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Assignment - I, Third Semester, July -2023.

21ECC205T: ELECTROMAGNETIC THEORY AND INTERFERENCE

(Regulations 2021)

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Part – A

1. Convert the point $(3, \pi/3, -4)$ from cylindrical to Cartesian co-ordinates

   (A) $(3/2, 3\sqrt{3}/2, 4)$ (B) $(3/2, 3\sqrt{3}/2, -4)$

   (C) $(3\sqrt{3}/2, 3/2, -4)$ (D) $(3\sqrt{3}/2, 3/2, 4)$

2. Divergence of gradient of a vector function is equivalent to

   (A) Laplacian operator (B) Curl operation

   (C) Double gradient operation (D) Tangent

   Answer: Laplacian of the Scalar function

3. A point charge 2nC is located at origin. What is the potential at $(1,0,0)$?

   (A) 12 (B) 14

   (C) 16 (D) 18

4. The electrostatic energy in an electric field does not depend on which of the following?

   (A) Magnitude of charges (B) Permitivity

   (C) Applied electric field (D) Flux lines

5. Calculate the magnetic field at a point on the centre of the circular conductor of radius 2m with current 8A

   (A) 1 (B) 2

   (C) 3 (D) 4

6. The point form of Ampere Law is given by

   (A) Curl(B) = I (B) Curl(D) = J

   (C) Curl(V) = I (D) Curl (H) = J

7. Electric field intensity is

   (A) Directly proportional to the force applied

   (B) Inversely proportional to the force applied

   (C) Directly proportional to the permittivity

   (D) Inversely proportional to the charge

8. The amount of work done in moving a charge from one point to another along an equipotential line or surface charge is

(A) Infinity (B) Two

(C) Zero (D) One

9. Evaluate $\nabla.F$, if the vector $F = x^2 a_x + yza_y + xya_z$

(A) Z+2 (B) 2x+Z

(C) x+Z (D) 2x+2Z

10. Three point charges, $Q_1 = 30nC, Q_2 = 150nC,$ and $Q_3 = -70nC,$ are enclosed by surface, S. What net flux crosses S ?

(A) 250nC (B) 110nC

(C) -110nC (D) 100nC

11. Divergence of a vector $\vec{F}$ in a spherical coordinate system is given as

(A) $\frac{1}{r}\frac{\partial}{\partial r}(rF_x) + \frac{1}{r}\frac{\partial F_\phi}{\partial \phi} + \frac{\partial F_\theta}{\partial z}$ (B) $\frac{\partial F}{\partial r}\vec{a}_r + \frac{1}{r}\frac{\partial F}{\partial \phi}\vec{a}_\phi + \frac{\partial F}{\partial z}\vec{a}_z$

(C) $\frac{\partial F}{\partial \rho}\vec{a}_\rho + \frac{1}{\rho}\frac{\partial F}{\partial \theta}\vec{a}_\theta + \frac{1}{\rho \sin\theta . \partial \phi}\vec{a}_\phi$

(D) $\frac{1}{\rho^2}\frac{\partial}{\partial \rho}(\rho^2 F) + \frac{1}{\rho \sin\theta}\frac{\partial}{\partial \theta}(F\sin\theta) + \frac{1}{\rho \sin\theta}\frac{\partial F}{\partial \phi}$

12. Two vectors $\vec{A}$ and $\vec{B}$ are such that $\vec{A} + \vec{B} = n\vec{A}$, where 'n' is a positive scalar. The angle between $\vec{A}$ and $\vec{B}$ is _____.

(A) $\frac{\pi}{2}$ (B) $\frac{3\pi}{4}$

(C) π (D) 2π

13. Which of the following are zero?

(A) Grad div (B) div grad

(C) Div curl (D) curl grad

14. Point charges $Q_1 = 1nC$ and $Q_2 = 2nC$ are at a distance apart. Which of the following statements are correct?

(A) The force on Q_1 is repulsive (B) The force on Q_2 is along the line joining them

(C) As the distance between them decreases, the force on Q_1 increases linearly (D) Both A and B

15. Match List I and List II

List – I	List – II
A. $\nabla^2 V = \frac{-\rho_v}{\varepsilon}$	1. Gauss Law
B. $\nabla^2 V = 0$	2. Divergence Theorem
C. $\oint_s D.ds = Q$	3. Laplace Equation
D. $\oint_v \nabla.Ddv = \oint_s B.ds$	4. Poisson's Equation
	5. Strokes theorem

(A) A – 4, B – 2, C – 5, D – 1. (B) A – 4, B – 3, C – 1, D – 5.
(C) A – 3, B – 1, C – 2, D – 4. (D) A – 4, B – 3, C – 1, D – 2.

16. Which of these statement is not characteristics of a static magnetic field?
(A) It is solenoidal (B) Magnetic flux lines are always closed
(C) It is conservative (D) It has no sinks or sources.

17. The force per unit charge can be represented by
(A) Magnetic field intensity (B) Magnetic dipole
(C) Electric field intensity (D) Electric dipole

18. $a_r, a_\theta, a\phi$ are the unit vectors of
(A) Elliptic (B) Circular cylindrical
(C) Rectangular (D) Spherical

19. Which of the following describe the electric field intensity due to volume charge?
(A) $Div\ \mathrm{D} = \rho_L \rho_V$ (B) $Div\ \mathrm{D} = \rho_S \rho_V$
(C) $Div\ \mathrm{D} = \rho_V$ (D) $Div\ \mathrm{D} = 0$

20. Electric flux density in electric field is referred to as
(A) Number of flux lines (B) Ratio of flux lines crossing a Surface and the surface area
(C) Direction of flux at a point (D) Flux lines per unit area

21. At a point on the axis of an electric dipole
(A) Electric field is zero (B) Electric potential is zero
(C) Neither electric field and Electric potential is zero (D) Electric field is directed perpendicular to the axis

22. Ampere's circuital law obeys
(A) $H.dL = I$ (B) $\int E.dL = I$
(C) $\int J.dL = I$ (D) $\int D.dL = Q$

23. Relation between magnetic flux and magnetic flux density is
(A) $B = \mu_0 H$ (B) εE
(C) D=0 (D) $D = \frac{\mu}{E}$

24. Biot savart law in magnetic field is analogous to which law in electric field?
    (A) Gauss's law (B) Faraday's law
    (C) Coulomb's law (D) Ampere's law

25. Find the Maxwell equation derived from faraday's law
    (A) $DIV(H) = J$ (B) $DIV(D) = I$
    (C) $CURL(E) = \frac{-dB}{dt}$ (D) $CURL(B) = \frac{-dH}{dt}$

26. Magnetic field can be produced by
    (A) Conduction current (B) Displacement current
    (C) Both Conduction current And Displacement current (D) It is produced naturally

27. The law deals with the force that a point charge exerts on another point charge
    (A) Coulomb's law (B) Gauss's law
    (C) Biot-savart law (D) Ampere's circuital law

28. The electric field E is given by
    (A) $E = \nabla V$ (B) $E = -\nabla V$
    (C) $E = (\nabla.\nabla)V$ (D) $E = -(\nabla.\nabla)V$

29. The electric field intensity due to line charge is
    (A) $E = \frac{\rho_L}{2\pi\varepsilon_0 r}.a_r$ (B) $E = \frac{\rho_S}{2\pi\varepsilon_0 r}.a_r$
    (C) $E = \frac{\rho_L}{2\varepsilon_0}$ (D) $E = \frac{\rho_S}{2\varepsilon_0}$

30. There exists a total charge of 12nC in a spherical volume of $0.1m^3$, the volume charge density is
    A. $210\,nC/m^3$.
    B. $420\,nC/m^3$
    C. $100\,nC/m^3$
    D. $120\,nC/m^3$

31. Given a vector $A=3x.a_x + y.a_y + 5z.a_z$. The Curl of A is
    A. $\nabla XA=1$.
    B. $\nabla XA=0$.
    C. $\nabla XA=9x+y+25z$.
    D. $\nabla XA=\sqrt{3}x+\sqrt{1}y+\sqrt{5}z$.

32. The electric field intensity is defined as
    A. Force per unit charge
    B. Force on a test charge
    C. Force per unit charge on a test charge
    D. Product of force and charge

33. Which of the following correctly states Gauss law?

A. Electric flux is equal to charge
B. Electric flux per unit volume is equal to charge
C. Electric field is equal to charge density
D. Electric flux per unit volume is equal to volume charge density

34. What are the various coordinates of Cartesian Coordinate systems?

A. (x, y, z)

B. (ρ, ψ, z)

C. (r, θ, ψ)

D. (x, y, r)

35. Charges filled inside a cylindrical will posses flux in which direction?

A. Upwards
B. Downwards
C. Laterally outwards
D. Inwards

36. For $A = (1,3,4)$ and $B = (1,0,2)$, the value of $A.B$ is

A. 30
B. 9
C. 11
D. 65

37. If a force $F = 4a_x + a_y + 2a_z$ moves $1\mu C$ charge through a displacement of $4a_x + 2a_y - 6a_z$, the resultant work done is

A. $6\mu J$
B. $12\mu J$
C. $18\mu J$
D. $24\mu J$

39. Potential due to a charge at a point situated at ∞ is

A. Zero
B. ∞
C. $-\infty$
D. 1

PART – B

1. Find the electric field intensity at $P(-4,6,-5)$ in free space caused by a charge of $0.1mC$ at $(2,-1,-3)$.
2. Explain the concept of divergence theorem with their applications.
3. Explain the concept of displacement vector.
4. What are the different coordinate system used to represent field vectors? Discuss about them in brief.
5. Write in detail about the spherical coordinate system and the transformations.
6. Transform vector $\vec{B}=y.\vec{a}_x - x.\vec{a}_y + z.\vec{a}_z$ into cylindrical coordinates.
7. A Charge, Q_A=-20μC is located at $A(-6,4,7)$ and a charge, Q_B=50μC is at $B(5,8,-2)$ in free space. If the distances are given in meters, find (a) $\vec{R}_{AB}$ (b) $|\vec{R}_{AB}|$. Determine the vector force exerted on Q_A by Q_B if $\varepsilon_0 = 8.854\times10^{-12}$ F/m.
8. Transform vector $\vec{G} = \left(\frac{xz}{y}\right)\hat{a}_x$ into Spherical Coordinates.
9. Calculate the Electrical field intensity, $\vec{E}$ at $P(1,1,1)$ caused by four identical, $3nC$ charges located at $P_1(1,1,0), P_2(-1,1,0), P_3(-1,-1,0)$ and $P_4(1,-1,0)$.
10. A point charge $Q = 10nC$ is at the origin in free space. Find the electric field at $P(1,0,1)$. Also find the electric flux density at P
11. A pair of negative and positive charges of $10\mu C$ each are separated by a distance of $0.1m$ along the x-axis. Find the dipole moment.
12. If a dielectric material of $\varepsilon_r = 4$ is kept in an electric field, $E = 3a_x + 2a_y + a_z, V/m$. Find the Polarization.
13. The electric potential in a region of space is given by $V = (2x - 9x^2y + 5y^2 + 8yz - 4z)volt$, where distances are measured in meters. Deduce an expression for electric field intensity. Calculate y component of field at $(1,5,-2)$.
14. Transform vector $\vec{B}=y.\vec{a}_x - x.\vec{a}_y + z.\vec{a}_z$ into cylindrical coordinates.

PART – C

1. Derive the electric field intensity due to infinite line charge using Coulomb's law.
2. Derive the expression for Electric Field, $\vec{E}$ due to line charge density. Also obtain the expression for the Electric Field, $\vec{E}$ due to Infinite Line charge.
3. Examine the electric field intensity due to infinite sheet of charge having uniform density of $\rho_c\ C/m^2$.
4. Given the Electric Flux density, $\vec{D} = 4.xy\,\hat{a}_x + 2x^2\,\hat{a}_y\ C/m^2$. Find the total charge lying within the region $0 \le x \le 2; 0 \le y \le 2; 0 \le z \le 4$ by the following two different methods using Divergence Theorem, (i) $\oint_s \vec{D}\,\vec{ds}$ and (ii) $\oint_v \left(\nabla.\vec{D}\right).dv$.
5. Derive the expression for Gauss Law in Point Form and show that $\rho_v = \left[\frac{\partial}{\partial x}\bar{a}_x + \frac{\partial}{\partial y}\bar{a}_y + \frac{\partial}{\partial z}\bar{a}_z\right](D_x\bar{a}_x + D_y\bar{a}_y + D_z\bar{a}_z)$.

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