



ST. ANNE'S COLLEGE OF ENGINEERING AND TECHNOLOGY

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ANGUCHETTYPALAYAM, PANRUTI – 607 106.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

QUESTION BANK

EE 3301 - ELECTROMAGNETIC FIELDS

III SEMESTER

Prepared by

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
QUESTION BANK

SUBJECT : EE 3301 - ELECTROMAGNETIC FIELDS

SEM / YEAR: III/II

UNIT I - ELECTROSTATICS – I					
Sources and effects of electromagnetic fields – Coordinate Systems – Vector fields – Gradient, Divergence, Curl – theorems and applications - Coulomb’s Law – Electric field intensity – Field due to discrete and continuous charges – Gauss’s law and applications.					
PART – A					
Q.No	Questions		BT Level	Knowledge Level	
1.	Points P and Q are located at (0,2,4) and (-3,1,5). Determine the distance vector from P to Q.		BTL 3	Apply	CO1
2.	State Stoke’s Theorem.		BTL 1	Remember	CO1
3.	List the sources of electromagnetic fields.		BTL 1	Remember	CO1
4.	Apply in matrix form the unit vector transformation from the rectangular to cylindrical coordinate system		BTL 3	Apply	CO1
5.	Two vectorial quantities $\vec{A} = 4\vec{i} + 3\vec{j} + 5\vec{k}$ and $\vec{B} = \vec{i} - 2\vec{j} + 2\vec{k}$ are known to be oriented in two unique directions. Determine the angular separation between them.		BTL 2	Understand	CO1
6.	State the conditions for a vector A to be (a) solenoidal (b) irrotational.		BTL 1	Remember	CO1
7.	State Divergence Theorem.		BTL 1	Remember	CO1
8.	State the electric flux density.		BTL 1	Remember	CO1
9.	Define divergence and its physical meaning.		BTL 1	Remember	CO1
10.	What are the practical applications of electromagnetic fields?		BTL 3	Apply	CO1
11.	Mention the criteria for choosing an appropriate coordinate system for solving a field problem easily. Explain with an example.		BTL 4	Analyze	CO1
12.	When a vector field is solenoid and irrotational.		BTL 6	Create	CO1
13.	Give the practical examples of diverging and curl field.		BTL 2	Understand	CO1
14.	Obtain the unit vector in the direction from the origin towards the point P (3,-3,2).		BTL 5	Evaluate	CO1
15.	Give the differential displacement and volume in spherical coordinate system.		BTL 2	Understand	CO1
16.	How can a vector field be expressed as the gradient of scalar field?		BTL 5	Evaluate	CO1
17.	Determine the curl of $\vec{P} = x^2yz\vec{a}_x + xz\vec{a}_z$		BTL 4	Analyze	CO1
18.	Verify the vector $\vec{A} = 4\vec{a}_x - 2\vec{a}_y + 2\vec{a}_z$, $\vec{B} = -6\vec{a}_x + 3\vec{a}_y - 3\vec{a}_z$ are parallel to each other.		BTL 6	Create	CO1

19.	Find the unit vector extending from the origin toward the point P (3,-1,-2)		BTL 4	Analyze	CO1
20.	Determine the electric field intensity in free space if $\vec{D} = 30\vec{a}_x \text{ C/m}^2$		BTL 2	Understand	CO1
21.	Transform the cartesian coordinates (2,1,3) into spherical coordinates.		BTL 4	Analyze	CO1
22.	Express the value of differential volume in rectangular coordinate and cylindrical coordinate system.		BTL 2	Understand	CO1
23.	Find the distance from A (1,2,3) to B (2,0, -1) in rectangular coordinates.		BTL 5	Evaluate	CO1
24.	Name a few applications of Gauss's law in electrostatics.		BTL 3	Apply	CO1
PART – B					
1.	i) Show that over the closed surface of a sphere of radius B, $ds = 0$ ii) Show that the vector $E = (6xy + z^3)\vec{a}_x + (3x^2 - z)\vec{a}_y + (3xz^2 - y)\vec{a}_z$ is Irrotational and find its scalar potential.	(4) (9)	BTL 3	Apply	CO1
2.	Express the vector B in Cartesian and cylindrical systems. Given $B = \frac{10}{r}\vec{a}_r + r \cos\theta\vec{a}_\theta + \vec{a}_\phi$. then find B at (-3, 4, 0) and (5, $\pi/2$, -2).	(13)	BTL 2	Understand	CO1
3.	i) Generalize the classification of vector fields. ii) If $B = y\vec{a}_x + (x + z)\vec{a}_y$ and a point Q is located at (-2, 6, 3), express (1) the point Q in cylindrical and spherical coordinates; (2) \vec{B} in spherical coordinates.	(5) (8)	BTL 6	Create	CO1
4.	Analyse the divergence of these vector fields. i) $P = x^2yz\vec{a}_x + xz\vec{a}_y$ ii) $Q = \rho \sin\phi\vec{a}_\rho + \rho^2 z\vec{a}_\phi + r \cos\phi\vec{a}_z$ iii) $T = \left\{\frac{1}{r^2}\right\} \cos\theta\vec{a}_r + r \sin\theta \cos\phi\vec{a}_\theta + \cos\theta\vec{a}_\phi$	(13)	BTL 4	Analyze	CO1
5.	i) Given point P (-2,6,3) and $\vec{A} = y\vec{i} + (x + z)\vec{j}$, express P and \vec{A} in cylindrical coordinates. ii) State and prove divergence theorem.	(6) (7)	BTL 2	Understand	CO1
6.	i) Find the electric field at a point P(0,0,6) due to a point charge Q1 of 0.35 μC placed at (0,5,0) and Q2 of -0.6 μC placed at (5,0,0). ii) Prove the identity $\nabla \times \nabla \times \vec{H} = \nabla(\nabla \cdot \vec{H}) - \nabla^2 \vec{H}$ Where the H is a vector.	(7) (6)	BTL 3	Apply	CO1

7.	i) State and describe divergence theorem. ii) Show that in Cartesian coordinates for any vector A, $\nabla \cdot (\nabla^2 \mathbf{A}) = \nabla^2 (\nabla \cdot \mathbf{A})$	(9) (4)	BTL 1	Remember	CO1
8.	i) With neat diagram, explain the spherical system with coordinates (R, θ , ϕ). ii) Apply Coulomb's law to find the electric field intensity at any point P due to a straight, uniformly charged wire of linear charge density ρ_l C/m. The point P is at a distance of 'L' m above the wire.	(13)	BTL 4	Analyze	CO1
9.	Write short notes on gradient, divergence, curl and stokes theorem.	(13)	BTL 1	Remember	CO1
10.	i) Verify the divergence theorem for a vector field $\mathbf{D} = x^2 \mathbf{a}_x + (3y + z) \mathbf{a}_y + (3z - 2x) \mathbf{a}_z$ in the region bounded by the cylinder $x^2 + y^2 = 9$ and the planes $x=0, y=0, z=2$ ii) A novel printing technique is based upon electrostatic deflection principal. Justify.	(9) (4)	BTL 1	Remember	CO1
11.	i) If $\mathbf{B} = y \mathbf{a}_x + (x + z) \mathbf{a}_y$ and a point Q is located at (-2,6,3), express a) The point Q in cylindrical and spherical co ordinates. b) \mathbf{B} in spherical co ordinates. ii) Derive coulomb's law of force.	(9) (4)	BTL 2	Understand	CO1
12.	i) By means of Gauss's law. Determine the electric field intensity at a point P distant 'L' m from an infinite line of uniform charge ρ_l C/m. ii) Explain the divergence of a vector field and Divergence theorem.	(6) (7)	BTL 4	Analyze	CO1
13.	i) Quote and prove Coulomb's Law. ii) Discover an expression for electric field due to a charged circular disc.	(7) (6)	BTL 1	Remember	CO1
14.	Given that $\mathbf{F} = (x^2 + y^2) \mathbf{i} - 2xy \mathbf{j}$ evaluate both sides of stokes theorem for a rectangular path bounded by the lines $x=0, a, y=0, y=b, z=0, z=c$.	(13)	BTL 5	Evaluate	CO1
15.	Prove that divergence of a curl of a vector is zero, using stoke's theorem.	(13)	BTL 4	Analyze	CO1
16.	State and verify divergence theorem for the vector $\mathbf{A} = 4x \mathbf{i} + 2y^2 \mathbf{j} + z^2 \mathbf{k}$ taken over the cube bounded by $x=0, x=1, y=0, y=1$.	(13)	BTL 5	Evaluate	CO1
17.	Find the total electric field at the origin due to 10^{-8} C charge located at P (0,4,4) m and -0.5×10^{-8} C charge at Q (4,0,2) m.	(13)	BTL 6	Create	CO1
PART C					

1.	Given that $\mathbf{A} = 30e^{-r}\mathbf{a}_r - 2z\mathbf{a}_z$ in cylindrical coordinates evaluate both sides of divergence theorem for the volume enclosed by $r=2, z=0$ and $z=5$.	(15)	BTL 5	Evaluate	CO1
2.	Given that $\mathbf{D} = 5r^2/4\mathbf{a}_r$, C/m ² . Evaluate both the sides of divergence theorem for the volume enclosed by $r= 4\text{m}$ and $\theta =\pi/4$	(15)	BTL 5	Evaluate	CO1
3.	Design & validity of the divergence theorem considering the field $\mathbf{D}=2xy\mathbf{a}_x+x^2\mathbf{a}_y$ C/m ²	(15)	BTL 6	Create	CO1
4.	Analyse 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)	(15)	BTL 4	Analyze	CO1
5.	A positive point charge 100×10^{-12} C is located in air at $x=0,y=0.1\text{m}$ and another charge at $x=0,y=-0.1\text{m}$.What is the magnitude and the direction of E at $x=0.2\text{m}$, $y=0$?	(15)	BTL 6	Create	CO1

UNIT II - ELECTROSTATICS – II

Electric potential – Electric field and equipotential plots, Uniform and Non-Uniform field, Utilization factor – Electric field in free space, conductors, dielectrics - Dielectric polarization - Dielectric strength - Electric field in multiple dielectrics – Boundary conditions, Poisson’s and Laplace’s equations, Capacitance, Energy density, Applications.

PART – A

Q.No	Questions		BT Level	Knowledge Level	
1.	Define electrical potential.		BTL 1	Remember	CO2
2.	Mention the properties of electric flux lines.		BTL 1	Remember	CO2
3.	State the electrostatic boundary conditions at the interface between two dielectrics.		BTL 1	Remember	CO2
4.	State the properties of electric flux lines.		BTL 1	Remember	CO2
5.	A dielectric slab of flat surface with relative permittivity 4 is disposed with its surface normal to a uniform field with flux density 1.5c/m^2 . The slab is uniformly polarized. Determine polarization in the slab.		BTL 3	Apply	CO2
6.	A parallel plate capacitor has a charge of 10^{-3}C on each plate while the potential difference between the plates is 1000v. Evaluate the value of capacitance.		BTL 5	Evaluate	CO2
7.	What is the practical significance of Lorentz Force?		BTL 1	Remember	CO2
8.	Define electric dipole moment.		BTL 1	Remember	CO2
9.	Write Poisson’s equation for a simple medium.		BTL 6	Create	CO2
10.	What is conservative field?		BTL 6	Create	CO2
11.	Define dielectric strength.		BTL 2	Understand	CO2
12.	What is meant by dielectric breakdown?		BTL 2	Understand	CO2
13.	A uniform line charge with $\rho_l =5 \mu\text{C/m}$ lies along the x-axis. Find \vec{E} at (3, 2, 1).		BTL 5	Evaluate	CO2

14.	Prepare the electric field intensity at a distance of 20 cm from a charge of 2 in vacuum.		BTL 3	Apply	CO2
15.	Write the expression for the energy density in electrostatic field.		BTL 2	Understand	CO2
16.	State the properties of electric flux lines.		BTL 2	Understand	CO2
17.	Define energy density.		BTL 3	Apply	CO2
18.	Write the equation for capacitance of coaxial cable.		BTL 4	Analyze	CO2
19.	Give the significant physical differences between Poisson's and Laplace's equations.		BTL 4	Analyze	CO2
20.	Evaluate the electric field intensity in free space if $D=30 \mu_{\text{C}}/\text{m}^3$.		BTL 4	Analyze	CO2
21.	Give the relationship between potential gradient and electric field.		BTL 2	Understand	CO2
22.	Define polarization in dielectric material.		BTL 2	Understand	CO2
23.	Find the electric potential at a point (4,3) m due to a charge of 10^{-9} C located at the origin in free space.		BTL 3	Apply	CO2
24.	Find the energy stored in a parallel plate capacitor of 0.5 m by 1 m has a separation of 2 cm and a voltage difference of 10 V.		BTL 4	Analyze	CO2
PART – B					
1.	Deduce an expression for the capacitance of parallel plate capacitor having two identical media.	(13)	BTL 4	Analyze	CO2
2.	(i) State and derive electric boundary condition for a dielectric to dielectric medium and a conductor to dielectric medium. (ii) Derive the expression for energy density in electrostatic field.	(6) (7)	BTL 1	Remember	CO2
3.	(i) State and explain coulomb's law and deduce the vector form of force equation between two-point charges. (ii) At an interface separating dielectric medium 1(ϵ_{r1}) and dielectric medium 2(ϵ_{r2}) show that the tangential component of \vec{E} is continuous across the boundary, whereas the normal component of \vec{E} is discontinuous at the boundary.	(2) (11)	BTL 1	Remember	CO2
4.	i) A circular disc of radius 'a' m is charged uniformly with a charge density of $\rho_s \text{ C/m}^2$. Find the electric potential at a point P distant 'h' m from the disc surface along its axis. ii) Find the value of capacitance of a capacitor consisting of two parallel metal plates of 30cm x 30cm surface area, separately by 5mm in air. What is the total energy stored by capacitor is charged to a potential difference of 1000v? What is the energy density?	(6) (7)	BTL 4	Analyze	CO2
5.	i) Find the potential at r A = 5 m with respect to r B = 15 m due to point charge Q=500 Pc at the origin and zero reference at infinity. ii) Find the capacitance of a parallel plate capacitor with dielectric $\epsilon_{r1} = 1.5$ and $\epsilon_{r2} = 3.5$ each occupy one half of the space between the plates of area 2 m^2 and $d= 10^{-3} \text{ m}$.	(6) (7)	BTL 3	Apply	CO2
6.	Find the potential at any point along the axis of a uniformly charged disc.	(13)	BTL 4	Analyze	CO2

7.	Interpret the expression for energy stored and energy density in electro static fields.	(13)	BTL 3	Apply	CO2
8.	i) In spherical coordinates $V = -25$ V on a conductor at $r = 2$ cm and $V = 150$ V at $r = 35$ cm. The space between the conductor is a dielectric of $\epsilon_r = 3.12$, Find the surface charge densities on the conductor. ii) Define Laplace and Poisson's equation.	(10) (3)	BTL 2	Understand	CO2
9.	Point charges 1 mC and -2 mC are located at (3,2,-1) and (-1, -1,4) respectively. Calculate the electric force on a 10nC charge located at (0,3,1) and the electric field intensity at the point.	(13)	BTL 2	Understand	CO2
10.	The relative permittivity ϵ_r of linear, homogeneous, isotropic dielectric material is 3.6 and the material is covering the space between $z=0$ and $z=1$. If $v = -6000z$ volts in the material. Find (1)E, (2)P,(3) ρ_v .	(13)	BTL 5	Evaluate	CO2
11.	i) A positive point charge 100×10^{-12} C is located in air at $x=0, 0.01$ m and another such charge at $x=0, y=-0.1$ m. What is the magnitude and direction of E? ii) Obtain 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.	(4) (9)	BTL 1	Remember	CO2
12.	i) Explain briefly the polarization in dielectrics. ii) Derive Laplace's and Poisson's equation from Gauss's law for a linear material medium. State the importance of these equations	(13)	BTL 1	Remember	CO2
13.	Distinguish between electric potential and electric potential difference. Two point charges -4 micro coulomb and 5 micro coulomb are located at (2,-1,3) and (0,4,-2) respectively. Find the potential at (1,0,1) assuming zero potential at infinity.	(13)	BTL 2	Understand	CO2
14.	i) Two point charges $-4\mu\text{C}$ and $5\mu\text{C}$ are located at (2,-1,3) and (0,4,-2) respectively. Find the potential at (1,0,1) assuming zero potential at infinity. ii) A Parallel plate capacitor has a plate separation t . The capacitance with air only between the plates is C . When a slab of thickness t' and relative permittivity ϵ' is placed on one of the plates, the capacitance is C' , show that $\frac{C'}{C} = \frac{\epsilon' + \epsilon''(\epsilon - \epsilon'')}{\epsilon' + \epsilon''(\epsilon - \epsilon'')}$	(13)	BTL 6	Create	CO2
15.	A parallel plate capacitance has free space between the plates. Compare the voltage gradient in this case to that in the free space. When a sheet of mica, $\epsilon_r = 5.4$, fills 20 % of the distance between the plates. Assume the same applied voltage in each case.	(13)	BTL 4	Analyze	CO2

16.	Two capacitors $C_1 = 1 \mu\text{F}$ and $C_2 = 2 \mu\text{F}$ are connected in parallel across a 1000V dc supply. Find the charge on capacitors.	(13)	BTL 6	Create	CO2
17.	Two parallel plate capacitors of unknown capacitance when connected in series are known to have an equivalent capacitance of 66.667 μF . When the same two capacitors are connected end to end, the equivalent capacitance is found to be 300 μF . What are the two unknown capacitances?	(13)	BTL 5	Evaluate	CO2
PART C					
1.	A capacitor consists of squared two metal plates each 100 cm side placed parallel and 2 mm apart. The space between the plates is filled with a dielectric having a relative permittivity of 3.5. A potential drop of 500 V is maintained between the plates. Evaluate (i) The capacitance, (ii) The charge of capacitor, (iii) The electric flux density, (iv) The potential gradient.	(15)	BTL 5	Evaluate	CO2
2.	Analyse the vector $V = x^2Y + 10Z + 2\log(x^2 + y^2)$ find V, E, D and ρ_v at (1,2,3).	(15)	BTL 4	Analyze	CO2
3.	Step by Step, develop a condition between (i) Conductor and Dielectric (ii) Dielectric and Dielectric	(15)	BTL 4	Analyze	CO2
4.	Solve one dimensional LAPLACE equation to obtain the field inside a parallel plate capacitor, and Evaluate the expression for the surface charge density at two plates.	(15)	BTL 5	Evaluate	CO2
5.	If a potential $V = x^2yz + Ay^3z$. Find the value of A so that Laplace's equation is satisfied and electric field at (2, -2,1).	(15)	BTL 6	Create	CO2
UNIT III - MAGNETOSTATICS					
Lorentz force, magnetic field intensity (H) – Biot–Savart's Law - Ampere's Circuit Law – H due to straight conductors, circular loop, infinite sheet of current, Magnetic flux density (B) – B in free space, conductor, magnetic materials – Magnetization, Magnetic field in multiple media – Boundary conditions, scalar and vector potential, Poisson's Equation, Magnetic force, Torque, Inductance, Energy density, Applications.					
PART – A					
Q.No	Questions		BT Level	Knowledge Level	
1.	Distinguish between magnetic scalar potential and magnetic vector potential.		BTL 4	Analyze	CO3
2.	What is Lorentz law of force?		BTL 1	Remember	CO3
3.	Write the expression for magnetic field H at the centre of a circular coil carrying a current of I amperes. The radius of the coil is a 'm'.		BTL 6	Create	CO3

4.	Determine the value of magnetic field intensity at the centre of a circular loop carrying a current of 10 A. The radius of the loop is 2 m.		BTL 3	Apply	CO3
5.	Expression for the magnetic force between an electromagnet and an armature to be attracted.		BTL 2	Understand	CO3
6.	Establish the inductance per unit length of a long solenoid of N turns and having a length ' L 'mtrs. Assume that it carries a current of I amperes.		BTL 3	Apply	CO3
7.	State Ampere's circuital law.		BTL 1	Remember	CO3
8.	State Biot savarts law.		BTL 1	Remember	CO3
9.	What is the total force acting on a moving charge Q in the presence of both electric and magnetic fields.		BTL 3	Apply	CO3
10.	Define the terms: magnetic moment and magnetic permeability.		BTL 1	Remember	CO3
11.	What is vector magnetic potential?		BTL 1	Remember	CO3
12.	Define Magnetostaic energy density.		BTL 1	Remember	CO3
13.	Design the BH curve for classifying magnetic materials.		BTL 5	Evaluate	CO3
14.	Estimate the mutual inductance of the two inductively coupled coils with self inductance of 25mH and100 mH.		BTL 2	Understand	CO3
15.	Illustrate self inductance and mutual inductance.		BTL 2	Understand	CO3
16.	A current of 3A flowing through an inductor of 100mH. Interpret the energy stored in the inductor?		BTL 4	Analyze	CO3
17.	Distinguish between diamagnetic, paramagnetic and ferromagnetic materials.		BTL 4	Analyze	CO3
18.	Sketch Gauss law for the magnetic field.		BTL 5	Evaluate	CO3
19.	What is the practical significance of Lorentz's Force?		BTL 2	Understand	CO3
20.	Compare magnetic scalar potential and magnetic vector potential		BTL 6	Create	CO3
21.	Define magnetic flux density.		BTL 2	Understand	CO3
22.	List the applications of Ampere's circuital law.		BTL 4	Analyze	CO3
23.	Give an equation of torque on a solenoid.		BTL 5	Evaluate	CO3
24.	A circular coil of radius 2 m carries a current of 4 A. What is the value of magnetic field intensity at the centre?		BTL 3	Apply	CO3
PART – B					
1.	State and explain Ampere's circuit law and show that the field strength at the end of a long solenoid is one half of that at the centre.	(13)	BTL 1	Remember	CO3
2.	a) State and explain Bio-savarts law. b) Derive an expression for the force between two long straight parallel current carrying conductors.	(6) (7)	BTL 1	Remember	CO3
3.	Derive a general expression for the magnetic flux density B at any point along the axis of a long solenoid. Sketch the variation of B from point to point along the axis.	(13)	BTL 2	Understand	CO3

4.	i) Obtain an expression for the magnetic field intensity due to straight finite conductor carrying current I amperes using Biot Savart's law ii) State and Prove Ampere's law	(8) (5)	BTL 2	Understand	CO3
5.	i) Show by means of Biot Savarts law that the flux density produced by an infinitely long straight wire carrying a current I at any point distant a normal to the wire is given by $\mu_0 \mu_r I / 2\pi a$. ii) State and prove magnetic boundary conditions.	(5) (8)	BTL 2	Understand	CO3
6.	i) Derive Biot Savart's law and ampere law using the concept of magnetic vector potential. ii) The core of a toroid is of 12 cm^2 area and is made of material with $\mu_r = 200$. If the mean radius of the toroid is 50cm. Calculate the number of turns needed to obtain an inductance of 2.5H.	(6) (7)	BTL 1	Remember	CO3
7.	i) Quote the expression for the magnetic field intensity inside and outside a co- axial conductor of inner radius 'a' and outer radius 'b' and carrying a current of I amperes in the inner and outer conductor. ii) Calculate the self inductance of infinitely long solenoid	(7) (6)	BTL 1	Remember	CO3
8.	i) Quote the expression for the magnetic vector potential in the cases of an infinitely long straight conductor in free space. ii) Consider the boundary between two media. Show that the angles between the normal to the boundary and the conductivities on either side of the boundary satisfy the relation.	(6) (7)	BTL 3	Apply	CO3
9.	Obtain the expression for energy stored in the magnetic field and also derive the expression for magnetic energy density.	(13)	BTL 3	Apply	CO3
10.	i) Derive and explain the expression for coefficient of coupling in terms of mutual and self inductance of the coils. ii) An iron ring with a cross sectional area of 8 cm^2 and a mean circumference of 120cm is wound with 480 turns of wire carrying a current of 2 A. the relative permeability of the ring is 1250. Calculate the flux established in the ring.	(7) (6)	BTL 4	Analyze	CO3
11.	i) Categorize the classification of magnetic materials in detail and draw a typical magnetization (B-H) curve. ii) What is 'Magnetization'? Explain the classification of magnetic materials.	(7) (6)	BTL 4	Analyze	CO3
12.	i) Obtain an expression for magnetic flux density and magnetic field intensity at any point along the axis of a circular coil. ii) Distinguish between scalar and vector magnetic potential.	(10) (3)	BTL 4	Analyze	CO3
13.	i) An air co-axial transmission line has a solid inner conductor of radius 'a' and a very thin outer conductor of inner radius 'b'. Organise the inductance per unit length of the line. ii) Compare the different magnetic materials	(9) (4)	BTL 5	Evaluate	CO3
14.	i) Prepare an expression for magnetic field intensity and magnetic flux density at any point due to finite length conductor. ii) Prepare an expression for inductance and torque on a long solenoid coil.	(9) (4)	BTL 6	Create	CO3

15.	Find the energy stored in the solenoid having 50 cm long and 5 cm in diameter and is wound with 2000 turns of wire, carrying a current of 10 A.	(13)	BTL 4	Analyze	CO3
16.	Calculate the magnetic flux density due to circular coil of 100 ampere turns and area of 70 cm ² on the axis of the coil at 10 cm from the center.	(13)	BTL 5	Evaluate	CO3
17.	A wire carrying a current of 100 A is bent in to the form of a circle of diameter 10 cm. Calculate (i) Flux density at the center of the coil (ii) Flux density at a point on the axis of the coil and 12 cm from it.	(13)	BTL 6	Create	CO3
PART C					
1.	Evaluate the loop inductance per km of a single-phase transmission circuit comprising two parallel conductor spaced 1 m apart and with diameters 0.5 cm and 0.8 cm respectively	(15)	BTL 5	Evaluate	CO3
2.	By means of Biot-Savart's law, derive an expression for the magnetic field intensity at any point on the line through the centre at a distance 'h' from the centre and perpendicular to the plane of a circular loop of radius 'p' and carrying current 'I'	(15)	BTL 5	Evaluate	CO3
3.	An iron ring, 0.2 m in diameter and 10 cm ² sectional area of the core is uniformly wound with 250 turns of wire. The wire carries a current of 4 A. The relative permeability of iron is 500. Determine the value of self inductance and the stored energy.	(15)	BTL 5	Evaluate	CO3
4.	A solenoid consisting of 1000 turns of wire wound on a former of length 100 cm and diameter 3 cm is placed coaxially within another solenoid of the same length and number of turns but with a diameter of 6 cm. Evaluate the mutual inductance and the coupling coefficient of the arrangement	(15)	BTL 5	Evaluate	CO3
5.	Two coils are connected in series and their total inductance is 4.4 mH. When one coil is reversed, the total inductance is 1.6 mH. All the flux due to first coil links the second coil, but only 40 % of the flux due to second coil links the first coil. Find the self-inductance of each coil and their mutual inductance.	(15)	BTL 5	Evaluate	CO3
UNIT IV - ELECTRODYNAMIC FIELDS					
Magnetic Circuits - Faraday's law – Transformer and motional EMF – Displacement current - Maxwell's equations (differential and integral form) – Relation between field theory and circuit theory – Applications.					
PART – A					
Q.No	Questions		BT Level	Knowledge Level	

1.	State the Faraday's law.		BTL1	Remember	CO4
2.	State the Faraday's law for the moving charge in a constant magnetic field		BTL1	Remember	CO4
3.	State Lenz's law.		BTL1	Remember	CO4
4.	Define displacement current density.		BTL1	Remember	CO4
5.	What are electric field and the power flow in the co-axial cable?		BTL1	Remember	CO4
6.	Define reluctance and permeability.		BTL1	Remember	CO4
7.	Write the Maxwell's equation from ampere's law both in integral and point forms.		BTL2	Understand	CO4
8.	Write down the Maxwell's equation from electric gauss's law in integral and point forms.		BTL2	Understand	CO4
9.	Illustrate mutual inductance and self inductance.		BTL3	Apply	CO4
10.	Write down the Maxwell's equation from magnetic gauss's law in integral and point form.		BTL2	Understand	CO4
11.	Write the Maxwell's equations from Gauss's law in integral form.		BTL2	Understand	CO4
12.	Estimate Maxwell's equations in integral form.		BTL4	Analyze	CO4
13.	Differentiate transformer and motional emf.		BTL2	Understand	CO4
14.	Find the characteristics impedance of the medium whose relative permittivity is 3 and relative permeability is 1		BTL3	Apply	CO4
15.	Calculate the emf induced in a conductor of length 1m moving with a velocity of 100m/s perpendicular to a field of 1 Tesla.		BTL3	Apply	CO4
16.	Distinguish between conduction and displacement currents		BTL4	Analyze	CO4
17.	Explain why $\nabla \cdot \mathbf{B} = 0$		BTL5	Evaluate	CO4
18.	Judge $\nabla \cdot \mathbf{D} = 0$		BTL6	Create	CO4
19.	In material for which $\sigma = 5.0 \text{ s/m}$, $\epsilon_r = 1$ and $\mathbf{E} = 250 \sin 10^8 t$ (v/m). Find conduction & displacement current densities.		BTL6	Create	CO4
20.	Moist soil has conductivity of 10^{-3} S/m and $\epsilon_r = 2.5$, estimate the displacement current density if $\mathbf{E} = 6.0 * 10^{-6} \sin 9.0 * 10^9 t$ (V/m)		BTL2	Understand	CO4
21.	Write the point form of continuity equation and explain its significance.		BTL3	Apply	CO4
22.	Write down the Maxwell's equations in integral phasor form.		BTL4	Analyze	CO4
23.	Explain why $\nabla \times \mathbf{E} = 0$.		BTL5	Evaluate	CO4
24.	What is the equation for total emf due to motion or transformer action?		BTL2	Understand	CO4
PART – B					
1.	Derive the Maxwell's equations both in integral and point forms.	(13)	BTL5	Evaluate	CO4

2.	<p>(i) Explain the relation between field theory and circuit theory in detail.</p> <p>(ii) A sinusoidal plane wave is transmitted through a medium whose electric field strength is 10KV/m and relative permittivity of the medium is 4. Determine the mean rms power flow/unit area.</p>	(6) (7)	BTL4	Analyze	CO4
3.	<p>(i) Explain the concept of emf induction in static and time varying magnetic field.</p> <p>(ii) In a material for which $\sigma = 5.0 \text{ S/m}$ and $\epsilon_r = 1$ with $\mathbf{E} = 250 \sin 10^{10} t$. Find J_c and J_D and also the frequency at which they equal magnitudes.</p>	(8) (5)	BTL4	Analyze	CO4
4.	Derive the set of Maxwells equations in integral form from fundamental laws for a good conductor.	(13)	BTL5	Evaluate	CO4
5.	Explain how the circuit equation for a series RLC circuit is derived from the field relations	(13)	BTL4	Analyze	CO4
6.	<p>(i) A parallel plate capacitor with plate area of $5 \text{ cm} \times \text{cm}$ and plate separation of 3 mm has a voltage of $50 \sin 10^8 t$ V applied to its plates. Calculate the displacement current assuming $\epsilon = 2 \epsilon_0$.</p> <p>(ii) The magnetic circuit of an iron ring with mean radius of 10 cm has a uniform cross section of 10^{-3} m^2. The ring is wound with two coils. If the circuit is energised by a current $i_1 = 3 \sin 100 \pi t$ A in the first coil with 200 turns</p>	(7) (6)	BTL3	Apply	CO4
7.	<p>i) Explain the relation between field theory and circuit theory and thus obtain an expression for ohm's law.</p> <p>ii) Compare and explain in detail conduction and displacement currents.</p>	(7) (6)	BTL5	Evaluate	CO4
8.	Describe the relationship between field theory and circuit theory.	(13)	BTL2	Understand	CO4
9.	Show that the ratio of the amplitudes of the conduction current density and displacement current density is $\frac{\sigma}{\omega \epsilon}$, for the applied $E = E_m \cos \omega t$. Assume $\mu = \mu_0$, what is the amplitude ratio, if the applied field is $E = E_m e^{-\alpha z} \cos \omega t$. where α is real?	(13)	BTL4	Analyze	CO4
10.	An iron ring with a cross sectional area of $3 \text{ cm} \times \text{cm}$ and a mean circumference of 15 cm is wound with 250 turns of wire carrying a current of 0.3 A . The relative permeability of the ring is 1500. Calculate the flux established in the ring.	(13)	BTL2	Understand	CO4
11.	Derive Maxwell's equation in both point and integral form for conducting medium and free space	(13)	BTL2	Understand	CO4

12.	State and derive the Maxwell's equations for free space in integral form and point form for time varying field	(13)	BTL3	Apply	CO4
13.	(i) A circular loop of wire is placed in a uniform magnetic field of flux density 0.5 wb/m^2 . The wire has 200 turns and frequency of rotation of 1000 revolution/minute. If the radius of the coil is 0.2m, determine (1) the induced emf, when the plane of the coil is 60° to the flux lines and (2) the induced emf when the plane of the coil is perpendicular to the field. (ii) Explain in detail about the difference between conduction and displacement currents.	(7) (6)	BTL5	Evaluate	CO4
14.	Derive the set of Maxwell's equations in integral form from fundamental laws for a free space.	(13)	BTL6	Create	CO4
15.	In free space, $H = 0.2 \cos(\omega t - \beta x) a_x$ A/m. Find the total power passing through a circular disc of radius 5 cm.	(13)	BTL5	Evaluate	CO4
16.	Given the conduction current density in a lossy dielectric as $J_c = 0.02 \sin 10^9 t$ A/m ² . Find the displacement current density if $\sigma = 10^3$ mho/m and $\epsilon_r = 6.5$.	(13)	BTL6	Create	CO4
17.	The magnetic field intensity in free space is given as $H = H_0 \sin \omega t a_y$ A/m, where $\omega = \beta c$ and β is a constant quantity. Determine the displacement current density.	(13)	BTL4	Analyze	CO4

PART C

1.	State Faraday's law. What are the different ways of emf generation? Explain with governing equation and suitable example for each.	(15)	BTL 5	Evaluate	CO4
2.	Obtain the expression for energy stored in the magnetic field and develop the expression for magnetic energy density.	(15)	BTL 6	Create	CO4
3.	State and prove boundary conditions by the application of Maxwell's equations.	(15)	BTL 5	Evaluate	CO4
4.	Show that the ratio of the amplitudes of the conduction current density and displacement current density is $\frac{\sigma}{\omega \epsilon}$. Find the current amplitude ratio if the applied field is $E = E_m e^{-\lambda z} \sin \omega t$ where λ is real.	(15)	BTL 5	Evaluate	CO4
5.	The conduction current flowing through a wire with conductivity $\sigma = 3 \times 10^7$ s/m and relative permeability $\mu_r = 1$ is given by $I_c = 3 \sin \omega t$ (mA). If $\omega = 10^8$ rad / sec. Find the displacement current.	(15)	BTL 6	Create	CO4

UNIT V - ELECTROMAGNETIC WAVES

Electromagnetic wave generation and equations – Wave parameters; velocity, intrinsic impedance, propagation constant – Waves in free space, lossy and lossless dielectrics, conductors- skin depth - Poynting vector – Plane wave reflection and refraction.

PART – A

Q.No	Questions		BT Level	Knowledge Level	
1.	Define intrinsic impedance.		BTL2	Understand	CO5
2.	Describe the properties of uniform plane wave		BTL2	Understand	CO5
3.	State the Poynting Theorem.		BTL2	Understand	CO5
4.	Discuss the Brewster angle.		BTL5	Evaluate	CO5
5.	Can a magnetic field exist in a good conductor if it is static (or) time varying? Explain.		BTL4	Analyze	CO5
6.	What is the relationship between E and H or brief about intrinsic impedance for a dielectric medium		BTL2	Understand	CO5
7.	What are Helmholtz equations or represent equation of electromagnetic wave in the phasor form?		BTL1	Remember	CO5
8.	A plane wave travelling in air is normally incident on a block of paraffins with $\epsilon_r = 2.3$. Find the reflection coefficient.		BTL3	Apply	CO5
9.	What is phase velocity?		BTL1	Remember	CO5
10.	If a plane wave is incident normal from medium 1 to medium 2, write the reflection and transmission coefficients.		BTL4	Analyze	CO5
11.	Develop the values of velocity and intrinsic impedance for free space.		BTL2	Understand	CO5
12.	Determine the velocity of a plane wave in a lossless medium having a relative permittivity 2 and relative permeability of unity.		BTL3	Apply	CO5
13.	Define skin depth or depth of penetration of a conductor.		BTL1	Remember	CO5
14.	Determine the skin depth of copper at 60 Hz with 5.8×10^7 s/m. Given $\mu = 1$.		BTL3	Apply	CO5
15.	Define linear, elliptical, and circular polarization?		BTL1	Remember	CO5
16.	Define snell's law of refraction.		BTL1	Remember	CO5
17.	Mention the Practical Importance of Skin Depth.		BTL1	Remember	CO5
18.	Describe the propagation constant.		BTL2	Understand	CO5
19.	Determine voltage reflection coefficient at the load end of a transmission.		BTL3	Apply	CO5
20.	State the properties of uniform plane wave.		BTL6	Create	CO5
21.	State the pointing theorem.		BTL1	Remember	CO5
22.	Define a wave.		BTL2	Understand	CO5
23.	Can a magnetic field exist in a good conductor if it is static or time varying? Explain.		BTL3	Apply	CO5
24.	Find the skin depth at a frequency of 2 MHz is a aluminium where $\sigma = 38.2$ M s/m and $\mu_r = 1$.		BTL6	Create	CO5
PART – B					
1.	Deduce the equation of the propagation of the plane electromagnetic waves in free space.	(13)	BTL5	Evaluate	CO5
2.	State and prove Poynting theorem	(13)	BTL3	Apply	CO5
3.	Deduce the expression for electromagnetic wave equation for conducting and perfect dielectric medium.	(13)	BTL5	Evaluate	CO5

4.	A 6580 MHz uniform plane wave is propagating in a material medium of $\epsilon_r = 2.25$. If the amplitude of the electric field intensity of lossless medium is 500V/m. Calculate the phase constant, propagation constant, velocity, wave length and intrinsic impedance.	(13)	BTL3	Apply	CO5
5.	(i) Deduce the wave equations for conducting medium. (ii) Discuss group velocity, phase velocity and propagation constant of electromagnetic waves.	(6) (7)	BTL5	Evaluate	CO5
6.	Write the short notes on the following: i) Plane waves in lossless dielectrics ii) Plane waves in free space. iii) Plane waves in good conductors.	(7) (6)	BTL3	Apply	CO5
7.	i) The electric field intensity associated with a plane wave travelling in a perfect dielectric medium is given by $E_x(z,t) = 10 \cos(2\pi \times 10^7 t - 0.1\pi z)$ V/m. What is the velocity of propagation? ii) Derive the Poynting theorem and state its significance.	(13)	BTL4	Analyze	CO5
8.	(i) Derive pointing theorem from Maxwells equation and explain . (ii) A uniform plane wave propagation in a medium has $\mathbf{E} = 2e^{-\alpha z} \sin(10^8 t - \beta z) \mathbf{a}_y$ V/m. If the medium is characterized by $\epsilon_r = 1$, $\mu_r = 20$ and $\sigma = 3$ S/m, Evaluate α , β and H.	(6) (7)	BTL5	Evaluate	CO5
9.	Obtain an expression for electromagnetic wave propagation in lossy dielectrics	(13)	BTL6	Create	CO5
10.	i) State pointing theorem and thus obtain an expression for instantaneous power density vector associated with electromagnetic field ii) A plane wave travelling in air normally incident on a block of paraffin with $\epsilon_r = 2.2$. Find the reflection coefficient	(9) (4)	BTL2	Understand	CO5
11.	Describe the concept of electromagnetic wave propagation in a linear, isotropic, homogeneous, lossy dielectric medium.	(13)	BTL2	Understand	CO5
12.	i) Find the velocity of a plane wave in a lossless medium having $\epsilon_r = 5$ and $\mu_r = 1$. ii) Show that the total power flow along a coaxial cable will be given by the surface integration of the pointing vector over any closed surface.	(3) (10)	BTL3	Apply	CO5
13.	Define polarization. What are the different types of wave polarization? Explain them with mathematical expression.	(13)	BTL1	Remember	CO5

14.	A plane travelling electromagnetic wave has $H = 0.008$ A/m in free space. Compute energy density and the velocity of this wave in glass, whose relative permittivity of glass is 3.	(13)	BTL4	Analyze	CO5
15.	Find the depth of penetration of a plane wave in copper at a power frequency of 60 Hz and at microwave frequency 10^{10} Hz. Given $\sigma = 5.8 \times 10^7$ mho/m.	(13)	BTL5	Evaluate	CO5
16.	A 10 MHz plane wave travelling in free space has an amplitude $E_0 = 50$ μ V/m. What is the average and peak energy density of the wave?	(13)	BTL6	Create	CO5
17.	A uniform plane wave in a medium having $\sigma = 10^{-3}$ s/m, $\epsilon_r = 80$ and $\mu_r = \mu_0$ is having a frequency of 10 KHz. i) Verify whether the medium is good conductor ii) Calculate the following, 1) Attenuation constant 2) Phase constant 3) Propagation constant 4) Intrinsic impedance 5) Wave length 6) Velocity of propagation	(13)	BTL3	Apply	CO5
PART C					
1.	A free space- silver interface has $E(\text{incident}) = 100$ V/m on the free space side. The frequency is 15 MHz and the silver constants are $\epsilon_r = \mu_r = 1$, $\sigma = 61.7$ MS/m. Evaluate $E(\text{reflected})$ and $E(\text{transmitted})$ at the interface.	(15)	BTL6	Create	CO5
2.	A plane wave travelling in +z direction in free space ($z < 0$) is normally incident at $z = 0$ on a conductor ($z > 0$) for which $\sigma = 61.7$ MS/m, $\mu_r = 1$. The free space E wave has a frequency $f = 1.5$ MHz and an amplitude of 1.0 V/m at the interface it is given by $E(0, t) = 1.0 \sin 2\pi f t \hat{a}_y$ (V/m). Analyse the wave and predict magnetic wave $H(z, t)$ at $z > 0$.	(15)	BTL4	Analyze	CO5
3.	Assume that E and H waves, travelling in free space, are normally incident on the interface with a perfect dielectric with $\epsilon_r = 3$. Evaluate the magnitudes of incident, reflected and transmitted E and H waves at the interface.	(15)	BTL5	Evaluate	CO5
4.	A plane wave propagating through a medium $\epsilon_r = 8$, $\mu_r = 2$ has $E = 0.5 \sin(10^8 t - \beta z) \hat{a}_z$ V/m. Determine i) wave impedance, ii) Wave velocity iii) β iv) H field .	(15)	BTL3	Apply	CO5

5.	A free space conductor interface has $H_i=1$ A/m on the free space side. The frequency is 31.8 MHz and the conductor constants are $\epsilon_r = \mu_r=1$ and $\sigma = 1.26$ M S/m. Determine H_r and H_i and depth of penetration of H_i .	(15)	BTL6	Create	CO5
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COURSE OUTCOMES:

1. Visualize and explain Gradient, Divergence, and Curl operations on electromagnetic vector fields and identify the electromagnetic sources and their effects.
2. Compute and analyse electrostatic fields, electric potential, energy density along with their applications.
3. Compute and analyse magneto static fields, magnetic flux density, vector potential along with their applications.
4. Explain different methods of emf generation and Maxwell's Equations
5. Explain the concept of electromagnetic waves and characterizing parameters