Total No. of Questions: 6 *Total No. of Printed Pages:3*

Enrollment No.....

Faculty of Engineering

End Sem (Even) Examination May-2022

EC3CO08 Engineering Electromagnetics

Programme: B.Tech. Branch/Specialisation: EC

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated.Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d.

Q.1 i. Dot product of a_x Cartesian coordinate with a_r spherical coordinate gives- **1**

(a) sinΘ cosΦ (b) sinΘ sinΦ

(c) cosΘ cosΦ (d) - sinΦ cosΘ

ii. $\nabla.(\nabla X \vec{A})$ is equal to- **1**

(a) $\nabla X \nabla \vec{A}$ (b) $\nabla^2 \vec{A}$ (c) 0 (d) 1

iii. A spherical shell of charge Q and radius R is centered at origin, electric field inside the spherical shell of radius a, where a<R **1**

(a) $\frac{Q}{4\pi\varepsilon R^2}$ (b) $\frac{Q}{4\pi\varepsilon a^2}$ (c) 0 (d) None of these

iv. Equipotential surface is a- **1**

(a) Real surface (b) Complex surface

(c) Imaginary surface (d) Not existing surface

v. What is the magnetic field intensity $\bar{H}$ for infinite sheet placed on Z-constant plane carrying surface current $\bar{K}= K_y a_y$ **1**

(a) $-K_y a_y$ (b) $\frac{1}{2} K_y a_y$ (c) $\frac{1}{2} K_y a_x$ (d) Zero

vi. Find the inductance when the energy is given by 2 Joule with a current of 16A. **1**

(a) 15.6mH (b) 36.5mH (c) 20.8mH (d) 72.8mH

vii. Which Maxwell's equation will be true, for free space condition? **1**

(a) $\nabla X \vec{B} = 0$ (b) $\nabla . \vec{B} = 0$ (c) $\vec{B} = \nabla . \vec{D}$ (d) $\vec{D} = \nabla X \vec{B}$

viii. The Poynting vector $\bar{P} = \bar{E} \times \bar{H}$ has the dimension of- **1**

(a) Power / Unit area (b) Volts

(c) Power (d) Volt / Unit length

P.T.O.

ix. In the uniform plan wave, the value of |E|/ |H| is- **1**
(a)$\sqrt{\mu/\varepsilon}$ (b) $\sqrt{\varepsilon/\mu}$ (c) $1/\sqrt{\mu\varepsilon}$ (d) $\sqrt{\mu\varepsilon}$

x. In which direction is the plane wave $\bar{E}$= 50 sin (10^6 t + 2z) a_y V/m. Travelling? **1**
(a) Along y-direction. (b) Along -ve y-direction.
(c) Along z-direction (d) Along –ve z-direction.

Q.2 i. Given three vectors $\vec{A}$ =2 a_x + a_y; $\vec{B}$ = 2 a_x + 2a_y – 2 a_z; $\vec{C}$ =2a_y + 2 a_z find $\vec{A}$. ($\vec{B}$ X $\vec{C}$). **2**

ii. Show that the field, $\vec{F}$ (ρ, Φ, z) = $\left(\frac{150}{\rho^2}\right)$ a_ρ + 10 a_Φ (cylindrical coordinate) is rotational and non-solenoidal. **3**

iii. If $\vec{G}$ (r, Θ, Φ) = 5 r $\sin^2$ Θ $\cos^2$ Φ a_r, evaluate both sides of the divergence theorem for the region r ≤ 2, 0 < Θ ≤ π, 0< Φ ≤ 2π **5**

OR iv. A vector field is given by $\vec{A}$ (ρ, Φ, z) = ρ cosΦ a_ρ + ρ z sinΦ a_z, transform this vector into rectangular co-ordinates and calculate its magnitude at P (1,0,1). **5**

Q.3 i. Determine the one-dimensional solution of Laplace equation in cylindrical coordinate system for V = f(ρ) only. **2**

ii. Derive the expression for energy density stored in electrostatic field. **3**

iii. Charge is distributed throughout the volume of a spherical conductor of radius ‘a’.Find: **5**
(a) $\vec{E}$ and V everywhere i.e. r < a, r = a, r > a
(b) Sketch E versus r

OR iv. A line charge density 24 nC/m is located in free space on the line lies y=1, z=2 find, **5**
(a) Find E at P (6, -1, 3).
(b) What point charge should be located at (-3, 4, 1) to cause y component of E to be zero at P?

Q.4 i. State Biot –Savart’s law and write its formula in vector form. **2**

ii. When the vector magnetic potential is given by $\vec{A}$(r, Θ, Φ) = $\frac{1}{r^3}$ (2cosΘ a_r + sinΘ a_Θ), find the magnetic flux density. **3**

iii. An infinite sheet of current is placed at z =0. The surface current density of the current sheet is K. The current is flowing in the positive y direction. Find the magnetic field intensity due to this infinite current sheet by using Ampere’s circuital law. **5**

OR iv. Derive magnetic boundary conditions for normal and tangential component. **5**

Q.5 i. Define Lorentz force and write its formula for moving charge in presence of both electric and magnetic fields. **2**

ii. What is displacement current? Derive its formula using point form of Ampere’s circuital law. **3**

iii. Derive four Maxwell’s equation in point form and integral form for Harmonically varying fields. **5**

OR iv. State and prove Poynting theorem also show that average power $P_{avg} = \frac{1}{2}\frac{E_m}{\eta}$ ($\frac{Watt}{m^2}$). **5**

Q.6 i. What is Polarization of wave? Write three differences between Linear, Elliptical and Circular polarization. **4**

ii. Derive the reflection co-efficient for a parallel (vertically) polarized wave incident obliquely at the interface of two dielectric, also find the Brewster angle. **6**

OR iii. A 9375 MHz uniform plane wave propagates in polystyrene (ε_r = 2.56, μ_r = 1). If amplitude of electric field intensity is 20 V/m and material is assumed to be lossless, find **6**
(a) Phase constant
(b) Wavelength
(c) Velocity of propagation
(d) Intrinsic impedance
(e) Propagation constant
(f) Amplitude of magnetic field intensity.

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Marking Scheme
EC3CO08 Engineering Electromagnetics

Q.1	i.	Dot product of a_x Cartesian coordinate with a_r spherical coordinate gives- (a) sinΘ cosΦ	**1**
	ii.	$\nabla . (\phi)$ is equal to- (c) 0	**1**
	iii.	A spherical shell of charge Q and radius R is centered at origin, electric field inside the spherical shell of radius a, where a<R (c) 0	**1**
	iv.	Equipotential surface is a- (c) Imaginary surface	**1**
	v.	What is the magnetic field intensity $\overline{H}$ for infinite sheet placed on Z-constant plane carrying surface current $\overline{K} = K_y a_y$ (b) $\frac{1}{2} K_y a_y$	**1**
	vi.	Find the inductance when the energy is given by 2 Joule with a current of 16A. (a) 15.6mH	**1**
	vii.	Which Maxwell's equation will be true, for free space condition? (b) $\nabla . \vec{B} = 0$	**1**
	viii.	The Poynting vector $\overline{P} = \overline{E} \times \overline{H}$ has the dimension of- (a) Power / Unit area	**1**
	ix.	In the uniform plan wave, the value of |E|/ |H| is- (a) $\sqrt{\mu/\varepsilon}$	**1**
	x.	In which direction is the plane wave $\overline{E} = 50 \sin (10^6 t + 2z) a_y$ V/m. Travelling? (d) Along –ve z-direction.	**1**
Q.2	i.	Given three vectors $\vec{A} = 2 a_x + a_y$; $\vec{B} = 2 a_x + 2a_y - 2 a_z$; $\vec{C} = 2a_y + 2 a_z$ find $\vec{A} . (\vec{B} \times \vec{C})$. 2 Marks	**2**
	ii.	Rotational 1.5 Marks Non-solenoidal. 1.5 Marks	**3**
	iii.	Evaluate both sides of the divergence theorem (2.5 Marks*2)	**5**
OR	iv.	Transform this vector into rectangular co-ordinates and calculate its magnitude at P (1,0,1). (2.5 Marks*2)	**5**
Q.3	i.	Determine the one-dimensional solution of Laplace equation (As per explanation)	**2**
	ii.	Derive the expression for energy density stored in electrostatic field.	**3**
	iii.	(a) $\vec{E}$ and V everywhere i.e. r < a, r = a, r > a 2.5 Marks (b) Sketch E versus r 2.5 Marks	**5**
OR	iv.	(a) Find E at P (6, -1, 3). 2.5 Marks (b) What point charge should be located at (-3, 4, 1) to cause y component of E to be zero at P? 2.5 Marks	**5**
Q.4	i.	State Biot –Savart's law 1 Marks its formula in vector form. 1 Marks	**2**
	ii.	Magnetic flux density. (As per explanation)	**3**
	iii.	Find the magnetic field intensity due to this infinite current sheet by using Ampere's circuital law. (As per explanation)	**5**
OR	iv.	Derive magnetic boundary conditions for normal and tangential component. (As per explanation)	**5**
Q.5	i.	Define Lorentz force 1 Mark write its formula 1 Mark	**2**
	ii.	What is displacement current 1 Mark Derive its formula. 2 Marks	**3**
	iii.	Derive four Maxwell's equation in point form and integral form for Harmonically varying fields. (1.25 Marks*4)	**5**
OR	iv.	State and prove Poynting theorem 2.5 Marks show that average power $P_{avg} = \frac{1}{2} \frac{E_m}{\eta} (\frac{Watt}{m^2})$. 2.5 Marks	**5**
Q.6	i.	What is Polarization of wave 1 Mark Write three differences between Linear, Elliptical and Circular polarization. 3 Marks	**4**
	ii.	Derive the reflection co-efficient 4 Marks find the Brewster angle. 2 Marks	**6**
OR	iii.	(a) Phase constant 1 Mark (b) Wavelength 1 Mark	**6**

(c) Velocity of propagation 1 Mark
(d) Intrinsic impedance 1 Mark
(e) Propagation constant 1 Mark
(f) Amplitude of magnetic field intensity. 1 Mark

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