Roll No										

PRESIDENCY UNIVERSITY
BENGALURU

SET A

SCHOOL OF ENGINEERING
END TERM EXAMINATION - JAN 2024

Semester : Semester III - 2022
Course Code : ECE3004
Course Name : Electromagnetic Theory
Program : B.Tech.

Date : 08-JAN-2024
Time : 9:30AM - 12:30 PM
Max Marks : 100
Weightage : 50%

Instructions:
(i) Read all questions carefully and answer accordingly.
(ii) Question paper consists of 3 parts.
(iii) Scientific and non-programmable calculator are permitted.
(iv) Do not write any information on the question paper other than Roll Number.

PART A

ANSWER ALL THE QUESTIONS **4 X 5M = 20M**

1. Write down the mathematical relationships between the tangential and normal components of $E-$ fields at the interface between a dielectric and a perfect conductor whose $\sigma \to \infty$.

(CO3) [Knowledge]

2. Write down the differential form of the Gauss's law for both electrostatics and magnetostatics.

(CO4,CO3) [Knowledge]

3. For a region in free-space having a magnetic field given by $\overrightarrow{H} = zx\hat{i} + xy\hat{j} + yz\hat{k}\ (\text{in A/m})$, determine the magnetic flux-density and current-density at a point $P\,(1,1,1)$ using Ampere's circuital law in differential form.

(CO3,CO4) [Knowledge]

4. Find the vector triple product of three vectors $\overrightarrow{a} = \hat{i} + \hat{j} + \hat{k}$, $\overrightarrow{b} = 2\hat{i} + 3\hat{j} + 4\hat{k}$ and $\overrightarrow{c} = 4\hat{i} + 3\hat{j} + 2\hat{k}$ *i.e.* evaluate $\overrightarrow{a} \times \left(\overrightarrow{b} \times \overrightarrow{c}\right)$.

(CO1) [Knowledge]

PART B

ANSWER ALL THE QUESTIONS **5 X 10M = 50M**

5. Consider a charge $Q = 25 * 10 - 6\ \text{C}$ in free-space . Find the electric field intensity at a distance 2 m away from the charge using the Coulomb's law.

(CO3) [Comprehension]

6. Suppose the magnetic flux density is given by $\vec{B} = -20x\hat{i} + \beta y\hat{j} + 20\hat{k}\ (\text{in T})$ where β is an unknown constant. Using Gauss's law of magnetostatics, evaluate β.

(CO4,CO3) [Comprehension]

7. If $\vec{a}$, $\vec{b}$ and $\vec{c}$ are unit coplanar vectors, then find the scalar triple product $\left[\ 2\vec{a}-\vec{b}\ \ 2\vec{b}-\vec{c}\ \ 2\vec{c}-\vec{a}\ \right]$.

(CO1) [Comprehension]

8. Suppose the xy-plane is the common boundary between two dielectric slabs (Regions ① and ②) of relative permittivities 1.1 and 6 respectively. If the electric field in Region ① is $\vec{E}_1 = 0.5\hat{a}_x - 1.2\hat{a}_y + 1.5\hat{a}_z\ (\text{in V/m})$, find the E-field intensities in Regions ① and ② and the angles made by the$E-$fields with the normals to the interface.

(CO3) [Comprehension]

9. Using the Biot-Savart's law, find the magnetic field

- (a) at a distance r from a finite line of length $2L$ carrying a uniform current $I\ (\text{in A})$ in free-space.
- (b) at the centre of a regular polygon of side N where each side is of length L, where each side carries a uniform current $I\ (\text{in A})$ in free-space.

(CO4,CO3) [Comprehension]

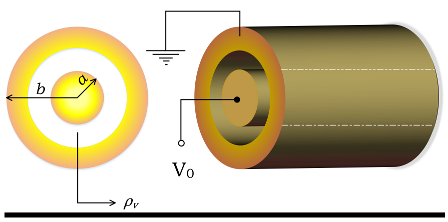
PART C

ANSWER ALL THE QUESTIONS **2 X 15M = 30M**

10. A point charge Q is placed at a distance d from the center of a grounded (at potential 0) conducting sphere of radius a . Calculate the charge induced on the surface of the sphere.

(CO3) [Application]

11. The figure below shows a coaxial cable in which the space between the inner and outer conductors is filled with an electron cloud having a volume density of charge $\rho_v = \frac{A}{r}$ for $a < r < b$where a and b are the radii of inner and outer conductors respectively. The inner conductor is held at a potential V_0 whereas the outer conductor is grounded (at 0 potential). Determine the potential distribution and the electric field in the region between the two conductors solving the Poisson's equation. You may find the expressions for the Laplacian $\nabla^2_{\text{cyl}}V = \frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial V}{\partial r}\right) + \frac{1}{r^2}\frac{\partial^2 V}{\partial \phi^2} + \frac{\partial^2 V}{\partial z^2}$ and the gradient $\nabla_{\text{cyl}} = \hat{a}_r\frac{\partial}{\partial r} + \hat{a}_\phi\frac{1}{r}\frac{\partial}{\partial \phi} + \hat{a}_z\frac{\partial}{\partial z}$ in cylindrical form useful for your solution.



(CO3) [Application]