

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) $\vec{E} = \frac{100 \cos \theta}{r^3} a_r + \frac{50 \sin \theta}{r^3} a_\theta$ An electric field intensity is given as $P(r=2, \theta=60, \phi=20)$ find (a) $ \vec{E} $ 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 $ \vec{E} $ 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 **07**
described by $\rho = 3$ m, $0 \leq \phi \leq \frac{\pi}{2}$, $0 \leq z \leq 3$ m

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) $3\pi a_z$ μ 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**
