[94] SEAT No._____ No. of Printed Pages : 2 5C

No. of printed pages:02

Sardar patel University
Vallabh Vidyanagar
M Sc. II Sem. Examination
Subject: PS02CPHY23 Electrodynamics
Day & Date: Friday, 13th April 2018 Time: 2:00 to 5:00pm

Note: Symbols have their usual meaning **Max. Marks 70**

I Choose the best possible answer from the choices given below each questions (8x1) (8)

1. According to Faraday's law, $-\frac{\partial}{\partial t}\oint \boldsymbol{B}.\boldsymbol{ds}$ is equal to
   (a) $\oint \nabla \times \boldsymbol{A}\, d^3r$ (b) $\oint \boldsymbol{E}.\boldsymbol{dl}$
   (c) $\oint \boldsymbol{A}.\boldsymbol{ds}$ (d) $\oint \boldsymbol{E}.\boldsymbol{ds}$

2. Find the direction of propagation of the electromagnetic wave whose electric field component is given by $\vec{E} = 20\sin(10^8 t - kz)\hat{y}$ V/m.
   (a) along x direction (b) along x-y plane
   (c) along y-z plane (d) along z direction

3. The magnetic polarization (magnetization), M results in a bound current J_b given by
   (a) $\boldsymbol{J_b = \nabla.M}$ (b) $\boldsymbol{J_b = \nabla XM}$
   (c) $\boldsymbol{J_b = 4\pi M}$ (d) $\boldsymbol{J_b = -\nabla M}$

4. In the case of an electromagnetic wave propagating through vacuum, its **E** and **B** components satisfy the relation given by
   (a) **E** and **B** fields are in phase (b) **E** lags behind the **B** field
   (c) **B** lagsbehind **E** field (d) **E** and **B** fields lags behind by 90^0.

5. A wave guide generally act as
   (a) an attenuator (b) low pass filter
   (c) resonator (d) high pass filter

6. In the radiation zone, the electric field component is related to the magnetic field component as
   (a) $\boldsymbol{E = cB \times \hat{r}}$ (b) $\boldsymbol{E = cB.\hat{r}}$
   (c) $\boldsymbol{E = \frac{c}{B}\hat{r}}$ (d) $\boldsymbol{E = c\hat{r} \times (B \times \hat{r})}$

7. The condition $\boldsymbol{\nabla.A = 0}$ is known as
   (a) Lorentz gauge condition (b) radiation gauge condition
   (c) Coulomb gauge condition (d) Axial gauge condition

8. The peak of the power density in the case of synchrotron radiation is proportional to relativistic factor γ as
   (a) γ^6 (b) γ^4
   (c) γ^8 (d) γ^2

II Attempt any seven of the following short answer questions (7x2) (14)

1. What are the boundary conditions satisfied by the **E** and **B** fields at the interface of two dielectric media.
2. Explain how Maxwell corrected the Ampere's law.
3. Define cut off frequency of a wave guide and give an expression for the cutoff wavelength of the dominant TE mode of propagation in a rectangular wave guide.
4. Explain the three zones surrounding an extended time varying source of electromagnetic radiation.
5. What is Cerenkov radiation? How is it different from synchrotron radiation?
6. Define retarded time, t_r and get an expression for retarded potentials.
7. Draw the angular distribution of the radiated power corresponds to Bremstrahlung radiation.
8. Show that $(\boldsymbol{v}.\nabla)\boldsymbol{r} = \boldsymbol{v}$ where v and r represent the retarded velocity of the moving charge and relative position of the charge with reference to the detector.
9. Explain why a hollow wave guide cannot propagate electromagnetic waves.

III A. Define Poynting vector. How is it related to the intensity of the electromagnetic wave? Then derive expression for the radiation pressure. (6)

B. Discuss the Reflection and Transmission of electromagnetic plane waves at normal incidence and show that R+T =1. (6)

OR

B. Obtain the dispersion relation for the electromagnetic plane wave propagating through a conducting medium. Deduce the real and imaginary parts of the propagation vector and interpret them separately with reference to the case of a very poor conducting and a good conducting medium. (6)

IV A. Define the retarded potentials and derive the generalized Coulomb's law. (6)

B. Explain Lie'nard-Wiechert potentials. Derive the power radiated by a non-relativistically moving point charge. Draw its power distribution pattern. (6)

OR

B. Find the potentials of a Hertzian dipole antenna. Derive its angular distribution of power radiated by this antenna. (6)

V A. Study the TE waves in a rectangular wave guide and obtain expression for the cutoff frequency. Compute the lowest cutoff frequency for the TE modes operating at a frequency of 30GHz for the wave guide whose cross section is 1.0 cm x 2.0 cm. (6)

B. For an oscillating magnetic dipole derive the electromagnetic potentials and the corresponding electric and magnetic fields. Then obtain an expression for the angular power distribution. (6)

OR

B. An air filled resonant cavity having dimensions a= 5 cm, b= 4 cm, and c= 10 cm is made of a conductor whose conductivity is 6×10^7 mhos/m. Determine its first three lowest order modes. (6)

VI A. Derive the Abraham- Lorentz formula and explain the physical basis of radiation reaction. (6)

B. Derive the Larmor formula in the case of power radiated by a moving point charge. (6)

OR

B. Derive the total power radiated by a relativistic point charge moving in a circular orbit. (6)

****