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(Autonomous/Affiliated to Anna University)
Coimbatore – 641 032

Degree / Branch : B.E/EEE **Semester / Year: III / II**

Subject Code & Title: 14E304 – ELECTROMAGNETIC THEORY

UNIT 1 VECTOR ANALYSIS

Part-B

(Essay Questions)

1. (a) Explain the differential elements in Cartesian coordinate system. (8)
   (b) Find the angle between the vectors A =2$\mathbf{a}_x$+4$\mathbf{a}_y$-$\mathbf{a}_z$ and B=3$\mathbf{a}_x$ +6$\mathbf{a}_y$-4$\mathbf{a}_z$ using Dot Product and Cross Product. (4)
   (c) Write short notes on Dot product. (4)

2. (a) Explain the differential elements in cylindrical coordinate system. (6)
   (b) Given the two points A (x=2, y=3, z=-1) and B (r=4, $\theta=25^0$, $\varphi=125^0$). Find the Spherical Coordinates of A, Cartesian coordinates of B and distance AB. (6)
   (c) Write short notes on cross product. (4)

3. (a) Explain the differential elements in Spherical coordinate system. (6)
   (b) Let **E** = xy $\mathbf{a}_x$ +x^2 $\mathbf{a}_y$, Find Electric flux density and Volume charge Density (6)
   (c) Show that the vector E= $(3x^2+2y^2+1)\ a^x - (4xy- 3y^2z-3)\ a^y$ is irrrotational (4)

4. (a) Derive an expression of electric field intensity for line charge distribution (6)
   (b) Derive an expression of electric field intensity for surface charge distributions (6)
   (c) State dot product properties. (4)

5. (a) State and Explain Coulomb's Law (6)
   (b) Derive Coulomb's Law in vector form (4)
   (c) Four point charges each of 10μC are placed in free space at the points (1, 0, 0), (-1,0,0) ,(0,1,0) and (0,-1,0) m respectively. Determine the force on a point charge of 30μC located at a point (0, 0, 1) m. (6)

6. (a) Define and Explain Electric field intensity E (4)
   (b) Derive an expression of electric field intensity for volume charge distribution (6)
   (c) Find the electric field intensity produced by a point charge distribution at P(1,1,1) caused by four identical 3nC point charges located at P_1(1,1,0), P_2(-1,1,0), P_3(-1,1,0) and P_4(1,-1,0). (6)

7. (a) Briefly Explain Electric field intensity (4)
   (b) Derive an expression of electric field intensity for point charge distribution (6)
   (c) Find the electric field intensity produced by a point charge distribution at P(1,1,1) caused by four identical 6nC point charges located at P_1(1,1,0), P_2(-1,1,0), P_3(-1,1,0) and P_4(1,-1,0). (6)

8. (a) Derive an expression for electric field intensity $\vec{E}$ due to an uniformly charged infinitely long straight line with constant charge density in C/m (6)
   (b) Explain about Cylindrical Coordinate system (4)
   (c) Find the angle between the vectors A =2$\mathbf{a_x}$+4$\mathbf{a_y}$-$\mathbf{a_z}$ and B=3$\mathbf{a_x}$ +6$\mathbf{a_y}$-4$\mathbf{a_z}$ using Dot Product and Cross Product. (4)

9. (a) State and Explain Coulomb's Law (8)
   (b) Four point charges each of 10μC are placed in free space at the various points (1,0,0), (-1, 0, 0), (0, 1, 0) and (0,-1, 0) m respectively. Determine the force on a point charge of 30μC located at a point (0,0,1) m. (4)
   (c) Write short notes on Dot product and Cross product. (4)

10. (a) Obtain the expression for electric field intensity due to infinite line charge having density ρ_L C/m, placed along z-axis, at a point P on y axis at a distance of r from the z axis. (6)
    (b) Given $\vec{A} = 5a_x$ and $\vec{B} = 4a_x + ta_y$. Find t such that the angle between $\vec{A}$ and $\vec{B}$is 45^0. (4)
    (c) State Scalar product properties. (4)

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UNIT II ELECTROSTATICS

Part-B

(Essay Questions)

1. (a) Explain the Electric flux (Ψ) and Electric flux density (D) (4)
   (b) Drive expression for electric flux density due to a point charge (6)
   (c) Write short notes on vector Operator. (4)

2. (a) How is the unit vectors defined in three co ordinate systems? (4)
   (b) Drive expression for electric flux density due to a line charge (6)
   (c) Given $\vec{A} = 2xy\,\vec{a}x + z\,\vec{a}y + yz^2\,\vec{a}z$ find ∇. $\vec{A}$ at P (2,-1, 3). (6)

3. (a) State and prove Divergence Theorem (8)
   (b) Given $A=2xya_x+Za_y+yz^2a_z$.Find ∇. A at P (2,-1, 3). (4)
   (c) Establish relationship between electric flux density and electric field intensity. (4)

4. (a) Derive the potential due to a point charge at the origin (4)
   (b) State and prove Gauss's Law with the help of a spherical system (8)
   (c) A dipole having moment $P = 3\vec{a_x} - 5\vec{a_y} + 10\vec{a_z}$ nCm is located at Q (1,-2, 4) in free space. Find V at P (2, 3, 4). (4)

5. (a) State divergence theorem. (4)
   (b) Define divergence in various coordinate systems with the help of DEL. (7)
   (c) Give the properties of divergence. (5)

6. (a) What do you mean by symmetrical charge distribution? (4)
   (b) Derive D due to a point charge and give the expression for D for various charge distribution. (7)
   (c) Derive Energy density in an electrostatic field with D and E (5)

7. (a) What do you mean by Gaussian surface? (4)
   (b) Derive the Mathematical representation of Gauss's law for line charge density along with its general form. (7)
   (c) Derive an expression for energy and energy density in the static electric field. (5)

8. (a) Derive the potential due a point charge at origin. (4)
   (b) Derive the Mathematical representation of Gauss's law for surface charge density along with its general form. (7)
   (c) What is potential and potential difference (5)

9. (a) Point Charges Q_1=1nC , Q_2=-2nC , Q_3=3nC and Q_4 = -4nC are placed one by one in the same order at (0,0,0) , (1,0,0) ,(0,0,-1) and (0,0,1) respectively. Calculate the energy in the system. (4)
   (b) Derive the Mathematical representation of Gauss's law for volume charge density along with its general form. (7)
   (c) Give the expression for potential due to many point charges and point charge not at origin. (5)

10. (a) A point charge Q = 0.4 nC is located at the origin and calculate the absolute potential of A (2, 2, 3). (4)
   (b) Define electric dipole moment and derive an expression for electric field intensity at point P due to an electric dipole. (6)
   (c) Prove Q = Ψ, due to point charge with the help of Gauss's law. (6)

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UNIT III CONDUCTORS, DIELECTRICS AND CAPACITORS

Part-B

(Essay Questions)

1. (a) List the properties of conductor (4)
   (b) Derive the expression for capacitance of a spherical capacitor. (8)
   (c) State continuity equation of current in point form and integral form. (4)

2. (a) Derive point form of ohm's law (3)
   (b) Define polarization and derive the mathematical expression for polarization. (5)
   (c) State the Boundary condition at the interface between two perfect dielectrics. (8)

3. (a) Derive the Laplace's and Poisson's equation. (6)
   (b) Derive the various components of D and E in the boundary between a conductor and free space. (7)
   (c) List the properties of dielectric material. (3)

4. (a) State and derive electric boundary conditions for a dielectric to dielectric medium and a conductor to dielectric medium. (7)
   (b) Derive the expression for energy stored in a capacitor. (5)
   (c) Verify that the potential field $V= 3x^2-3y^2+z^2$ satisfies the Laplace's equation (4)

5. (a) Derive an expression for the capacitance of a parallel plate capacitor with two dielectrics of relative permittivity ε_1 and ε_2 respectively interposed between the plates. (7)
   (b) Calculate the capacitance per kilo meter between a pair of parallel wires each having diameter of 1 cm at a spacing of 50 cm. (5)
   (c) State and prove uniqueness theorem. (4)

6. (a) Obtain the expression for energy stored in a capacitor. (5)
   (b) Derive the various components of D and E in the boundary between two perfect dielectrics. (8)
   (c) Explain conduction, convection and displacement currents? (3)

7. (a) Derive the expression for capacitance of isolated sphere coated with dielectric. (5)
   (b) Derive the boundary conditions between a conductor and free space. (8)
   (c) State the relationship between Current and current density (3)

8. (a) Derive the Laplace's and Poisson's equation. (5)
   (b) Derive the boundary conditions between a conductor and a dielectric. (7)
   (c) Find the energy stored in a parallel plate capacitor of 0.5m by 1m has a separation of 2 cm and a voltage difference of 10 V. (4)

9. (a) Obtain the expression for energy stored in a capacitor. (5)
   (b) Derive the boundary conditions between two perfect dielectrics. (8)
   (c) List the various properties of Dielectric materials. (3)

10. (a) Calculate the capacitance per kilo meter between a pair of parallel wires each having diameter of 1 cm at a spacing of 50 cm (5)
    (b) Derive the capacitance of parallel plate capacitor. (8)
    (c) Derive a continuity equation of the current in point form. (3)

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UNIT IV MAGNETO STATICS

Part-B

(Essay Questions)

1. (a) Explain self inductance and mutual inductance. (4)
   (b) State and prove Biot-Savart's law. (8)
   (c) Write comparison between electric and magnetic field (4)

2. (a) What is meant by magnetic torque? (3)
   (b) State and prove ampere's circuit law. (8)
   (c) A very long thin, straight wire located along z axis carries a current I in the z direction. Find the magnetic field intensity at any point in the free space using Ampere's law. (5)

3. (a) Explain curl and list the properties of curl. (4)
   (b) Find the magnetic flux intensity and density around infinitely long straight conductor using Biot-Savart's law. (8)
   (c) Write comparison between electric and magnetic field (4)

4. (a) State and prove stokes theorem. (5)
   (b) Explain Biot-Savart's Law. (5)
   (c) Derive an expression for magnetic field intensity at any point on the infinite sheet of current carrying conductor using ampere circuital law. (6)

5. (a) State and explain Biot-Savart's law. (4)
   (b) Derive the boundary condition between two magnetic materials. (8)
   (c) Write the tangential and normal components in the boundary between two magnetic materials (4)

6. (a) Explain magnetic dipole and magnetic dipole moment (4)
   (b) Derive the inductance of a solenoid and toroid. (8)
   (c) What is the relation between relative permeability and susceptibility? (4)

7. (a) Explain magnetic flux and magneto motive force (4)
   (b) Derive the inductance of a solenoid and coaxial cable. (8)
   (c) Differentiate between Reluctance and Permeance? (4)

8. (a) Derive the expression for co-efficient of coupling. (4)
   (b) Derive the inductance of a coaxial cable and toroid. (8)
   (c) Write comparison between electric and magnetic field (4)

9. (a) Derive an expression for inductance of a Co-axial cable. (7)
   (b) Derive the expression for magnetic flux density intensity and density due to an infinite long conductor using Ampere's law. (5)
   (c) A coil of 500 turns is wound on a closed iron ring of mean radius of 10 cm and cross-section area of 3 cm^2. Find the self inductance of the winding if the relative permeability of iron is 800. (4)

10. (a) State the boundary conditions at the interface between two perfect dielectrics. (4)
    (b) Obtain the expression for the energy stored in magnetic field (8)
    (c) Derive an expression for magnetic field intensity due to an infinite long conductor. (4)

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UNIT V ELECTRO MAGNETIC WAVES

Part-B

(Essay Questions)

1.	(a)	State and explain the Faraday's laws of electromagnetic induction	(4)
	(b)	Derive Maxwell's first equation with the help of divergence.	(8)
	(c)	State Maxwell's equation for time varying fields.	(4)
2.	(a)	Give the wave equation of a wave in a perfect dielectric medium with T = 0.	(4)
	(b)	Derive the wave equation for magnetic field and electric field in phasor form.	(8)
	(c)	State Maxwell's equation for free space.	(4)
3.	(a)	Explain Poynting vector	(4)
	(b)	State and prove boundary conditions by the application of Maxwell's equations.	(8)
	(c)	State Maxwell's equation for static fields.	(4)
4.	(a)	Briefly explain the significance of displacement current.	(4)
	(b)	What is a Poynting Vector and derive the average power by Poynting theorem	(8)
	(c)	State Maxwell's equation for good conductor.	(4)
5.	(a)	Explain the depth of penetration.	(4)
	(b)	Derive the Maxwell's equation using Ampere's Circuital law.	(8)
	(c)	State Maxwell's equation for free space.	(4)
6.	(a)	State and explain the Faraday's laws of electromagnetic induction	(4)
	(b)	Drive EM wave equation for free space in terms of electric and magnetic Field.	(8)
	(c)	State Maxwell's equation for good conductor.	(4)
7.	(a)	State Poynting Theorem.	(4)
	(b)	Derive the general form of wave equation.	(8)
	(c)	Write Maxwell's equation from Faraday's law in integral form and point form.	(4)
8.	(a)	Write short notes on skin effect	(4)
	(b)	Derive the expression for Poynting vector.	(8)
	(c)	Explain about standing wave ratio.	(4)
9.	(a)	Derive the wave equation for magnetic field and electric field in phasor form.	(4)
	(b)	Compare between electric circuits and magnetic circuits.	(8)
	(c)	Briefly explain about skin effect.	(4)

10. (a) Write short notes on EMI and EMC (4)
    (b) Derive the average power using Poynting theorem (8)
    (c) Explain the electromagnetic wave propagation in perfect dielectric. (4)

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