

# KADI SARVA VISHWAVIDHYALAYA

B.E. Semester V Examination November 2016

Subject Code: EC- 503

Date: 15/11/2016

Time: 10:30am to 01:30pm

Subject Name: Electromagnetic Theory

Total Marks: 70

## Instructions:

1. Answer Each Section in Separate Answer sheet.
2. Use of Scientific Calculator is permitted.
3. All questions are compulsory.
4. Indicate **clearly**, the options you attempted along with its respective question number.
5. Use the last page of supplementary for rough work.

## SECTION 1

**Q.1 (a)** Write differential normal surface area in Cartesian, cylindrical and spherical coordinate systems [05]

**(b)** Derive equation for Electric Field Intensity due to a line charge located in Z axis. [05]

**(c)** Convert points P(1,3,5),T(0,-4,3),and S(-3,-4,10) from Cartesian to cylindrical and spherical coordinates [05]

**OR**

**(c)** The three vertices of a triangle are located at A(6,-1,2),B(-2,3,-4),and C(-3,1,5). Find (a)  $\mathbf{R}_{AB} \times \mathbf{R}_{AC}$ ;(b) the area of the triangle;(c) a unit vector perpendicular to the plane in which the triangle is located. [05]

**Q.2 (a)** State Coulomb's law. Define Electric Field Intensity. [05]

**(b)** Derive equation for Electric Field Intensity due to a infinite sheet charge located in YZ plane. [05]

**OR**

**Q.2 (a)** Define Electric Flux density. Show that electric flux density is directly proportional to electric field strength. [05]

**(b)** Describe application of Gauss's law to differential volume element. [05]

**Q-3 (a)** Derive Maxwell's First equation,  $\text{div } \mathbf{D} = \rho_v$ . [05]

**(b)** Find a numerical value for Div  $\mathbf{D}$  at the point specified (i)  $\mathbf{D} = (2xyz-y^2)\mathbf{a}_x + (x^2z-2xy)\mathbf{a}_y + x^2y\mathbf{a}_z$  C/m<sup>2</sup> at P<sub>A</sub>(2,3,-1); (ii)  $\mathbf{D} = 2\rho z^2 \sin 2\phi \mathbf{a}_\rho + \rho z^2 \sin 2\phi \mathbf{a}_\phi + 2\rho z \sin^2 \phi \mathbf{a}_z$  C/m<sup>2</sup> at P<sub>B</sub> ( $\rho=2, \phi=110^\circ, z=-1$ ). [05]

**OR**

**Q-3 (a)** Describe application of Gauss's law to symmetrical charge distribution. [05]

**(b)** In free space, let  $\mathbf{D} = (8xyz^4)\mathbf{a}_x + (4x^2z^4)\mathbf{a}_y + 16x^2yz^3\mathbf{a}_z$  pC/m<sup>2</sup>. Find the total electric flux passing through the rectangular surface  $z=2, 0 < x < 2, 1 < y < 3$ , in the  $\mathbf{a}_z$  direction. [05]

## SECTION 2

- Q.4 (a)** State & explain Biot-Savart law [05]  
**(b)** Explain Ampere's Circuital law. [05]  
**(c)** Determine  $\mathbf{H}$  at  $P_2(0.4,0.3,0)$  in the field of an 8 A filamentary current directed inward from infinity to the origin on the positive x axis, and then outwards to infinity along y axis. [05]

**OR**

- (c)** A current filament carrying 15 A in the  $\mathbf{a}_z$  direction lies along the entire z axis. [05]  
Find  $\mathbf{H}$  in the rectangular coordinates at (i)  $P_A(\sqrt{20},0,4)$ ; (ii)  $P_B(2,-4,4)$

- Q.5 (a)** Explain potential gradient. [05]  
**(b)** Define current & current density. Show that  $\mathbf{J} = \rho_v \mathbf{V}$ . [05]

**OR**

- Q.5 (a)** Write boundary conditions for conductor-free space boundary. Write relations for  $\mathbf{E}$  and  $\mathbf{D}$  at boundary. [05]  
**(b)** Write expression for capacitance of coaxial cable and spherical capacitor formed by two concentric spherical conducting shell of radius a and b,  $b>a$  [05]

- Q-6 (a)** Explain Faraday's law. [05]  
**(b)** Show that  $\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$  [05]

**OR**

- Q-6(a)** Write Maxwell's 4 equations for time varying fields in point form. [05]  
**(b)** Explain magnetic boundary conditions [05]
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# KADI SARVA VISHWAVIDHYALAYA

B.E. Semester V Examination April 2015

Subject Code: EC- 503  
Date: 22/04/2015  
Time: 10:30am to 01:30pm

Subject Name: Electromagnetic Theory  
Total Marks: 70

**Instructions:**

1. Answer Each Section in Separate Answer sheet.
2. Use of Scientific Calculator is permitted.
3. All questions are compulsory.
4. Indicate **clearly**, the options you attempted along with its respective question number.
5. Use the last page of supplementary for rough work.

## SECTION 1

- Q.1 (a)** State the experimental law of Coulomb. Write the equation. [05]
- (b)** Derive the electric field at a point due to point charge. [05]
- (c)** Transform to cylindrical coordinates: (i)  $\mathbf{F} = 10a_x - 8a_y + 6a_z$  at point P(10,-8,6);  
(ii)  $\mathbf{G} = (2x+y)a_x - (y-4x)a_y$  at point Q( $\rho, \phi, z$ )  
**OR**
- (c)** Transform the following vectors to spherical coordinates at the points given ; [05]  
(i)  $10a_x$  at P( $x=-3, y=2, z=4$ )  
(ii)  $10a_y$  at Q( $\rho=5, \phi=30^\circ, z=4$ )
- Q.2 (a)** Derive the electric field at a point due to volume charge. [05]
- (b)** A charge of  $-0.3 \mu\text{C}$  is located at A(25,-30,15) (in cm), and a second charge of  $0.5 \mu\text{C}$  is at B(-10,8,12) cm. Find  $\mathbf{E}$  at: (i) the origin; (ii) P(15,20,50)cm. [05]

**OR**

- Q.2 (a)** Derive the Maxwell's First equation. [05]
- (b)** Explain Stokes theorem [05]
- Q.3 (a)** Explain Dipole. Derive equation for  $\mathbf{E}$  [05]
- (b)** Let the region  $z < 0$  be composed of a uniform dielectric material for which  $\epsilon_r = 3.2$ , while the region  $z > 0$  is characterized by  $\epsilon_r = 2.0$ . Let  $D_1 = -30a_x + 50a_y + 70a_z$  nC/m<sup>2</sup> and find: (i)  $D_{N1}$  (ii)  $D_{t1}$   
**OR**
- Q.3 (a)** Derive equation for energy expended in moving a point charge in an electric field. [05]
- (b)** If we take the zero reference for potential at infinity, find the potential at (0,0,2) caused by this charge configuration in free space (i) point charge of 12 nC on the line  $\rho=2.5$  m,  $z=0$ ; (ii) point charge of 18 nC at (1,2,-1) [05]

[PTO]

## SECTION 2

- Q.4 (a)** Explain and derive the equation for Biot Savart's law. State its significance. [05]
- (b) A current filament carrying  $15\text{A}$  in the  $\mathbf{a}_z$  direction lies along the entire  $z$  axis. [05]  
Find  $\mathbf{H}$  in rectangular coordinates at: (i)  $P_A (\sqrt{20}, 0, 4)$  (ii)  $P_B (2, -4, 4)$
- (c) Show the Gradient in terms of partial derivatives in rectangular, cylindrical and spherical coordinates. [05]

**OR**

- (c) Derive the point form of the Ohm's law. [05]
- Q.5 (a)** Write Maxwell's four equations for steady electric and steady magnetic field in point form & integral form. Give their statements and significance. [05]
- (b) Write equations for Capacitance of parallel plate, coaxial cable and two concentric spherical shells. State your assumptions. [05]

**OR**

- Q.5 (a)** Explain continuity of current [05]
- (b) Explain Poynting's theorem [05]
- Q.6 (a)** Explain uniqueness theorem. [05]
- (b) Explain Ampere's circuital law. [05]

**OR**

- Q.6(a)** Explain Wave polarization. [05]
- (b) Write notes on Standing wave ratio. [05]

# KADI SARVA VISHWAVIDHYALAYA

B.E. Semester V Examination November 2014

**Subject Code:** EC- 503  
**Date:** 18/11/2014  
**Time:** 10:30am to 01:30pm

**Subject Name:** Electromagnetic Theory  
**Total Marks:** 70

## Instructions:

1. Answer Each Section in Separate Answer sheet.
2. Use of Scientific Calculator is permitted.
3. All questions are compulsory.
4. Indicate **clearly**, the options you attempted along with its respective question number.
5. Use the last page of supplementary for rough work.

## SECTION 1

- Q.1 (a)** List the applications of Gauss's law. Explain any one. [05]
- (b)** Derive the electric field at a point due to line charge. [05]
- (c)** Infinite uniform line charge of  $5nC/m$  lie along the positive and negative x and y axes in free space. Find  $\mathbf{E}$  at (i)  $P_A(0,0,4)$  (ii)  $P_B=(0,3,4)$  [05]

### OR

- (c)** Find the total charge within each of the indicated volumes; [05]  
(i)  $0.1 \leq |x|, |y|, |z| \leq 0.2$ ;  $\rho_v = 1/(x^3 y^3 z^3)$   
(ii)  $0 \leq \rho \leq 0.1$ ,  $0 \leq \phi \leq \pi$ ,  $2 \leq z \leq 4$ ;  $\rho_v = \rho^2 z^2 \sin 0.6\phi$

- Q.2 (a)** List divergence of vector in rectangular, cylindrical and spherical coordinates. [05]
- (b)** An electric field is given as  $\mathbf{E} = -10e^y(\sin^2 z \mathbf{a}_x + x \sin^2 z \mathbf{a}_y + 2x \cos^2 z \mathbf{a}_z)$  V/m. [05]  
(i) Find  $\mathbf{E}$  at  $P(5,0,\pi/12)$ . (ii) How much work is done in moving a charge of 2 nC an incremental distance of 1mm from P in the direction of  $\mathbf{a}_x$ ? (iii) of  $\mathbf{a}_y$ ?  
(iv) of  $\mathbf{a}_z$ ? (v) of  $(\mathbf{a}_x + \mathbf{a}_y + \mathbf{a}_z)$ ?

### OR

- Q.2 (a)** Derive the point form of the continuity equation. [05]

- (b)** Explain Stokes theorem [05]

- Q.3 (a)** Explain Dipole. Derive equation for  $\mathbf{E}$  [05]

- (b)** Let  $\mathbf{J} = 400 \sin \theta / (r^2 + 4) \mathbf{a}_r$  A/m<sup>2</sup>. (a) Find the total current flowing through that portion of the spherical surface  $r=0.8$ , bounded by  $0.1\pi < \theta < 0.3\pi$ ,  $0 < \phi < 2\pi$ . (b) Find the average value of  $\mathbf{J}$  over the defined area .

### OR

- Q.3 (a)** Explain the boundary condition for perfect dielectric materials. [05]

- (b)** Let  $V(x,y) = 4e^{2x} + f(x) - 3y^2$  in a region of free space where  $\rho_v=0$ . It is known that both  $E_x$  and  $V$  are zero at the origin. Find  $f(x)$  and  $V(x,y)$ . [05]

## SECTION 2

- Q.4 (a)** Explain and derive the equation for Biot Savart's law. State its significance. [05]
- (b)** A conducting cylinder with a radius of 1 cm and at a potential of 20 V is parallel to a conducting plane which is at zero potential. The plane is 5 cm distant from the cylinder axis. If the conductors are embedded in a perfect dielectric for which  $\epsilon_r = 4.5$ , find (i) the capacitance per unit length between cylinder and plane; (ii)  $\rho_{s,\max}$  on the cylinder. [05]
- (c)** Explain energy density in the electrostatic field and show that [05]  
$$W_E = \frac{1}{2} \int_V D \cdot E \, dv$$

**OR**

- (c)** Derive the point form of the Ohm's law. [05]
- Q.5 (a)** Write Maxwell's four equations for steady electric and steady magnetic field in point form & integral form. Give their statements and significance. [05]
- (b)** Write equations for Capacitance of parallel plate, coaxial cable and two concentric spherical shells. State your assumptions. [05]

**OR**

- Q.5 (a)** Explain the dipole moment and derive equation for it. [05]
- (b)** Explain Poynting's theorem [05]
- Q-6 (a)** Explain uniqueness theorem. [05]
- (b)** Explain Displacement current. Derive Maxwell's equation  $\nabla \times \mathbf{H} = \mathbf{J} + \partial \mathbf{D} / \partial t$ . [05]

**OR**

- Q-6(a)** Explain Wave polarization. [05]
- (b)** Write notes on Standing wave ratio. [05]

# KADI SARVA VISHWAVIDYALAYA

B.E SEMESTER - V EXAMINATION (NOVEMBER / 2015)

SUBJECT CODE: EC -503

SUBJECT NAME: Electromagnetic Theory

DATE: 23/11/2015

TIME: 10:30am TO 1:30pm

TOTAL MARKS: 70

## Instructions:

1. Answer each section in separate Answer Sheet.
2. Use of scientific Calculator is permitted.
3. All questions are compulsory.
4. Indicate **clearly**, the options you attempted along with its respective question number.
5. Use the last page of main supplementary for rough work.

## Section - 1

Q: 1

- (A) Explain scalar and vector with examples. 05
- (B) Transform the vector  $B = ya_x - xa_y + za_z$  into cylindrical coordinates. 05
- (C) Transform the vector field  $G = (xz/y)a_x$  into spherical components and variables. 05  
**OR**
- (C) A charge  $Q_1 = 3 \times 10^{-4}$  C at M (1, 2, 3) and a charge  $Q_2 = -10^{-4}$  at N (2, 0, 5) are located in a vacuum. Find the force exerted on  $Q_2$  by  $Q_1$  05

Q: 2

- (A) Explain Gauss's law with question. 05
- (B) Evaluate both sides of the divergence theorem for the field  $D = 2xya_x + x^2a_y$  C/m<sup>2</sup> 05  
And the rectangular parallelepiped formed by the planes x=0 and 1, y=0 and 2, and z=0 and 3.  
**OR**
- (A) Find equation of the desired distant fields of the dipole E. 05
- (B) Potential  $V = 100(x^2 - y^2)$  and a point P (2, -1, 3) that is stipulated to lie on a conductor free space boundary. Find V, E, D and  $\rho_s$  at P and also the equation of the conductor surface. 05

Q: 3

- (A) Discuss boundary conditions for perfect dielectric materials. 05
- (B) Write short note on capacitance of a parallel plate capacitor. 05  
**OR**
- (A) Explain uniqueness theorem. 05
- (B) Derive poisson's and Laplace equations. 05

## Section - 2

Q: 4

- (A) State and explain Biot- Savart law with equations. 05  
(B) State and explain Stoke's theorem. 05  
(C) Explain Ampere's Circuital law. 05

**OR**

- (C) Discuss concept of scalar and vector magnetic potential. 05

Q: 5

- (A) Explain Faraday's law with equations. 05  
(B) Let  $\mu = 10^{-5} \text{ H/m}$ ,  $\epsilon = 4 \times 10^{-9} \text{ F/m}$ ,  $\sigma = 0$  and  $\rho_v = 0$ . Find k so that each of the following pairs of fields satisfies Maxwell's equations:  
(a)  $D = 6a_x - 2ya_y + za_z \text{ nC/m}^2$ ,  $H = kxa_x + 10ya_y - 25za_z \text{ A/m}$   
(b)  $E = (20y - kt)a_x V/m$ ,  $H = (y + 2 \times 10^6 t)a_z \text{ A/m}$

**OR**

- (A) Explain displacement current. 05  
(B) Explain Maxwell's equations in integral form. 05

Q: 6

- (A) Derive equations for Poynting vector. 05  
(B) The field intensity vector  $E_s = 100\angle 30^\circ a_x + 20\angle -50^\circ a_y + 40\angle 210^\circ a_z \text{ V/m}$ . 05  
Derive the vector as a real function of time.  
**OR**  
(A) What is skin effect? Derive equation of  $\alpha$  05  
(B) A uniform plane wave in air partially reflected from the surface of the material whose properties are unknown. Measurements of the electric field in the region in front of the interface yield a 1.5 m spacing between maxima, with the first maximum occurring 0.75m from the interface. A standing wave ratio of 5 is measured. Determine the intrinsic impedance  $\eta_u$ , of the unknown material. 05

-----All the Best -----