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

Enrollment No.....

Faculty of Engineering

End Sem (Odd) Examination Dec-2018

EE3CO05/EX3CO05 Electro-Magnetic Theory

Programme: B.Tech. Branch/Specialisation: EE/EX

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. The divergence of a field is zero, indicates the field is **1**

(a) Irrotational (b) Solenoidal

(c) Scalar (d) Vector

ii. Which of following is zero? **1**

(a) Grad div A (b) Div Gradient V

(c) Div curl A (d) Curl curl A

iii. A metal sphere with 1 m radius and surface charge density of 10 Coulombs/m^2 is enclosed in a cube of 10 m side. The total outward electric displacement normal to the surface of the cube is **1**

(a) 40 π Coulombs (b) 10 π Coulombs

(c) 5 π Coulombs (d) None of these

iv. A field line and an equipotential surface are **1**

(a) Always parallel (b) Always at 90°

(c) Inclined at any angle (d) None of these

v. Changing the magnetic field intensity in a closed loop of wires induces **1**

(a) Current (b) Voltage

(c) Both (a) and (b) (d) Neither of these

vi. If a current element is z-directed, vector magnetic potential is **1**

(a) x-directed (b) y-directed

(c) xy-directed (d) z-directed

vii. The magnetic field intensity (in mA) at the centre of a circular coil of diameter 1 metre and carrying a current of 2 A is **1**

(a) 8 (b) 4 (c) 3 (d) 2

P.T.O.

viii. In a travelling electromagnetic wave, E and H vector fields are **1**
(a) Perpendicular in space
(b) Parallel in space
(c) E is in the direction of wave travel
(d) H is in the direction of wave travel

ix. Polarization of a wave is **1**
(a) Direction of electric field
(b) Direction of magnetic field at some fixed point in space
(c) Either (a) or (b)
(d) None of these

x. A plane electromagnetic wave travelling along the + z direction, has its electric field given by $E_x = 2\cos(\omega t)$ *and* $E_y = 2\cos(\omega + 90^0)$ the wave is **1**
(a) Linearly polarized (b) Right circularly polarized
(c) Left circularly polarized (d) Elliptically polarized

Q.2 i. Discuss the concept of differential surface vector. **2**

ii. Transform vector $A = ya_x - xa_y + za_z$ into cylindrical coordinates. **3**

iii. Verify that the vector field $A = yza_x + zxa_y + xya_z$ is both irrotational and solenoid. **5**

OR iv. State and explain with physical significance : **5**
(a) Divergence theorem, (b) Stoke's theorem.

Q.3 i. State and prove continuity equation. **4**

ii. Explain Poisson's and Laplace equation. Show that it has unique solution. **6**

OR iii. Using Gauss law in differential form, obtain the electric field intensity at different points due to the following charge distribution in spherical coordinates, **6**

$$\rho(r, \theta, \Phi) = \begin{cases} \rho_0 (r/a), & o < r < a \\ 0, & a < r < \infty \end{cases}$$

Q.4 i. Write short note on vector magnetic potential. **3**

ii. Derive the expressions for boundary relations for magnetic field for **7**
(a) Tangential components (b) Normal components.
Assume the two different media having constants μ_1, ϵ_1 and μ_2, ϵ_2. The common boundary has surface current density of K_s A/m.

OR iii. A filamentary current of 10 A is directed in from infinity to the origin on the positive *x* axis, and then back out to infinity along the positive *y* axis. Use the Biot-Savart law to find field intensity H at P (0, 0, 1). **7**

Q.5 i. Explain the terms **3**
(a) Intrinsic Impedance (b) Skin depth.

ii. Define and derive for Poynting Vector. **7**

OR iii. A 9375 MHz uniform plane wave is propagating in polystyrene. If the amplitude of the electric field intensity is 20 V/m and the material is assumed to be lossless, find: **7**
(a) Attenuation constant (α)
(b) Phase constant (β)
(c) Wavelength in polystyrene
(d) Velocity of propagation
(e) Intrinsic Impedance
(f) Propagation constant
(g) Amplitude of the magnetic field intensity.

Q.6 Attempt any two:

i. Explain polarization and derive the equation, **5**

$$D = \varepsilon_0 E + P$$

where D is electric flux density, E is electric field intensity and P is polarization.

ii. Write short note on: **5**
(a) Standing wave ratio (b) Brewster angle

iii. Explain and derive reflection of uniform plane waves. **5**

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Marking Scheme
EE3CO05/EX3CO05 Electro-Magnetic Theory

Q.1	i.	The divergence of a field is zero, indicates the field is (b) Solenoidal	**1**
	ii.	Which of following is zero? (c) div curl A	**1**
	iii.	A metal sphere with 1 m radius and surface charge density of 10 Coulombs/m^2 is enclosed in a cube of 10 m side. The total outward electric displacement normal to the surface of the cube is (a) 40 π Coulombs	**1**
	iv.	A field line and an equipotential surface are (b) always at 90°	**1**
	v.	Changing the magnetic field intensity in a closed loop of wires induces (c) Both (a) and (b)	**1**
	vi.	If a current element is z-directed, vector magnetic potential is (d) z-directed	**1**
	vii.	The magnetic field intensity (in mA) at the centre of a circular coil of diameter 1 metre and carrying a current of 2 A is (a) 8	**1**
	viii.	In a travelling electromagnetic wave, E and H vector fields are (c) E is in the direction of wave travel	**1**
	ix.	Polarization of a wave is (a) Direction of electric field	**1**
	x.	A plane electromagnetic wave travelling along the + z direction, has its electric field given by $E_x = 2\cos(\omega t)$ and $E_y = 2\cos(\omega + 90^0)$ the wave is (c) Left circularly polarized	**1**
Q.2	i.	Discuss the concept of differential surface vector. Equation 1 mark Explanation 1 mark	**2**
	ii.	Transform vector A = $ya_x - xa_y + za_z$ into cylindrical coordinates. r, Φ, z components 1 mark for each components (1 mark *3)	**3**
	iii.	Verify that the vector field A = $yza_x + zxa_y + xya_z$ is both Irrotational 2.5 marks	**5**
		Solenoid. 2.5 marks	
OR	iv.	State and explain with physical significance : (a) Divergence theorem, 2.5 marks (b) Stoke's theorem. 2.5 marks	**5**
Q.3	i.	State and prove continuity equation. Statement 1 mark Equations 1 mark Proof 2 marks	**4**
	ii.	Explain Poisson's and Laplace equation. Show that it has unique solution. Poisson's equation 3 marks Laplace equation 3 marks	**6**
OR	iii.	Using Gauss law in differential form, obtain the electric field intensity at different points due to the following charge distribution in spherical coordinates, Solution for o < r < a 3 marks Solution for a <r < ∞ 3 marks	**6**
Q.4	i.	Write short note on vector magnetic potential. Equation 1 mark Explanation 2 marks	**3**
	ii.	Derive the expressions for boundary relations for magnetic field for (a) tangential components and (b) normal components. Diagram 2 marks Tangential components 2.5 marks Normal components 2.5 marks	**7**
OR	iii.	Use the Biot-Savart law to find field intensity H at P(0, 0, 1). Hx component 3.5 marks Hx component 3.5 marks	**7**
Q.5	i.	Explain the terms (a) Intrinsic Impedance, 1.5 marks (b) Skin depth. 1.5 marks	**3**
	ii.	Define and derive for Poynting Vector.	**7**
OR	iii.	(a) attenuation constant (α), 1 mark	**7**

	(b) phase constant (β),	1 mark		
	(c) wavelength in polystyrene,	1 mark		
	(d) Velocity of propagation,	1 mark		
	(e) Intrinsic Impedance,	1 mark		
	(f) Propagation constant,	1 mark		
	(g) Amplitude of the magnetic field intensity.	1 mark		
Q.6	Attempt any two:			
i.	Polarization	2 marks	**5**	
	Derive the equation $D = \varepsilon_0 E + P$.	3 marks		
ii.	(a) Standing wave ratio,	2.5 marks	**5**	
	(b) Brewster angle	2.5 marks		
iii.	Plane waves at normal incidence		**5**	
	Diagram	1 mark		
	Equation	1 mark		
	Explanation	3 marks		

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