Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER–IV EXAMINATION – WINTER 2025

Subject Code:3140912 Date:15-11-2025

Subject Name:Electromagnetic Fields

Time:02:30 PM TO 05:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			MARKS
Q.1	**(a)**	Define (1) Scalar Field (2) Vector Field (3) Cross product	**03**
	(b)	Explain spherical coordinate system. Write the expression of incremental volume element and any two surface areas of the volume element. Derive the expression of scalar transformation between cartesian and spherical coordinate system.	**04**
	(c)	An electric field intensity is given as $\vec{E} = \frac{100\cos\theta}{r^3} a_r + \frac{50\sin\theta}{r^3} a_\theta$, at a point $P(r=2, \theta=60, \phi=20)$ find (a) $\lvert\vec{E}\rvert$ and (b) a unit vector in the direction of $\vec{E}$ at P in cartesian coordinate system	**07**
Q.2	**(a)**	Derive the expression of work done in moving a point charge from an initial position A to final position B	**03**
	(b)	Define divergence and explain its physical significance	**04**
	(c)	An infinite uniform sheet charge of $\rho_s = 2nC/m^2$ is present at $x=3$ in free space and an infinite uniform line charge of $\rho_L = 20nC/m$ is located at $x=1, z=4$. Find the direction of electric field intensity at $P(4,5,6)$.	**07**
		OR	
	(c)	Calculate $\lvert\vec{E}\rvert$ at $M(3,-4,2)$ in free space caused by charges $Q_1 = 2\mu C$ at $P_1(0,0,0)$ and $Q_2 = 3\mu C$ at $P_2(-1,2,3)$	**07**
Q.3	**(a)**	Explain the boundary condition for a dielectric material	**03**
	(b)	Derive the continuity of current equation in point form	**04**
	(c)	Evaluate both sides of divergence theorem for $\vec{D} = 3y^2 a_x + 3x^2 y a_x + 5a_z C/m^2$ over the surface $0 < x, y, z < 2$	**07**
		OR	
Q.3	**(a)**	Explain the phenomenon of Polarization	**03**
	(b)	Derive the expression of capacitance of a parallel plate capacitance	**04**
	(c)	For a given flux density vector $\vec{D} = (2\cos\theta/r^3)\vec{a_r} + (\sin\theta/r^3)\vec{a_\theta}$ C/m^2, evaluate the charge enclosed within the surface given by $1 < r < 2$, $0 < \theta < \pi/2$, $0 < \phi < \pi/2$ using gauss's law	**07**
Q.4	**(a)**	State and explain Biot-Savart's law	**03**

(b) A potential field is given as $V = 3x^2yz + ky^3z \ \ V/m$. Find k if the field satisfies Laplace's equation **04**

(c) If $\vec{H} = \frac{1}{\rho}\cos\phi\, a_\rho \ A/m$, determine the magnetic flux for the surface described by $\rho = 3\ m,\ 0 \le \phi \le \frac{\pi}{2},\ 0 \le z \le 3\ m$ **07**

OR

Q.4 **(a)** State and explain Ampere's circuital law **03**

(b) A potential field is given by $V = 2(x+1)^2(y+2)^2(z+3)^2 \ \ V/m$ in free space. Obtain ρ_v at $P(1,2,3)$ **04**

(c) Find incremental contribution $\Delta\vec{H}$ to magnetic field intensity at the origin caused by current element in free space equal to (a) $3\pi a_z \ nA$ located at $(3,-4,0)$ (b) (a) $3\pi a_z \ \mu A$ located at $(3,2,-4)$ **07**

Q.5 **(a)** Explain the magnetic boundary condition **03**

(b) Derive the expression of a force on differential current element **04**

(c) Write maxwells equations in point and integral form and state the meaning of each pair (pair means a set of equation in point and integral form) **07**

OR

Q.5 **(a)** Define self and mutual inductances **03**

(b) Derive the equation of force between differential current elements **04**

(c) State faraday's law. Derive the expression of faraday's law for time changing fields. Derive its point form. **07**

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Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER–IV (NEW) EXAMINATION – WINTER 2024

Subject Code:3140912 Date:21-11-2024

Subject Name: Electromagnetic Fields

Time:02:30 PM TO 05:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			Marks
Q.1	**(a)**	List the applications of the cross product.	**03**
	(b)	Calculate the divergence of the vector field G at the point P(1,−2,3) where G=yz ax + 4xy ay + y az.	**04**
	(c)	Explain the Cartesian coordinate system and derive the equations for differential length, differential surface area, and differential volume elements.	**07**
Q.2	**(a)**	Describe the concept of the magnetic dipole moment.	**03**
	(b)	Analyse the expression for the electric field due to an infinite surface charge distribution in free space.	**04**
	(c)	Given point charges of 1 mC and −2 mC located at (3,2,−1) and (−1,−1,4) respectively, calculate the electric force on a 10 nC charge located at (0,3,1) and determine the electric field intensity at that point.	**07**
		OR	
	(c)	Explain the physical significance of divergence and state its properties.	**07**
Q.3	**(a)**	Explain the phenomenon of polarization.	**03**
	(b)	Describe the boundary conditions for dielectric materials.	**04**
	(c)	Derive the boundary conditions at a dielectric-dielectric interface.	**07**
		OR	
Q.3	**(a)**	Explain concept of electric potential difference	**03**
	(b)	Write Poisson's and Laplace equation. Also state use of this equation.	**04**
	(c)	Define potential difference and potential gradient. Also Establish relation between Electrical field and potential gradient.	**07**
Q.4	**(a)**	State and explain Biot-Savart's law.	**03**
	(b)	State and explain Ampere's circuital law.	**04**
	(c)	Derive Maxwell's equations in both integral and differential forms.	**07**
		OR	
Q.4	**(a)**	Differentiate between a steady magnetic field and a time-varying magnetic field.	**03**
	(b)	Define the physical significance of the curl of a vector field.	**04**
	(c)	Derive Stokes' theorem and present its mathematical expression.	**07**
Q.5	**(a)**	Define inductance and explain the concepts of self-inductance and mutual inductance.	**03**
	(b)	Classify different types of magnetic materials.	**04**
	(c)	Explain the force between two differential current elements.	**07**

OR

Q.5	**(a)**	Discuss the applications of the Lorentz force equation.	**03**
	(b)	Define displacement current and current density.	**04**
	(c)	Analyze Maxwell's equations for Static fields. Explain how they are modified for time varying electric and magnetic fields. Derive the time varying Maxwell's equation for curl of H and also mention its physical significance.	**07**

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GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV (NEW) EXAMINATION – WINTER 2023

Subject Code:3140912 Date:17-01-2024

Subject Name: Electromagnetic Fields

Time: 10:30 AM TO 01:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

Q.1	**(a)**	Explain cylindrical coordinate system in brief.	**03**
	(b)	Explain Electrical dipole.	**04**
	(c)	Explain spherical coordinate system and give the relationship between Cartesian and spherical coordinate system.	**07**
Q. 2	**(a)**	State and explain Coulomb's law.	**03**
	(b)	State and explain the Gauss's law.	**04**
	(c)	Obtain equation for flux density due to infinite line charge using Gauss's law.	**07**
		OR	
	(c)	Give the potential field, $V = 2x^2y - 5z$, and a point P (–4, 3, 6). Find out the several numerical value at P (1) the potential V, (2) the Electric field Intensity E, (3) the direction of E, (4) the electric flux density D and the volume charge density ρ_v.	**07**
Q.3	**(a)**	Define displacement current and current density.	**03**
	(b)	Derive the point form of the continuity equation.	**04**
	(c)	Obtain the Expression for field intensity **H** at the center of a circular carrying current **I**, using Biot-Savart law.	**07**
		OR	
Q.3	**(a)**	Explain concept of dot product and cross product.	**03**
	(b)	Explain phenomenon of polarization.	**04**
	(c)	Discuss Poisson's and Laplace equation.	**07**
Q.4	**(a)**	Classify magnetic materials.	**03**
	(b)	Explain the physical significance of the term: Curl of a vector.	**04**
	(c)	Derive Maxwell's equation in integral and Point form.	**07**
		OR	
Q.4	**(a)**	Explain difference between steady magnetic field and time varying magnetic field.	**03**
	(b)	Define divergence.	**04**
	(c)	Explain Stoke's theorem with its mathematical expression.	**07**
Q.5	**(a)**	Explain concept of electric potential difference.	**03**
	(b)	State and explain Ohm's law in point form.	**04**
	(c)	Eplain boundary conditions between two perfect dielectric materials.	**07**
		OR	
Q.5	**(a)**	Explain concept of scalar magnetic potential and magnetic vector potential.	**03**
	(b)	Explain Electrical field as the Gradient of the electrical potential.	**04**
	(c)	State and explain ampere's circuit law, both in integral differential form as used in magnetic field.	**07**

Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV(NEW) EXAMINATION – WINTER 2022

Subject Code:3140912 Date:14-12-2022

Subject Name:Electromagnetic Fields

Time:10:30 AM TO 01:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			MARKS
Q.1	**(a)**	Explain how cross product of vectors can be obtained. Does cross product obey the commutative law? Comment	**03**
	(b)	A certain vector F is given by $F = -5a_x - a_y(3x+2) + a_z$. Find $\|F\|$ and unit vector in the direction of F	**04**
	(c)	Discuss cylindrical and spherical co-ordinate system of vectors. Also explain how a vector in Cartesian co-ordinate system can be converted into cylindrical and spherical system.	**07**
Q.2	**(a)**	State Coulomb's law and hence define electric field intensity	**03**
	(b)	If $Q_1 = 3 \times 10^{-4}$ C is located at M (1,2,3) and $Q_2 = -10^{-4}$C is located at N(2,0,5) in vacuum, find the vector force on Q_2 by Q_1 using Coulomb's law	**04**
	(c)	Derive the equation for electric field intensity due to uniform sheet charge located at z = 0 plane at any point on the positive z-axis. What do you infer from the result obtained?	**07**
		OR	
	(c)	Determine the total charge (i) on cylinder $\rho = 3$, $0< z <4$, if $\rho_s = \rho z^2$ nC/m^2. (ii) within the sphere if $\rho_v = 10/r\sin\theta$ C/m^3	**07**
Q.3	**(a)**	State and explain Gauss' law.	**03**
	(b)	An infinite line charge on the z-axis passes through the centre of the cylinder (having radius ρ) which is lying on the z = 0 plane. Using Gauss' law, find the total charge enclosed	**04**
	(c)	Discuss the application of Gauss' law to differential volume element and hence explain divergence theorem	**07**
		OR	
Q.3	**(a)**	State the expression for work done in carrying a point charge from one place to another in an electric field. Hence, define potential difference.	**03**
	(b)	In the region of free space that includes the volume, $2<x,y,z<3$ and $D = \frac{2}{z^2}(yza_x + xza_y - 2xya_z)$ C/m^2, find the total charge enclosed using divergence theorem.	**04**
	(c)	Define potential gradient. Prove that E = -grad V	**07**
Q.4	**(a)**	State the point form of Ohm's law	**03**
	(b)	Derive the continuity equation $\nabla \cdot J = -\frac{\partial \rho_v}{\partial t}$	**04**
	(c)	State and explain uniqueness theorem	**07**
		OR	
Q.4	**(a)**	State and explain Biot Savart's law	**03**

	(b)	Starting from the point form of Gauss' law, derive Poisson's and Laplace's equations	**04**
	(c)	Given the vector magnetic potential $A = -\rho^2/4\ a_z\ Wb/m^2$, calculate the total magnetic flux crossing the surface, $\Phi = \pi/2$, $1< \rho <2m$, $0< z <5m$.	**07**
Q.5	**(a)**	State and explain Lorentz force equation	**03**
	(b)	Explain the term 'displacement current' in brief	**04**
	(c)	For uniform magnetic field intensity, prove that torque on a closed circuit is given by the cross product of magnetic dipole moment and flux density.	**07**

OR

Q.5	**(a)**	Explain Stoke's theorem in brief.	**03**
	(b)	Explain in brief, different types of magnetic materials	**04**
	(c)	Discuss Maxwell's equations in integral form and point form. Explain how they relate and electric and magnetic fields with each other. State applications of the same	**07**

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