)
   (a) $n = \sqrt{\frac{\varepsilon\varepsilon_r}{\varepsilon_o}}$
   (b) $n = \sqrt{\frac{\varepsilon_r}{\varepsilon_o}}$
   (c) $n = \sqrt{\frac{\varepsilon}{\varepsilon_o}}$
   (d) $n = \sqrt{\frac{\varepsilon\varepsilon_o}{\varepsilon_r}}$
2. In the interface between two different dielectric medium, the boundary condition for magnetic field parallel to the interface is ($\vec{K}_f$ *is sheet current*)
   (a) $H_1^{\parallel} - H_2^{\parallel} = |\vec{K}_f \times \hat{n}|$
   (b) $H_1^{\parallel} = -H_2^{\parallel}$
   (c) $\frac{B_1^{\parallel}}{\mu_1} = \frac{B_2^{\parallel}}{\mu_2}$
   (d) $B_1^{\parallel} - B_2^{\parallel} = |\vec{K}_f \times \hat{n}|$
3. For an em wave travelling along the Z-axis and enters the second dielectric medium at $z = 0$, the relation between the incident, reflected and transmitted electric field vector is
   (a) $(\vec{E}_I + \vec{E}_R)_{at\ z=0} = (\vec{E}_T)_{at\ z=0}$
   (b) $(\vec{E}_I - \vec{E}_R)_{at\ z=0} = (\vec{E}_T)_{at\ z=0}$
   (c) $(\vec{E}_I + 2\vec{E}_R)_{at\ z=0} = (\vec{E}_T)_{at\ z=0}$
   (d) $(\vec{E}_I + \vec{E}_R)_{at\ z=0} = (-\vec{E}_T)_{at\ z=0}$
4. The two Fresnel's equations for the polarization of electromagnetic wave perpendicular to the plane of incidence (where the symbols have their usual meaning)
   (a) $E_{OR} = \frac{(1+\alpha\beta)}{(1-\alpha\beta)} E_{OI}\ and\ E_{OT} = \frac{E_{OI}}{1-\alpha\beta}$
   (b) $E_{OR} = \frac{(1-\alpha\beta)}{(1+\alpha\beta)} E_{OI}\ and\ E_{OT} = \frac{2E_{OI}}{1+\alpha\beta}$
   (c) $E_{OR} = \left(\frac{\alpha-\beta}{\alpha+\beta}\right) E_{OI}\ and\ E_{OT} = \left(\frac{2}{\alpha+\beta}\right) E_{OI}$
   (d) $E_{OR} = \left(\frac{\alpha+\beta}{\alpha-\beta}\right) E_{OI}\ and\ E_{OT} = \left(\frac{2}{\alpha-\beta}\right) E_{OI}$
5. If n_1 and n_2 are refractive indices of the two media, at the Brewster's angle θ_B for light incident from medium 1 to medium 2,
   (a) $\cot\theta_B = \left(\frac{n_2}{n_1}\right)$
   (b) $\cot\theta_B = \left(\frac{n_2+n_1}{n_1}\right)$
   (c) $\cot\theta_B = \left(\frac{n_2-n_1}{n_1}\right)$
   (d) $\cot\theta_B = \left(\frac{n_1}{n_2}\right)$

6. If $\vec{B}_o = \frac{k}{\omega}(\hat{k} \times \vec{E}_o)$, then
   (a) $B_{oy} = \frac{k}{\omega} E_{oz}$
   (b) $B_{ox} = \frac{k}{\omega} E_{ox}$
   (c) $B_{oy} = \frac{k}{\omega} E_{ox}$
   (d) $B_{oy} = \frac{\omega}{k} E_{ox}$
7. Magnitude of electric and magnetic field vectors associated with an em wave are related as
   (a) $|\vec{B}_o| = \frac{k}{\omega} |\vec{E}_o|$
   (b) $|\vec{B}_o| = \frac{\omega}{k} |\vec{E}_o|$
   (c) $|\vec{B}_o| = -\frac{\omega}{k} |\vec{E}_o|$
   (d) $|\vec{B}_o| = -\frac{k}{\omega} |\vec{E}_o|$
8. Average value of Poynting vector $\langle S \rangle$ equals
   (a) $\frac{E_{max}^2}{2c\mu_o} + \frac{B_{max}^2}{2\mu_o}$
   (b) $\frac{B_{max}^2}{2\mu_o}$
   (c) 0
   (d) $\frac{E_{max}^2}{2c\mu_o}$
9. The relation between intensity of an em wave and the total energy density U_{em} is
   (a) $I = c\langle U_{em} \rangle$
   (b) $I = \varepsilon_o \mu_o \langle U_{em} \rangle$
   (c) $I = \frac{1}{\varepsilon_o \mu_o} \langle U_{em} \rangle$
   (d) $I = \langle U_{em} \rangle$
10. In terms of Poynting vector S, the momentum transported by an em wave is
   (a) $\frac{S}{c}$
   (b) $\frac{2S}{c}$
   (c) $\frac{\langle S \rangle}{c}$
   (d) $\frac{\langle S \rangle}{2c}$
11. If $\vec{P}$ is the polarization of a dielectric material placed under electric field, the bound volume charge density due to polarization is (where $\hat{n}$ is outward unit vector from dielectric material)
   (a) $\vec{P}.\hat{n}$
   (b) $-\vec{P}.\hat{n}$
   (c) $-\vec{\nabla}.\vec{P}$
   (d) $\vec{\nabla}.\vec{P}$

12. In dielectric medium, which of the following relations are correct (where $\vec{P}$= Polarization vector, $\vec{E}$= Electric field, $\vec{M}$= Magnetization, $\vec{H}$= Magnetic field strength, ε_o= permittivity of free space, μ_o= permeability, χ_e= electric susceptibility, χ_m= magnetic susceptibility)
    (a) $\vec{P} = \chi_e\vec{E}, \vec{M} = \chi_m\vec{H}$
    (b) $\vec{P} = \varepsilon_o\chi_e\vec{E}, \vec{M} = \chi_m\vec{H}$
    (c) $\vec{P} = \varepsilon_o\chi_e\vec{E}, \vec{M} = \mu_o\chi_m\vec{H}$
    (d) $\vec{P} = \chi_e\vec{E}, \vec{M} = \mu_o\chi_m\vec{H}$
13. For steady current
    (a) $\vec{\nabla}.\vec{J} = -\frac{\partial\rho}{\partial t}$
    (b) $\vec{\nabla}\times\vec{J} = -\frac{\partial\rho}{\partial t}$
    (c) $\vec{\nabla}\times\vec{J} = 0$
    (d) $\vec{\nabla}.\vec{J} = 0$
14. If L is self-inductance of an inductor and I is the current passing through it, then the energy stored in an inductor is
    (a) $\frac{LI^2}{2}$
    (b) LI^2
    (c) $\frac{I^2}{2L}$
    (d) $\frac{L}{2I^2}$
15. In free space, the modified Ampere's law becomes
    (a) $\vec{\nabla}\times\vec{B} = \mu\vec{J} + \varepsilon_o\mu_o\frac{\partial\vec{E}}{\partial t}$
    (b) $\vec{\nabla}\times\vec{B} = \varepsilon_o\mu_o\frac{\partial\vec{E}}{\partial t}$
    (c) $\vec{\nabla}\times\vec{B} = \mu_o\vec{J} + \varepsilon_o\mu_o\frac{\partial\vec{E}}{\partial t}$
    (d) $\vec{\nabla}\times\vec{B} = -\varepsilon_o\mu_o\frac{\partial\vec{E}}{\partial t}$
16. Coulomb Gauge condition is
    (a) $\vec{\nabla}\times\vec{A} = 0$
    (b) $\vec{\nabla}.\vec{A} = 0$
    (c) $\vec{\nabla}\varphi = 0$
    (d) $\frac{\partial\vec{A}}{\partial t} = 0$
17. Expression for D'Alembertian operator is
    (a) $\nabla^2 - \varepsilon\mu\frac{\partial^2}{\partial t^2}$
    (b) $\nabla^2 + \varepsilon\mu\frac{\partial^2}{\partial t^2}$
    (c) $-\nabla^2 - \varepsilon\mu\frac{\partial^2}{\partial t^2}$
    (d) $-\nabla^2 + \varepsilon\mu\frac{\partial^2}{\partial t^2}$
18. Lorentz gauge condition is given
    (a) $\vec{\nabla}.\vec{A} = 0$
    (b) $\vec{\nabla}.\vec{A} = \vec{J}$
    (c) $\vec{\nabla}.\vec{A} = -\varepsilon_o\mu_o\frac{\partial\phi}{\partial t}$
    (d) $\vec{\nabla}.\vec{A} = \vec{E}$
19. Poisson's equation can be expressed as

(a) $\nabla^2 \phi = \frac{\rho}{\varepsilon_o}$
(b) $\nabla^2 \vec{A} = -\mu_o \vec{J}$
(c) $\nabla^2 \vec{A} = +\mu_o \vec{J}$
(d) $\nabla^2 \vec{A} = 0$

20. In terms of scalar and vector potentials, electric and magnetic fields can be expressed as
    (a) $\vec{B} = \vec{\nabla} \times \vec{A}$ and $\vec{E} = -\vec{\nabla}\phi + \frac{\partial \vec{A}}{\partial t}$
    (b) $\vec{B} = \vec{\nabla} \times \vec{A} + \frac{\partial \vec{A}}{\partial t}$ and $\vec{E} = -\vec{\nabla}\phi$
    (c) $\vec{B} = \vec{\nabla} \times \vec{A} - \frac{\partial \vec{A}}{\partial t}$ and $\vec{E} = -\vec{\nabla}\phi$
    (d) $\vec{B} = \vec{\nabla} \times \vec{A}$ and $\vec{E} = -\vec{\nabla}\phi - \frac{\partial \vec{A}}{\partial t}$
21. Young's double slit experiment can be explained by
    (a) Particle nature of light
    (b) Wave nature of light
    (c) Dual nature of light
    (d) None
22. Classical law fails below
    (a) 10^{-10}m
    (b) 10^{-2} m
    (c) 10^{-31} m
    (d) None
23. Stefan and Boltzmann law is also called
    (a) Fifth power law
    (b) Square law
    (c) Fourth power law
    (d) None
24. In LASER action the life time of an atom in E_2 is
    (a) 10^{-10} s
    (b) 10^{-2} s
    (c) 10^{-8} s
    (d) None
25. The distance up to which a LASER beam remain parallel is called
    (a) Jean's range
    (b) Planck's range
    (c) Rayleigh's range
    (d) None

B. Fill up the blanks [15 (3 from each unit)]

1. If there is any charge distribution inside a conductor, it will eventually dissipate to the surface after a time interval of ……………
2. If for pure water, the permittivity is $80.1\varepsilon_o$, permeability $\mu = \mu_o$,and conductivity is $\sigma = \frac{1}{2.5\times10^5}$ Siemens/meter, then the depth an electromagnetic wave will penetrate through water is ………..

3. When a plane electromagnetic wave strikes a conducting surface from linear dielectrics, all the waves will be ………………
4. Intensity of a wave is associated with the energy carried by an em wave and is equal to ……………….
5. When an em wave is completely reflected by an a surface, the pressure exerted on the surface will be ……. the pressure exerted when it is completely absorbed.
6. In a plane wave propagation in free space, the component of electric field along the ………………… is zero always
7. Maxwell made modification in Ampere's law as it is inconsistent in the case of ……… current
8. In dielectric medium, due to ………………., Guass's law has to be modified with the inclusion of new term called electric displacement.
9. The perpendicular component of electric displacement vector will be discontinuous at the boundary if there are ………….. at the interface.
10. If λ is a scalar quantity, we can add $\vec{\nabla}\lambda$ to $\vec{A}$ and subtract $\frac{\partial\lambda}{\partial t}$ from ϕ. None of this will affect the electric and magnetic field. Such changes in $\vec{A}$ and ϕ are known as ………
11. d'Alembertian operator is a ………….. operator.
12. d'Alembertian operator operating on a scalar potential equals ……
13. Full form of LASER is …………….
14. Mismatch of Rayleigh-Jean law with Experimental result at low λ is called ………….
15. The ratio of emissive power to absorptive power of normal body is equal to ……….

Key Answers

A. Multiple Choice
   1. c
   2. c
   3. a
   4. b
   5. d
   6. c
   7. a
   8. d
   9. a
   10. c
   11. c
   12. b
   13. d
   14. a
   15. b
   16. b
   17. a
   18. c
   19. b
   20. d
   21. b
   22. b
   23. b
   24. c
   25. c

B. Fill in the blanks

1. $\frac{\varepsilon}{\sigma}$,where $\varepsilon = permittivity, \sigma = conductivity$
2. 12 Km
3. Reflected
4. Average value of Poynting vector
5. Two times
6. direction of propagation
7. non-steady
8. polarization
9. free charges
10. Gauge transformations
11. scalar
12. $-\frac{\rho}{\varepsilon_o}$
13. light amplification by stimulated emission of radiation
14. UV-Catastrophe
15. Emissive power of black body