Roll No.												

PRESIDENCY UNIVERSITY
BENGALURU

School of Engineering

Mid - Term Examinations - November 2024

Semester: III | **Date**: 05/11/2024

Course Code: EEE2028 | **Time**: 02:00pm – 03:30pm

Course Name: Electromagnetic Fields | **Max Marks**: 50

Program: B. Tech-EEE | **Weightage**: 25%

Instructions:

(i) Read all questions carefully and answer accordingly.

(ii) Do not write anything on the question paper other than roll number.

Part A

Answer ALL the Questions. Each question carries 2marks. **5QX2M=10M**

1	Depending upon the nature of the quantity under consideration, the field may be a vector or a scalar field. Define a scalar and vector with some examples.	2 Marks	L1	CO1
2	Define the following fields. a. Divergence of a vector b. curl of a vector	2 Marks	L1	CO1
3	A fundamental fact of electricity is that every proton and electron in an atom have a unique, fascinating trait called an electric charge. State Coulomb's law	2 Marks	L1	CO2
4	Define Electric dipole. List the expression for Electric field E due to a dipole.	2 Marks	L1	CO2
5	State point form of Ohm's law	2 Marks	L1	CO2

Part B

Answer ALL Questions. Each question carries 10 marks. **4QX10M=40M**

6	6a.	The steepness of the slope at a point is given by the magnitude of the gradient vector. The gradient can also be used to measure how a scalar field changes in other directions. In view of this solve for the gradient of the following functions in their respective coordinates. $P = 10x^2y + 8y^3z$, $Q = rz\cos\Phi$	6Marks	L3	CO1
	6b.	The collection of partial derivative operators. is commonly called the del operator. summarize the possible ways of using the del operator in electromagnetic fields.	4Marks	L2	CO1

or

7	7a.	A point or vector can be represented in any curvilinear coordinate system, which may be orthogonal or nonorthogonal. Examples of orthogonal coordinate systems include the Cartesian (or rectangular), the circular cylindrical, the spherical, the elliptic cylindrical, the parabolic cylindrical. Given the point P(-2, 6, 3), solve for P to cylindrical and spherical coordinates.	4Marks	L3	CO1
	7b.	The divergence of a vector field simply measures how much the field is expanding at a given point. It does not indicate in which direction the expansion is happening. Hence, the divergence is a scalar. Interpret the divergence of the following vector fields: (a) $P = x^2yz\ a_x + xz\ a_z$ (b) $Q = r\sin\varphi\ a_r + r^2\ z\ a_\varphi + z\cos\varphi\ a_z$	6Marks	L3	CO1
8		Explain the concept of directional derivative. The temperature in an auditorium is given by, $T = x^2 + y^2 - z$ A mosquito located at (1, 1, 2) in the auditorium desires to fly in such a direction that it will get warm as soon as possible. Interpret the direction must it fly?	10Marks	L2	CO1
9	9a.	A vector field is uniquely characterized by its divergence and curl. Neither the divergence nor curl of a vector field is sufficient to completely describe the field. Given the vector field $G = (16xyz)\ a_x + (8x^2)\ a_y - x\ a_z$. Illustrate whether the given field is irrotational or not.	5Marks	L2	CO1
	9b.	The divergence of a vector field simply measures how much the field is expanding at a given point. If a gas is heated, it will expand. This will cause a net motion of gas particles outward in all directions. Consider the vector field given below, and identify its strength at the point Q(-2,1,6). Model the results. P = x2yz ax + xz az	5Marks	L3	CO1
10	10a.	Explain Gauss's law with the mathematical expression	3Marks	L2	CO2
	10b.	Coulomb's law is an experimental law formulated in 1785 by the French colonel, Charles Augustin de Coulomb. It deals with the force a point charge exerts on another point charge. Point	7Marks	L3	CO2

		charges 5 nC and -2 nC are located at (2,0,4) and (-3,0, 5), respectively. Apply Coulomb's law to determine the force on a 1-nC point charge located at (1, —3, 7).			
		or			
11	11a.	If the electric field exists in a region consisting of two different media, the conditions that the field must satisfy at the interface separating the media are called boundary conditions. These conditions are helpful in determining the field on one side of the boundary if the field on the other side is known Explain the boundary conditions with respect to Electric field at the boundary between a)two different dielectric media with dielectric constants $\epsilon r1$ and $\epsilon r2$ b) A dielectric and a conductor	5Marks	L2	CO2
	11b.	Given the potential $V = \frac{10}{r^2} \sin\theta \cos\varphi$, Solve for the electric flux density D at $(2, \pi/2, 0)$	5Marks	L3	CO2
12	12a.	A total charge Q = 60 μC is split into two equal charges located at 180° intervals around a circular loop of radius 4 m. Estimate the potential at the center of the loop.	5Marks	L3	CO2
	12b.	The Electro-hydrodynamic (EHD) pumping is based on the force transmitted to the cooling fluid by charges in an electric field. The procedure for determining the electric field E is either using Coulomb's law or Gauss's law when the charge distribution is known, or from the potential V if it is known throughout the region. In free space if $V = x^2 y(z + 3)$ V, find E at (3, 4, -6)	5Marks	L3	CO2
		or			
13	13a.	The flux due to the electric field E can be calculated using the general definition of flux in electric field. For practical reasons, however, this quantity is not usually considered as the most useful flux in electrostatics. The vector field D is called the electric flux density and is measured in coulombs per square meter. Given that $D = z\, r \cos^2(Ø)\, az$ C/m^2, infer the volume charge density at (1, Π/4, 3) in C/m3	4Marks	L2	CO2

13b.	The xerographic copying machine is an important application of electrostatics. The surface of the photoconductor is initially charged uniformly. When light from the document to be copied is focused on the photoconductor, the charges on the lower surface combine with those on the upper surface to neutralize each other. The image is developed by pouring a charged black powder over the surface of the photoconductor. The electric field attracts the charged powder, which is later transferred to paper and melted to form a permanent image. Using Laplace's equation we can determine the electric field below and above the surface of the photoconductor. Among the following choose the vector fields which obeys Laplace's equation.	6Marks	L3	CO2

1) $V= r\,z\sin\varphi + r^2$, 2) $x^2 + y^2 - 2z^2 + 10$