BENNETT UNIVERSITY

DO NOT WRITE ANYTHING ON QUESTION PAPER EXCEPT YOUR NAME, DEPARTMENT AND ENROLMENT No.

POSSESSION OF MOBILE, SMART WATCH ETC, IN EXAMINATION IS A UFM PRACTICE

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Department /School ---SCSET---

BENNETT UNIVERSITY, GREATER NOIDA

End-Term Examination, Odd Semester 2022-23

COURSE CODE: EPHY105L MAX. DURATION: **TWO HOUR**

COURSE NAME: ELECTROMAGNETICS MAX. MARKS: **35**

Note

- Please write the question number clearly on the answer script and follow the sequence.
- You have to show all the steps of the answer clearly.
- No part marking will be given if the steps are not shown clearly.

Q1. (a) Consider a vector $\vec{A} = xy\hat{x} + 2yz\hat{y} + 3xz\hat{z}$. Show that, for this vector $\vec{\nabla}.(\vec{\nabla} \times \vec{A}) = 0$. You need to show all the steps clearly.
(b) Consider a circular disc of radius R with surface charge density $\sigma = kr$, where k is a constant and r is the radial distance. Calculate the total charge of the disc.
(c) A $+q$ charge placed at the origin. Now bring another charge $+2q$ to the point (1,2,0) from infinity. Calculate the electrostatic work done in the process. 3+2+2

Q2. A long cylinder of radius R, carries a charge density $\rho = \frac{k}{s}$, where k is a constant and s is the distance from the axis. Using Gauss's law,
(a) find the electric field inside the cylinder, and
(b) find the electric field outside the cylinder. 4+3

Q3. (a) A magnetic dipole with dipole moment $\vec{m} = m_0\hat{z}$ is placed at the origin. Calculate the vector potential due to this dipole at the point (1,1,0).
(b) Calculate the magnetic field that gives rise to the vector potential $\vec{A} = y^2\hat{x} - x^2\hat{y}$. Find out the corresponding current density $\vec{J}$.
(c) Consider an infinitely long solenoid with circular cross-section of radius R having n turns per unit length and carrying a current I. A cylindrical rod of radius $a < R$ and made of a linear magnetic material of susceptibility χ_m is placed coaxial within the solenoid. Calculate the auxiliary field ($\vec{H}$) inside the rod using Ampere's law and from the result calculate the values of bound surface and volume current densities. 2+2+3

Q4: A thick and long cylindrical wire of radius R is carrying a current with volume current density $\vec{J} = J_0(1 - \frac{s}{R})\hat{z}$, where s is the distance from the axis of the cylinder and J_0 is a constant.

(a) Find the total current flowing through the wire.

(b) Calculate the magnetic field outside the cylinder at a distance s from the axis of the cylinder $(s > R)$.

(c) Using differential form of Ampere's law, find out the value of $\vec{\nabla} \times \vec{B}$ at a point on the axis of the wire.

3+2+2

Q5: Consider a thick spherical shell made of a linear dielectric material with inner radius R_1 and outer radius R_2. In the region $R_1 < r < R_2$, the displacement vector is given by $\vec{D} = \frac{2}{r^2}\hat{r}$.

(a) Find out the free charge density inside the shell.

(b) If the dielectric constant of the materials is 2, find the permittivity of the material and electric field $\vec{E}$ inside the shell?

(c) Consider a point charge Q placed at the center of a solid sphere of radius R which is made of a linear dielectric materials with dielectric constant K. Obtain the bound surface charge density on the surface of the sphere.

2+2+3