CSIR-UGC-NET/JRF | GATE - PHYSICS

UNIT TEST-3

[ELECTROMAGNETIC THEORY]

Time : 00: 45 Hour **Date : 12-10-2017**

M.M. : 30

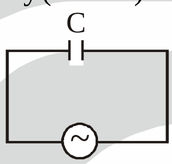
INSTRUCTION:

(I) Question Paper contains 15 objective type questions, each question carry 2 marks.

(II) There is negative marking, 0.5 mark will be deducted for each wrong answer.

(III) Attempt all the questions, use of calculator is not allowed.

1. A parallel plate air gap capacitor is made up of two plates of area 10 cm^2 each kept at a distance of 0.88mm. A sine wave of amplitude 10V and frequency 50Hz is applied across the capacitor as shown in the figure. The amplitude of the displacement current density (in A/m^2) between the plates will be



(a) 3×10^{-5} (b) 3×10^{-6} (c) 5×10^{-6} (d) 5×10^{-5}

2. Two circular loops of conducting wires having radius R and 2R, carrying current $I_0\cos(100\pi t)$ and $I_0\cos(50\pi t)$ respectively. The ratio of power radiated by the loops is

(a) 1 (b) 4 (c) 32 (d) 16

3. The vector $\vec{A}=\frac{1}{2}\alpha t\left(x\hat{j}-y\hat{i}\right)$, $\phi=\frac{1}{4}\alpha\left(x^2+y^2\right)$ where 'α' is a constant and 't' is time. The electric field $\left(\vec{E}\right)$ and magnetic field $\left(\vec{B}\right)$ corresponding to these potentials are, respectively

(a) $\frac{1}{4}\alpha\left[(x+y)\hat{i}+(x-y)\hat{j}\right],\frac{1}{2}\alpha t\,\hat{k}$

(b) $-\frac{1}{2}\alpha\left[(x-y)\hat{i}+(x+y)\hat{j}\right],\alpha t\,\hat{k}$

(c) $-\frac{1}{2}\alpha\left[x\hat{i}+y\hat{j}\right],\alpha t\,\hat{k}$

(d) $-\frac{1}{4}\alpha\left[(x+y)\hat{i}+(x-y)\hat{j}\right],\alpha t\,\hat{k}$

4. The transformation equation relating the electric fields $\overline{E}$ and $\overline{E}'$ of an e.m. wave in two frames S and S' moving with velocity $\overline{v}$ with respect to each other is:

(a) $E'_{||}=E_{||}\left(1-v^2/c^2\right)^2$

(b) $E'_{||}=E_{||}$

(c) $E'_{||}=\frac{E_{||}}{\sqrt{1-\frac{v^2}{c^2}}}$

(d) $E'_{||}=E_{||}\left(1-\frac{v^2}{c^2}\right)^{3/2}$

5. In an air filled rectangular wave guide y-component of electric field of a TE mode is given by

$$E_y = 5\sin\left(\frac{m\pi x}{2}\right)\cos\left(\frac{n\pi y}{3}\right)\sin\left(\frac{3\pi}{2}10^8 t - 12z\right) \text{V/m}$$

where x and y are in centimeters. The cut-off wavelength of dominant mode is

(a) 6 cm (b) 3 cm (c) 4 cm (d) 2 cm

6. The electric field of an electroamgnetic waves $\vec{E}(\vec{r}, t) = \sqrt{2}\, E_0 \hat{z} \cos(x - y - \omega t)$. If 'c' stands for the velocity of the wave, the magnetic field $\vec{B}(\vec{r}, t)$ is :

(a) $\vec{B}(\vec{r}, t) = -\frac{1}{c\sqrt{2}}(\hat{x} + \hat{y}) E_0 \cos(x - y - \omega t)$ (b) $\vec{B}(\vec{r}, t) = -\frac{1}{c}(\hat{x} - \hat{y}) E_0 \cos(x - y - \omega t)$

(c) $\vec{B}(\vec{r}, t) = -\frac{1}{c}(\hat{x} + \hat{y}) E_0 \cos(x - y - \omega t)$ (d) $\vec{B}(\vec{r}, t) = \frac{1}{c\sqrt{2}}(\hat{x} - \hat{y}) E_0 \cos(x - y - \omega t)$

7. In a lossy dielectric material of relative permitivity 12, the displacement current density is 25 times greater than conduction current at 1 MHz. The conductivity of the dielectric is:

(a) $267\ \Omega^{-1}\text{m}^{-1}$ (b) $534\ \Omega^{-1}\text{m}^{-1}$ (c) $150\ \Omega^{-1}\text{m}^{-1}$ (d) $750\ \Omega^{-1}\text{m}^{-1}$

8. A charge particle with charge 'q' moves with constant velocity $\vec{v}$ along z-direction. Its scalar and vector potentials are

$$\phi = \frac{q}{\sqrt{(1-\beta^2)(x^2+y^2)+(z-vt)^2}} \text{ and } \vec{A} = \frac{\vec{v}}{c^2}\phi$$

where $\beta = \frac{v}{c}$ and c is speed of light. These potentials define electromagnetic waves under

(a) Coulomb Gauge only. (b) Lorentz-Gauge only.
(c) Both (d) Neither

9. For normal incidence at air-dielectric (non-magnetic) interface with dielectric constant $\varepsilon_r = 4$. The fraction of energy reflected in to air is given by

(a) 0.36 (b) 0.22 (c) 0.11 (d) 0.04

10. A beam of unpolarized light is incident on a glass plate at an angle of 60° from normal, the reflected light is completely plane polarized. If angle of incidence is 45°, the angle of refraction is:

(a) $\sin^{-1}\left(\frac{\sqrt{3}}{2}\right)$ (b) $\cos^{-1}\left(\frac{\sqrt{3}}{2}\right)$ (c) $\sin^{-1}\left(\frac{1}{\sqrt{6}}\right)$ (d) $\sin^{-1}\left(\frac{1}{\sqrt{3}}\right)$

11. Two electromagnetic waves superimpose to give resultant electric field $\vec{E} = E_0 \cos kz \sin \omega t \hat{i}$. which of the following statements is ***NOT*** correct

(a) corresponding magnetic field is $\vec{B} = \frac{E_0 k}{\omega} \sin kz \cos \omega t\ \hat{j}$

(b) the waves are propagating in opposite direction along *z*-axis.

(c) average value of energy density is $\frac{1}{2}\varepsilon_0 E_0^2$

(d) average value of energy density is $\frac{1}{4}\varepsilon_0 E_0^2$

12. When two plane electromagnetic waves whose electric fields are $\vec{E}_1 = E_0\hat{i}\sin\left(kz - \omega t + \frac{\pi}{3}\right)$ and $\vec{E}_2 = E_0\hat{j}\sin\left(kz - \omega t - \frac{\pi}{6}\right)$ are superposed the resulting wave is

(a) A standing wave
(b) Left elliptically polarized progressive wave
(c) Left circularly polarized progressive wave
(d) Plane polarized progressive wave

13. Consider a transformation of electromagnetic potentials $\vec{A} \to \vec{A}'$, $\phi \to \phi'$ which leaves the electromagnetic fields unchanged. If transformed vector potential is $\vec{A}' = \vec{A} - \frac{A_0 t}{r^2}\hat{r}$, the transformed scalar potential (ϕ') is

(a) $\phi + \frac{A_0}{r}$ (b) $\phi + \frac{A_0}{r^2}$ (c) $\phi - \frac{A_0}{r}$ (d) $\phi - \frac{A_0}{r^2}$

14. In an air filled rectangular wave guide y-component of electric field of a TE mode is given by

$$E_y = 5\sin\left(\frac{m\pi x}{2}\right)\cos\left(\frac{n\pi y}{3}\right)\sin\left(2\pi \times 10^8 t - 12z\right)\text{V/m}$$

where x and y are in meters. The possible modes of operation are:

(a) TE_{10}, TE_{01} & TE_{11} (b) Only TE_{10} (c) Only TE_{01} (d) TE_{10} & TE_{01}

15. A long straight solenoid of radius R and 'n' turns per unit length carries a current $I = \alpha t$, where $'\alpha'$ is constant and 't' is time. The axis of the solenoid is along z-axis. The poynting vector $(\vec{S})$ at a distance $(s < R)$ from the axis of solenoid is?

(a) 0 (b) $-\frac{\mu_0 n^2 \alpha^2 ts}{2}\hat{s}$ (c) $\frac{\mu_0 n^2 \alpha^2 t\, s}{2}\hat{s}$ (d) $-\frac{\mu_0 n^2 \alpha^2 R^2 t}{2s}\hat{s}$

CSIR-UGC-NET/JRF | GATE - PHYSICS

UNIT TEST-3

[ELECTROMAGNETIC THEORY]

Time : 00: 45 Hour **Date : 12-10-2017**

M.M. : 30

[ANSWERS]

1. (a)	2. (a)	3. (b)	4. (b)	5. (a)	6. (c)	7. (a)
8. (b)	9. (c)	10. (c)	11. (c)	12. (c)	13. (a)	14. (a)
15. (b)						