GURU NANAK INSTITUTE OF TECHNOLOGY
An Autonomous Institute under MAKAUT
2022
ELECTROMAGNETIC FIELDS
EE404

TIME ALLOTTED : 3 Hrs 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 scalar potential $\varphi = xyz$, then the vector $\underset{F}{\rightarrow} = Grad\ \varphi$ is (a) Irrotational (b) Solenoidal (c) Both (a) & (b) (d) None of these	1	CO1
	(ii) The continuity equation for steady current is (a) Vector around the path (b) Intensity around the path (c) Circulation around the path (d) Density around the path	1	CO3
	(iii) Pointing vector signifies (a) Power density vector producing electromagnetic field (b) Current density vector producing electromagnetic field (c) Power density vector producing electrostatic field (d) Current density vector producing electrostatic field	1	CO4
	(iv) The vector identity of $\nabla \times (\nabla \times \vec{A})$ (a) $\nabla(\nabla.\vec{A}) - \nabla^2\vec{A}$ (b) $\nabla(\nabla \times \vec{A}) - \nabla^2\vec{A}$ (c) $(\nabla \times \vec{A}) - \nabla^2\vec{A}$ (d) $\nabla \times (\nabla.\vec{A}) - \nabla^2\vec{A}$	1	CO4
	(v) Curl of a gradient of a scalar field results (a) A scalar function with non-zero value (b) A vector function with non-zero value (c) A zero vector (d) A periodic function	1	CO1

(vi)	The magnetic field strength $\vec{H}$ produced by a conductor carrying current I at a distance 'r' is given by (a) $\vec{H}$= 2Πrl (b) $\vec{H}$= $I/2\Pi r$ (c) $\vec{H} = I/4\Pi r$ (d) $\vec{H}$= $4\Pi r/I$	1	CO2
(vii)	The concept of displacement current was a major contribution attributed to (a) Faraday's law (b) Lenz law (c) Lorentz equation (d) Maxwell equation	1	CO3
(viii)	Which of the following is not Maxwell's equation? (a) $\vec{\nabla}.\vec{D} = \rho$ (b) $\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$ (c) $\vec{\nabla} \times \vec{H} = J + \frac{\partial \vec{D}}{\partial t}$ (d) $\vec{\nabla}.\vec{J} = -\frac{\partial \vec{\rho}}{\partial t}$	1	CO3
(ix)	A solenoid of length 50 cm, having 100 turns carries a current of 2.5 A. What will be the magnetic field in the interior of solenoid (a) $3.14 \times 10^{-4} T$ (b) $6.28 \times 10^{-4} T$ (c) $6.28 \times 10^{-6} T$ (d) $3.14 \times 10^{-6} T$	1	CO4
(x)	In good conductors, the phases of $\underset{E}{\rightarrow}$ and $\underset{H}{\rightarrow}$ differ by (a) 0^0 (b) 45^0 (c) 90^0 (d) 180^0	1	CO4
(xi)	Electric field containing in charge free regions can be found using (a) Laplace's equation (b) Poisson's equation (c) Coulombs law (d) Helmholtz equation	1	CO2
(xii)	Volume charge density is given by (a) $\frac{dq}{dl}$ (b) $\frac{dq}{ds}$ (c) $\frac{dq}{dA}$ (d) $\frac{dq}{dV}$	1	CO1

GROUP – B
(Short Answer Type Questions)
(Answer any *three* of the following) 3 x 5 = 15

		Marks	CO No.
2.	State and explain vector form of Coulomb's law in electrostatic field.	5	CO4
3.	State and explain Stokes Theorem.	5	CO2
4.	Show that for a moving field point and a fixed source point Grad ($\frac{1}{r}$) $= -\left(\frac{1}{r^2}\right)\underset{a_r}{\rightarrow}$, where r is the distance between the source point & the field point.	5	CO1
5.a)	Given a vector, $\underset{A}{\rightarrow} = \left(\frac{5}{r^2}\right)\sin\varphi \underset{a_r}{\rightarrow} + r\cot\theta \underset{a_\theta}{\rightarrow} + r\sin\theta\cos\varphi \underset{a_\varphi}{\rightarrow}$ Find the curl of $\underset{A}{\rightarrow}$	3	CO2
b)	Write down Magnetic scalar potential & magnetic vector potential.	2	CO1
6.	Derive the equation of continuity for time varying fields i.e $\underset{\nabla}{\rightarrow}.\underset{J}{\rightarrow} + \frac{\partial\rho}{\partial t} = 0$	5	CO3

GROUP – C
(Long Answer Type Questions)
(Answer any *three* of the following) 3 x 15 = 45

		Marks	CO No.
7. a)	What is Poynting Vector? Prove that Poynting vector gives the power flow per unit area of cross-section, at a point in the medium.	7	CO4
b)	Derive Biot-Savart's law from magnetic vector potential.	3	CO2
c)	Prove that the electric field intensity is negative gradient of potential that is $E = -\nabla.V$	5	CO1
8.a)	Discuss Poisson's and Laplace's equation.	8	CO3
b)	Derive the wave equation for a conducting medium in terms of magnetic field intensity, $\underset{H}{\rightarrow}$ $$\nabla^2 \underset{H}{\rightarrow} = \mu\sigma\frac{\partial \underset{H}{\rightarrow}}{\partial T} + \mu\varepsilon\frac{\partial^2 \underset{H}{\rightarrow}}{\partial t^2}$$	7	CO4
9.a)	Deduce boundary conditions for electric vector $\vec{E}$ and $\vec{D}$ for dielectric-dielectric interface.	7	CO2
b)	A plane polarized wave is travelling along Z-axis. Show that $\frac{E_y}{H_z} = 377\Omega$	8	CO4
10.a)	Write and explain differential & integral forms of Maxwell's equations for free space and sinusoidal time varying fields.	7	CO3
b)	Find the conduction and displacement current densities in a material having conductivity of 10^{-3}s/m and $\varepsilon_r = 2.5$ if the electric field in the material is $E = 5.0 \times 10^{-6}\sin(9.0 \times 10^9 t)\ v/m$	5	CO2
c)	Find whether the potential functions in a region of free space satisfy the Laplace's equation: $V = \frac{30}{r^2}\cos\theta$	3	
11.	Write short notes on any *three* of the following:	3x5=15	
a)	Modified Ampere's circuital law	5	CO2
b)	Displacement Current	5	CO1
c)	Faraday's Law of Electromagnetic Induction	5	CO1
d)	Skin effect and skin depth	5	CO2
e)	Uniform plane wave	5	CO3