GURU NANAK INSTITUTE OF TECHNOLOGY
An Autonomous Institute under MAKAUT
2022
ELECTROMAGNETIC THEORY AND TRANSMISSION LINE
EI404

TIME ALLOTTED: 3 HOURS   **FULL MARKS: 70**

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable

GROUP – A
(Multiple Choice Type Questions)

Answer any *ten* from the following, choosing the correct alternative of each question: 10×1=10

		Marks	CO No.
1(i)	A field can exists if it satisfies –	1	CO6

    a) Gauss's Law
    b) Faraday's Law
    c) Coulomb's Law
    d) All Maxwell's equation

(ii) Which one is true for charge free region?   1   CO2
    a) $\nabla^2 \phi = 1$
    b) $\nabla^2 \phi = 0$
    c) $\nabla^2 \phi = -\varepsilon/\rho$
    d) none of the these

(iii) Given a vector, $\mathbf{A} = 3x\mathbf{a}_x + y\,\mathbf{a}_y + 5z\mathbf{a}_z$ find the curl of $\mathbf{A}$ 1   CO1
    a) xz
    b) 0
    c) 4z
    d) x+z

(iv) What is the unit of magnetic field intensity?   1
    a) ampere – meter square   CO4
    b) coulomb
    c) ampere – meter
    d) ampere

(v) For static magnetic field   1   CO4
    a) $\nabla \times \mathbf{B} = \rho$
    b) $\nabla \times \mathbf{B} = \mu\mathbf{J}$
    c) $\nabla \cdot \mathbf{B} = \mu_0 \mathbf{J}$
    d) $\nabla \times \mathbf{B} = 0$

(vi) For free space   1   CO2
    a) $\mathbf{E} = -\nabla V$
    b) $\mathbf{E} = -\nabla V - \mathbf{A}$
    c) $\mathbf{E} = -\nabla V - \mathbf{B}$
    d) $\mathbf{E} = -\nabla V - \mathbf{D}$

(vii)	Curl of gradient $\nabla \times \nabla V$ a) -1 b) 1 c) infinity d) zero	1	CO2
(viii)	Divergence of gradient of a vector function is equivalent to a) Laplacian operation b) Curl operation c) Double gradient operation d) Null vector	1	CO2
(ix)	Gauss's law in point form is a) $\nabla . \mathbf{D} = \rho_v$ b) $\nabla . \mathbf{D} = \rho_s$ c) $\nabla . \mathbf{D} = Q$ d) $\nabla \mathbf{D} = \rho_v$	1	CO2
(x)	For free space a) $\sigma = \infty$ b) $\sigma = 0$ c) $J = 0$ d) b & c	1	CO5
(xi)	Which one is conservation of charge equation for thr steady currents? a) 1 b) $\nabla . \mathbf{J} = 0$ c) $\nabla . \mathbf{J} = 4\pi$ d) $\nabla . \mathbf{J} = \rho$	1	CO3
(xii)	The cross product of the vectors $3i + 4j - 5k$ and $-i + j - 2k$ is, a) $-3i + 11j + 7k$ b) $3i - 11j + 7k$ c) $-3i - 11j - 7k$ d) $-3i + 11j - 7k$	1	CO1

GROUP – B
(Short Answer Type Questions)
(Answer any *three* of the following)

3 x 5 = 15

|		Marks	CO No.
2. a)	What do you mean by solenoidal field.	1	CO1
b)	What do you mean by irrotational field	1	CO1
c)	State & explain Stoke's theorem.	3	CO1
3.	By Applying Biot-Savart's law find out magnetic intensity vector **H** for an infinite long wire	5	CO4
4.	Why electrostatic field is a conservative field? Explain	5	CO2
5.	Two point charges of equal mass m, and charge Q are suspended at a common point by two threads of negligible mass and length l. Show that at equilibrium the inclination angle α of each thread to the vertical is given by $$Q^2 = 16\pi\varepsilon_0 \, mgl^2 \sin 2\alpha \, \tan\alpha$$ If α is very small show that: $$\alpha = [Q^2 / 16\pi\varepsilon_0 mgl^2]^{1/3}$$	5	CO2

		Marks	CO No.
6.	What necessary modification had been done by Maxwell for time varying EM field? Explain your answer starting from Ampere's Circuital law.	5	CO4

GROUP – C
(Long Answer Type Questions)
(Answer any *three* of the following)

$3 \times 15 = 45$

		Marks	CO No.
7. a)	What is Transmission line?	2	CO6
b)	Draw and explain the equivalent circuit of a transmission line.	5	
c)	Determine wave equation for lossy dielectric medium.	8	CO6
8.a)	Given point P (-2, 6, 3) and vector $\mathbf{A} = y \, \mathbf{a_x} + (x + z) \, \mathbf{a_y}$, express P and $\mathbf{A}$ in cylindrical and spherical coordinates. Evaluate $\mathbf{A}$ and P in the Cartesian, cylindrical, and spherical systems.	5	CO1
8.b)	Write down the definitions of : a) irrotational field, b) solenoidal field, c) conservative field	3	CO1
8.c)	For a vector field A, show explicitly that $\nabla . \nabla \times A = 0$.	3	CO1
8.d)	Given that $\mathbf{F} = x^2 \mathbf{a_x} - xz \, \mathbf{a_y} - y^2 \mathbf{a_z}$, calculate the circulation of F around the closed path shown in Figure	4	CO1
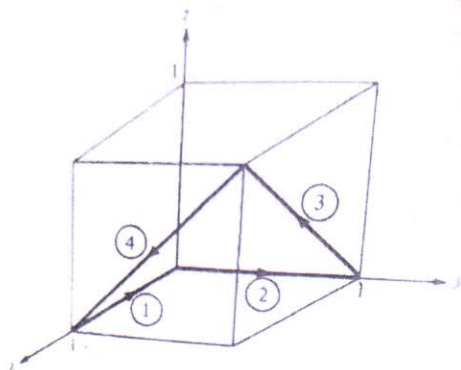
		Marks	CO No.
9.a)	State and prove Divergence theorem.	5	CO2
9.b)	Write the physical signification of divergence and curl.	4	CO2
9.c)	Define coulomb's law.	2	CO3
9.d)	What is Laplacian operator? Write Poisson's equation	4	CO3
10.a)	State and explain Gauss's law in differential form and explain what you mean by div. **D.**	5	CO3
10.b)	Prove that $E = -\nabla V$.	3	CO2
10.c)	Two point Charges -4 μC and 5 μC are located at (2,-1,3) and (0,4,-2) respectively. Find the potential at (1,0,1), assuming zero potential at infinity.	4	CO2
10.d)	State and explain Faraday's Law and Lenz's law of Electromagnetic induction.	3	CO5
11.	Write a short notes from the given following (any three)	$3 \times 5 = 15$	
a)	Maxwell's equation for static fields	5	CO3
b)	Magnetic Vector potential.	5	CO4
c)	Electric field due to a uniformly charged sphere.	5	CO2
d)	Energy density in Electrostatic field	5	CO2
e)	Poynting Theorem	5	CO5