Code : 102101

B.Tech 1st Semester Special Exam., 2020

(New Course)

PHYSICS

(Electromagnetism)

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

*(iv) Question No. **1** is compulsory.*

(v) Symbols used (if any) have their usual meanings.

1. Answer any *seven* of the following questions : 2×7=14

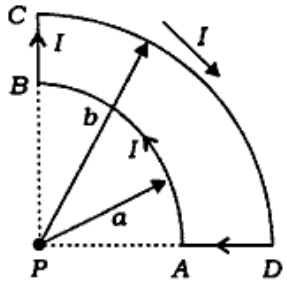
(a) Find the electric field inside a spherical shell of radius R that carries a uniform charge density σ.

(b) Write down Poisson's equation for electrostatic potential V.

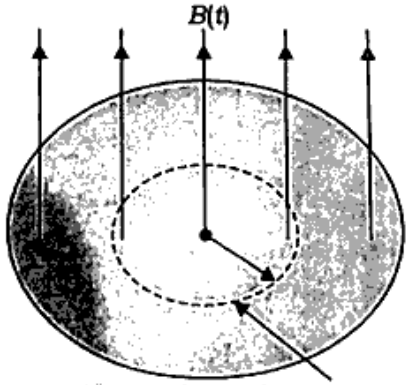
(c) What is the physical interpretation of bound charges?

(d) Define diamagnetism. Give two examples of diamagnetic materials.

(e) Find the magnetic field at point P for the following steady-state current I configuration :



(f) A uniform magnetic field $B(t)$, pointing straight up, fills the shaded circular region of given figure. If B is changing with time, what is the induced electric field?



Amperian loop of radius s

(g) Define displacement current.

(h) If the magnitude of $\vec{H}$ in a plane wave is 1 amp/meter, find the magnitude of $\vec{E}$ for the same wave in free space.
Given : $\mu_0 = 4\pi \times 10^{-7}$ H/m and
$\varepsilon_0 = 8 \cdot 85 \times 10^{-12}\, C^2/N\text{-}m^2$

(i) Write down the differential form of Maxwell's equations in vacuum.

(j) Define Biot-Savart law.

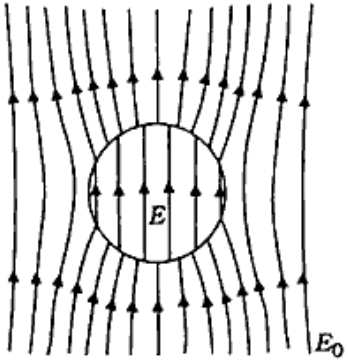
2. (a) Find the electric field at a distance z above the centre of a square loop (side a) carrying uniform line charge λ. 10

(b) Write down the expression for electric field due to surface charge distribution of surface charge density σ. 4

3. (a) A point charge q is situated at a distance a from the centre of a grounded conducting sphere of radius R. Using the method of images, find the potential outside the sphere. 10

(b) What is Faraday cage? 4

4. A sphere of homogeneous linear material is placed in an otherwise uniform electric field E_0 as shown in figure given below. Find the electric field inside the sphere : 14



5. Discuss magnetic vector potential. If $\vec{B}$ is the uniform, show that $\vec{A}(r) = -\frac{1}{2}(\vec{r} \times \vec{B})$, that is, check that $\vec{\nabla} \cdot \vec{A} = 0$ and $\vec{\nabla} \times \vec{A} = \vec{B}$. 4+10=14

6. Derive the expression for magnetic susceptibility for diamagnetic materials. Plot susceptibility vs. temperature for diamagnetic materials. 10+4=14

7. (a) Derive continuity equation for current densities. 7

(b) State and derive Poynting theorem. 7

8. Derive the expression for reflection coefficient of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence. 14

9. Write short notes on the following : 6+8=14

(a) Momentum carried by electromagnetic wave and resultant pressure

(b) Propagation of electromagnetic waves in vacuum and their transverse nature

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