Roll No												

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING
END TERM EXAMINATION - JAN 2023

Semester : Semester III - 2021
Course Code : ECE3004
Course Name : Sem III - ECE3004 - Electromagnetic Theory
Program : B.Tech. Electronics and Communication Engineering

Date : 16-JAN-2023
Time : 1.00PM - 4.00PM
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.

PART A

ANSWER ALL THE FIVE QUESTIONS **5 X 2 = 10M**

1. What is the gradient of the function $x^2 + y^2 + z^2$ at the point (1,1,1)?

(CO1) [Knowledge]

2. If a circular conducting loop carrying current (in clockwise direction) is placed in the XY-plane, what will be the direction of magnetic field? Justify your answer mentioning the relevant law.

(CO2) [Knowledge]

3. Write down the mathematical relationship between electric field and electric potential.

(CO2) [Knowledge]

4. Can a static magnetic field produce an electric field? Why or why not?

(CO3) [Knowledge]

5. An electric field associated with an EM wave is given by $\vec{E} = E_0 \cos(\omega t - \beta x)\,\hat{a}_z$. What is the direction of the electric field and that of propagation of the wave?

(CO4) [Knowledge]

PART B

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

6. (a) What do you mean by an irrotational vector? Give an example of an irrotational function.
(b) A function is given as $\vec{F} = (y+z)\,\hat{i} + (z+x)\,\hat{j} + (x+y)\,\hat{k}$. Find its divergence and curl. Verify that the function is irrotational and hence find its scalar potential.

(CO1) [Comprehension]

7. (a) Give the statement of Gauss's law.
(b) Write down the mathematical form of Gauss's law for both electrostatics and magnetostatics.
(c) Consider an infinite sheet placed in the ZX-plane that has a uniform charge density of $\rho_S\ \mathrm{C/m^2}$. Using Gauss's law, find the electric field at any point on the Y -axis, perpendicular to the sheet.
(d) Can electric field exist inside a perfect conductor?

(CO2) [Comprehension]

PART C

ANSWER ALL THE THREE QUESTIONS **3 X 20 = 60M**

8. (a) Write down the statement of Faraday's law
(b) Write down the mathematical form of mathematical law
(c) What is the unit of magnetic flux density?
(d) Can a static magnetic field produce an electric field? Why? Or why not?
(e) If the electric field intensity in free-space is given as $\vec{E} = E_0 \sin(\alpha x) \sin(\omega t)$, find the magnetic field intensity $\vec{H}$ using Faraday's law.

(CO2) [Application]

9. Write down the mathematical form of Ampere's circuital law and Faraday's law. Assume a homogenous material of infinite extent with $\varepsilon = 2 \times 10^{-6}$ (F/m) and $\mu = 1.25 \times 10^{-5}$ (H/m). Let the electric field intensity be $\vec{E} = 400\cos(10^6 t - kz)\,\hat{\imath}$ (V/m). If all the fields vary sinusoidally, find $k, \vec{D}, \vec{B}\ and\ , \vec{H}$. You can use the Ampere's circuital law and the Faraday's law for your solution.

(CO3) [Application]

10. An electric field intensity is given in free-space as $\vec{E} = 100 * \cos\left(10^6 t - z * 10^6 \sqrt{\mu_0 \varepsilon_0}\right)\ (V/m)$. Calculate the following

a. Amplitude, frequency and speed of propagation of the wave
b. Directions of propagation of the wave and the magnetic field associated with this wave
c. Phase-constant β
d. If the free-space is replaced by a medium of $\varepsilon_r = 81$ (i.e. water) calculate the change in velocity of propagation of the water

(CO4) [Application]

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