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[129] SEAT No._____

SEAT No._____ No. of Printed Papers: 02

SARDAR PATEL UNIVERSITY

M.Sc. (Physics) 2nd Semester Examination

Saturday, 23rd March, 2019

Subject: PS02CPHY23 (Electrodynamics)

Time: 02:00 pm to 05:00 pm **Total Marks: 70**

Q-1 Eight multiple choice questions. (MCQ) **[01 mark each]**

1. Total energy density of the electromagnetic field is given by____
   (a) $\varepsilon_0E^2 + \mu_0H^2$ (b) $1/2[\varepsilon_0E^2 + \mu_0H^2]$ (c) $1/2[\varepsilon_0E + \mu_0H]$ (d) None

2. For the interior of the hollow rectangular waveguide, ____ is zero
   (a) Curl of E (b) divergence of E (c) curl of B (d) None

3. "Magnetic monopoles do not exist". This statement is expressed as____
   (a) $\nabla \times B = \mu_0J + \mu_0\varepsilon_0\, dE/dt$ (b) $\nabla.E = 0$ (c) $\nabla \times E = -dB/dt$ (d) $\nabla.B = 0$

4. The dominant mode of EM transmission through a rectangular waveguide is____
   (a) TE_{11} (b) TM_{11} (c) TM_{10} (d) TE_{10}

5. What would be the length of a half wave dipole antenna operating in air at 50 MHZ?
   (a) 3 m (b) 6 m (c) 50 m (d) 25 m

6. A radio wave transmitting antenna is located in a city 15,000km away from a town. How much time does the signal from the antenna reach the town?
   (a) 3 ms (b) 40 μs (c) 50 ms (d) 5 μs

7. The Lorentz gauge condition is expressed as____
   (a) $\nabla.A = 0$ (b) $\nabla.A + \frac{\partial\phi}{\partial t} = 0$ (c) $\nabla.B = 0$ (d) r.A = 0

8. The Lienard –Wiechert potentials are related among themselves as _____
   (a) $\vec{A} = \frac{\vec{v}}{C^2}\varphi(r,t)$ (b) $\vec{A} = \frac{\vec{v}}{C}\varphi(r,t)$ (c) $\vec{A} = \frac{c}{v}\varphi(r,t)$ (d) $\vec{A} = C^2\varphi(r,t)$

Q -2 Attempt any 7 of the following 9 question briefly. **[02 marks each]**

1. Explain Poynting theorem.
2. Describe three fundamental laws of Optics.
3. Explain total internal reflection. What are the conditions for total internal reflection?
4. Define cutoff frequency of a wave guide and give an expression for the cutoff wavelength

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of the dominant TE wave in a rectangular wave guide.

5. A copper rectangular cavity resonator is structured by 3x1x4 Cm, Calculate its resonant frequency for TM_{110} dominant mode.
6. What are retarded potentials? How are they computed?
7. Explain the different field zones of an extended radiating source.
8. What are synchrotron, Bremsstrahlung and Cerenkov radiations?
9. What is retarded time? Where is it used?

Q-3

(a) Using Lorentz force derive total electromagnetic force on the electric charges in volume V in terms of Maxwell stress tensor. **[06]**

(b) Obtain three dimensional decoupled second order wave equations for $\vec{E}$ and $\vec{B}$ using Maxwell equations. Show that the $\vec{E}$ and $\vec{B}$ are always in phase with each other, mutually perpendicular to each other and perpendicular to propagation direction of EM wave. **[06]**

OR

(b) Obtain reflection and transmission coefficients for oblique incidence of electromagnetic wave at interface between dielectric media. **[06]**

Q-4

(a) Prove that the magnetic field always lags behind the electric field when the Electromagnetic wave travels in a conductor. **[06]**

(b) Obtain electric and magnetic field components for TM mode in hollow rectangular waveguide. **[06]**

OR

(b) Work out the TE mode in hollow cylindrical wave guide. **[06]**

Q-5

(a) Using retarded potentials derive the generalized Coulomb's law. **[06]**

(b) Show that the total radiated power of the Hertzian dipole antenna is proportional to the square of the normalized length of the dipole. Find out the radiation resistance of Hertzian dipole antenna. **[06]**

OR

(b) Derive the power radiated by a center-fed dipole linear antenna. Draw angular distribution of its power. **[06]**

Q-6

(a) Derive the Larmor formula for the power radiated by a point charge. **[06]**

OR

(b) Explain Lienard-Wiechert potentials. Derive the power radiated by a non-relativistically moving point charge. Draw its power distribution pattern. **[06]**

(b) Derive the Abraham-Lorentz formula and explain the physical basis of radiation reaction **[06]**