# 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 $\sigma$.

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



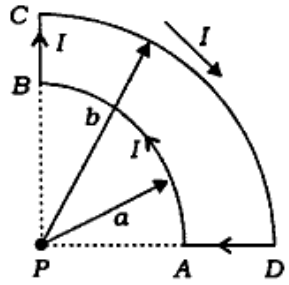




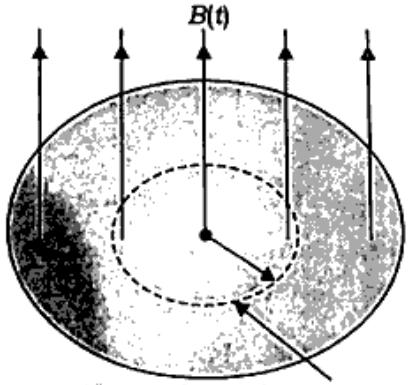
*(c)* What is the physical interpretation of bound charges?

*(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 $\lambda$. 10

(b) Write down the expression for electric field due to surface charge distribution of surface charge density $\sigma$. 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

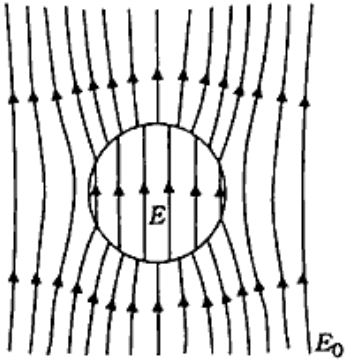








4. A sphere of homogeneous linear material is placed in an otherwise uniform electric field $E_0$ as shown in figure given below. Find the electric field inside the sphere : 14




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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