SRM VALLIAMMAI ENGINEERING COLLEGE

(Autonomous Institution)

DEPARTMENT OF

ELECTRICAL AND ELECTRONICS ENGINEERING

QUESTION BANK

IV SEMESTER

1905405 ELECTROMAGNETIC THEORY

Regulation – 2019

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Prepared by

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DEPARTMENT OF ELECRICAL AND ELECTRONICS ENGINEERING

QUESTION BANK

SUBJECT :	1905405 ELECTROMAGNETIC THEORY
SEM / YEAR:	IV/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**	**Competence**	
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**	**Applying**	**CO1**
2.	State Stoke's Theorem.		**BTL 1**	**Remembering**	**CO1**
3.	List the sources of electromagnetic fields.		**BTL 1**	**Remembering**	**CO1**
4.	Apply in matrix form the unit vector transformation from the rectangular to cylindrical coordinate system		**BTL 3**	**Applying**	**CO1**
5.	Two vectorial quantities $\bar{A} = 4\bar{i}+3\bar{j}+5\bar{k}$ and $\bar{B} = \bar{i}-2\bar{j}+2\bar{k}$ are known to be oriented in two unique directions. Determine the angular separation between them.		**BTL 2**	**Understanding**	**CO1**
6.	State the conditions for a vector A to be (a) solenoidal (b) irrotational.		**BTL 1**	**Remembering**	**CO1**
7.	State Divergence Theorem.		**BTL 1**	**Remembering**	**CO1**
8.	State the electric flux density.		**BTL 1**	**Remembering**	**CO1**
9.	Define divergence and its physical meaning.		**BTL 1**	**Remembering**	**CO1**
10.	What are the practical applications of electromagnetic fields?		**BTL 3**	**Applying**	**CO1**
11.	Mention the criteria for choosing an appropriate coordinate system for solving a field problem easily. Explain with an example.		**BTL 4**	**Analysing**	**CO1**
12.	When a vector field is solenoid and irrotational.		**BTL 6**	**Creating**	**CO1**
13.	Give the practical examples of diverging and curl field.		**BTL 2**	**Understanding**	**CO1**
14.	Obtain the unit vector in the direction from the origin towards the point P (3,-3,2).		**BTL 5**	**Evaluating**	**CO1**
15.	Give the differential displacement and volume in spherical co-ordinate system.		**BTL 2**	**Understanding**	**CO1**
16.	How can a vector field be expressed as the gradient of scalar field?		**BTL 5**	**Evaluating**	**CO1**
17.	Determine the curl of $\bar{P} = x^2yz\overline{a_x} + xz\overline{a_z}$		**BTL 4**	**Analysing**	**CO1**
18.	Verify the vector $\bar{A}=4\overline{a_x}-2\overline{a_y}+2\overline{a_z}$, $\bar{B}=-6\overline{a_x}+3\overline{a_y}-3\overline{a_z}$ are parallel to each other.		**BTL 6**	**Creating**	**CO1**

19.	Find the unit vector extending from the origin toward the point P (3,-1,-2)		**BTL 4**	**Analysing**	**CO1**
20.	Determine the electric field intensity in free space if $\vec{D} = 30 \vec{a}_x \ C/m^2$		**BTL 2**	**Understanding**	**CO1**
21.	Transform the cartesian coordinates (2,1,3) into spherical coordinates.		**BTL 4**	**Analysing**	**CO1**
22.	Express the value of differential volume in rectangular coordinate and cylindrical coordinate system.		**BTL 2**	**Understanding**	**CO1**
23.	Find the distance from A (1,23) to B (2,0, -1) in rectangular coordinates.		**BTL 5**	**Evaluating**	**CO1**
24.	Name a few applications of Gauss's law in electrostatics.		**BTL 3**	**Applying**	**CO1**
	PART – B				
1.	i)Show that over the closed surface of a sphere of radius B,ds =0 ii)Show that the vector $E = (6xy + z^3)\, a_x + (3x^2 - z)\, a_y + (3xz^2 - y)\, a_z$ is Irrotational and find its scalar potential.	**(4)** **(9)**	**BTL 3**	**Applying**	**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, π/2,-2).	**(13)**	**BTL 2**	**Understanding**	**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**	**Creating**	**CO1**
4.	Analyse the divergence of these vector fields. i)P = $x^2 yz\, \vec{a}_x + xz\, \vec{a}_z$ ii)Q = $\rho\sin\phi\, \vec{a}_\rho + \rho^2 z\, \vec{a}_\phi + z\cos\phi\, \vec{a}_z$ 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**	**Analysing**	**CO1**
5.	i) Given point P (-2,6,3) and $\bar{A}$= y$\bar{\imath}$ + (x + z)$\bar{\jmath}$, express P and $\bar{A}$ in cylindrical coordinates. ii) State and prove divergence theorem.	**(6)** **(7)**	**BTL 2**	**Understanding**	**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 $\nabla \times \nabla \times H = \nabla(\nabla . H) - \nabla^2 H$ Where the H is a vector.	**(7)** **(6)**	**BTL 3**	**Applying**	**CO1**

7.	i) State and describe divergence theorem. ii) Show that in Cartesian coordinates for any vector A, $\nabla.(\nabla^2 A) = \nabla^2(\nabla.A)$	**(9)** (4)	**BTL 1**	**Remembering**	**CO1**
8.	i) With neat diagram, explain the spherical system with co-ordinates(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**	**Analysing**	**CO1**
9.	Write short notes on gradient, divergence, curl and stokes theorem.	**(13)**	**BTL 1**	**Remembering**	**CO1**
10.	i)Verify the divergence theorem for a vector field $D = 3x^2 a_x + (3y+z)a_y + (3z-x)a_z$ 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**	**Remembering**	**CO1**
11.	i) If $\overrightarrow{B}$ = y $\overline{a_x}$ + (x + z) $\overline{a_y}$ and a point Q is located at (-2,6,3),express a) The point Qin cylindrical and spherical co ordinates. b) $\overrightarrow{B}$ in spherical co ordinates. ii) Derive coulomb's law of force.	**(9)** **(4)**	**BTL 2**	**Understanding**	**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**	**Analysing**	**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**	**Remembering**	**CO1**
14.	Given that $\bar{F} = (x^2+y^2)\bar{\imath}$ - 2xy$\bar{\jmath}$ 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**	**Evaluating**	**CO1**
15.	Prove that divergence of a curl of a vector is zero, using stoke's theorem.	**(13)**	**BTL 4**	**Analysing**	**CO1**
16.	State and verify divergence theorem for the vector $A = 4x\vec{i} - 2y^2\vec{j} + z^2\vec{k}$ taken over the cube bounded by x=0, x=1, y=0,y=1.	**(13)**	**BTL 5**	**Evaluating**	**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 x 10^{-8} C charge at Q (4,0,2) m.	**(13)**	**BTL 6**	**Creating**	**CO1**
	PART C				

1.	Given that $A = 30e^{-r}\overrightarrow{a_r} - 2z\overrightarrow{a_z}$ in cylindrical coordinates evaluate both sides of divergence theorem for the volume enclosed by r =2, z=0 and z=5.	(15)	BTL 5	Evaluating	CO1
2.	Given that $D = 5r^2/4\overrightarrow{a_r}$ C/m^2. Evaluate both the sides of divergence theorem for the volume enclosed by r= 4m and θ =π/4	(15)	BTL 5	Evaluating	CO1
3.	Design & validity of the divergence theorem considering the field D=2xy$\vec{a_x}$+$x^2\vec{a_y}$ C/m^2	(15)	BTL 6	Creating	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	Analysing	CO1
5.	A positive point charge 100 x 10^{-12} C is located in air at x=0,y=0.1m and another charge at x=0,y=-0.1 m .What is the magnitude and the direction of E at x=0.2 m , y=0?	(15)	BTL 6	Creating	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	Competence	
1.	Define electrical potential.		BTL 1	Remembering	CO2
2.	Mention the properties of electric flux lines.		BTL 1	Remembering	CO2
3.	State the electrostatic boundary conditions at the interface between two dielectrics.		BTL 1	Remembering	CO2
4.	State the properties of electric flux lines.		BTL 1	Remembering	CO2
5.	A dielectric slap 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	Applying	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	Evaluating	CO2
7.	What is the practical significance of Lorentz Force?		BTL 1	Remembering	CO2
8.	Define electric dipole moment.		BTL 1	Remembering	CO2
9.	Write Poisson's equation for a simple medium.		BTL 6	Creating	CO2
10.	What is conservative field?		BTL 6	Creating	CO2
11.	Define dielectric strength.		BTL 2	Understanding	CO2
12.	What is meant by dielectric breakdown?		BTL 2	Understanding	CO2
13.	A uniform line charge with ρl =5 μC/m lies along the x-axis. Find $\vec{E}$ at (3, 2, 1).		BTL 5	Evaluating	CO2

14.	Prepare the electric field intensity at a distance of 20 cm from a charge of 2 in vacuum.		BTL 3	Applying	CO2
15.	Write the expression for the energy density in electrostatic field.		BTL 2	Understanding	CO2
16.	State the properties of electric flux lines.		BTL 2	Understanding	CO2
17.	Define energy density.		BTL 3	Applying	CO2
18.	Write the equation for capacitance of coaxial cable.		BTL 4	Analysing	CO2
19.	Give the significant physical differences between Poisson's and Laplace's equations.		BTL 4	Analysing	CO2
20.	Evaluate the electric field intensity in free space if D=30 a_x C/m^3.		BTL 4	Analysing	CO2
21.	Give the relationship between potential gradient and electric field.		BTL 2	Understanding	CO2
22.	Define polarization in dielectric material.		BTL 2	Understanding	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	Applying	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	Analysing	CO2
PART – B					
1.	Deduce an expression for the capacitance of parallel plate capacitor having two identical media.	(13)	BTL 4	Analysing	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	Remembering	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(εr_1) and dielectric medium 2(εr_2) show that the tangential component of $\bar{E}$ is continuous across the boundary, whereas the normal component of $\bar{E}$ is discontinuous at the boundary.	(2) (11)	BTL 1	Remembering	CO2
4.	i)A circular disc of radius 'a' m is charged uniformly with a charge density of ρ_s 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	Analysing	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 εr_1 = 1.5 and εr_2 = 3.5 each occupy one half of the space between the plates of area 2 m^2 and d= 10^{-3} m.	(6) (7)	BTL 3	Applying	CO2
6.	Find the potential at any point along the axis of a uniformly charged disc.	(13)	BTL 4	Analysing	CO2

7.	Interpret the expression for energy stored and energy density in electro static fields.	(13)	BTL 3	Applying	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 εr = 3.12, Find the surface charge densities on the conductor. ii) Define Laplace and Poisson's equation.	(10) (3)	BTL 2	Understanding	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	Understanding	CO2
10.	The relative permittivity εr 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	Evaluating	CO2
11.	i)A positive point charge $100*10^{-12}$ C is located in air at x=0,0.01m and another such charge at x=0, y=-0.1m.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 $\varepsilon_1$and ϵ_2 respectively interposed between the plates.	(4) (9)	BTL 1	Remembering	CO2
12.	i)Explain briefly the polarization in dielectrics. ii) Derive Laplace's and Poisson's equation from Gauss's law for a	(13)	BTL 1	Remembering	CO2
13.	Distinguish between electric potential and electric potential difference. Two point charges -4 micro coulomb and 5micro 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	Understanding	CO2
14.	i) Two point charges -4µC and 5µC 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 $\frac{C'}{C} = \frac{\varepsilon'}{(t' + \varepsilon'(t - t'))}$	(13)	BTL 6	Creating	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, ε_r = 5.4, fills 20 % of the distance between the plates. Assume the same applied voltage in each case.	(13)	BTL 4	Analysing	CO2

16.	Two capacitors C_1 = 1 μF and C_2 = 2 μF are connected in parallel across a 1000V dc supply. Find the charge on capacitors.	**(13)**	**BTL 6**	**Creating**	**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**	**Evaluating**	**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**	**Evaluating**	**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**	**Analysing**	**CO2**
3.	Step by Step, develop a condition between (i) Conductor and Dielectric (ii) Dielectric and Dielectric	**(15)**	**BTL 4**	**Analysing**	**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**	**Evaluating**	**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**	**Creating**	**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**	**Competence**	
1.	Distinguish between magnetic scalar potential and magnetic vector potential.		**BTL 4**	**Analysing**	**CO3**
2.	What is Lorentz law of force?		**BTL 1**	**Remembering**	**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**	**Creating**	**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	Applying	CO3
5.	Expression for the magnetic force between an electromagnet and an armature to be attracted.		BTL 2	Understanding	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	Applying	CO3
7.	State Ampere's circuital law.		BTL 1	Remembering	CO3
8.	State Biot savarts law.		BTL 1	Remembering	CO3
9.	What is the total force acting on a moving charge Q in the presence of both electric and magnetic fields.		BTL 3	Applying	CO3
10.	Define the terms: magnetic moment and magnetic permeability.		BTL 1	Remembering	CO3
11.	What is vector magnetic potential?		BTL 1	Remembering	CO3
12.	Define Magnetostaic energy density.		BTL 1	Remembering	CO3
13.	Design the BH curve for classifying magnetic materials.		BTL 5	Evaluating	CO3
14.	Estimate the mutual inductance of the two inductively coupled coils with self inductance of 25mH and100 mH.		BTL 2	Understanding	CO3
15.	Illustrate self inductance and mutual inductance.		BTL 2	Understanding	CO3
16.	A current of 3A flowing through an inductor of 100mH. Interpret the energy stored in the inductor?		BTL 4	Analysing	CO3
17.	Distinguish between diamagnetic, paramagnetic and ferromagnetic materials.		BTL 4	Analysing	CO3
18.	Sketch Gauss law for the magnetic field.		BTL 5	Evaluating	CO3
19.	What is the practical significance of Lorentz's Force?		BTL 2	Understanding	CO3
20.	Compare magnetic scalar potential and magnetic vector potential		BTL 6	Creating	CO3
21.	Define magnetic flux density.		BTL 2	Understanding	CO3
22.	List the applications of Ampere's circuital law.		BTL 4	Analysing	CO3
23.	Give an equation of torque on a solenoid.		BTL 5	Evaluating	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	Applying	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	Remembering	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	Remembering	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	Understanding	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	Understanding	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	Understanding	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 μ_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	Remembering	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 ampers in the inner and outer conductor. ii) Calculate the self inductance of infinitely long solenoid	(7) (6)	BTL 1	Remembering	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	Applying	CO3
9.	Obtain the expression for energy stored in the magnetic field and also derive the expression for magnetic energy density.	(13)	BTL 3	Applying	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 8cm^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	Analysing	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	Analysing	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	Analysing	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	Evaluating	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	Creating	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**	**Analysing**	**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**	**Evaluating**	**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**	**Creating**	**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 o.5 cm and 0.8 cm respectively	**(15)**	**BTL 5**	**Evaluating**	**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**	**Evaluating**	**CO3**
3.	An iron ring,0.2 m in diameter and 10cm*cm sectional area of the core is uniformly wound with 250 turns of wire. The wire carries a current of 4A.The wire carries a current of 4A.The relative permeability of iron is 500.Determine the value of self inductance and the stored energy.	**(15)**	**BTL 5**	**Evaluating**	**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 6cm.Evaluate the mutual inductance and the coupling coefficient of the arrangement	**(15)**	**BTL 5**	**Evaluating**	**CO3**
5.	Two coils are connected in series and their total inductance is 4.4 m H. 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**	**Evaluating**	**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**	**Competence**	

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

2.	(i) Explain the relation between field theory and circuit theory in detail. (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.	**(6)** **(7)**	BTL4	**Analysing**	**CO4**
3.	(i) Explain the concept of emf induction in static and time varying magnetic field. (ii) In a material for which σ =5.0S/m and ε_r= 1 with $E = 250 \sin 10^{10} t$.Find J_c and J_D and also the frequency at which they equal magnitudes.	**(8)** **(5)**	BTL4	**Analysing**	**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	**Analysing**	**CO4**
6.	(i)A parallel plate capacitor with plate area of 5cm*cm and plate separation of3 mm has a voltage of 50$\sin 10^3$t V applied to its plates. Calculate the displacement current assuming ε=2ε_0. (ii)The magnetic circuit of an iron ring with mean radius of 10cm 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 $i_1 = 3sin100\pi t$ A in the first coil with 200 turns	**(7)** **(6)**	BTL3	**Applying**	**CO4**
7.	i)Explain the relation between field theory and circuit theory and thus obtain an expression for ohm's law. ii)) Compare and explain in detail conduction and displacement currents.	**(7)** **(6)**	BTL5	**Evaluate**	**CO4**
8.	Describe the relationship between field theory and circuit theory.	**(13)**	BTL2	**Understanding**	**CO4**
9.	Show that the ratio of the amplitudes of the conduction current density and displacement current density is $\sigma/\omega\varepsilon$, for the applied E= Em cosωt. Assume μ =μ_0, what is the amplitude ratio, if the applied field is E= Em $e^{-t/\tau}$ .where τ is real?	**(13)**	BTL4	**Analysing**	**CO4**
10.	An iron ring with a cross sectional area of 3 cm*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	**Understanding**	**CO4**
11.	Derive Maxwell's equation in both point and integral form for conducting medium and free space	**(13)**	BTL2	**Understanding**	**CO4**

12.	State and derive the Maxwell's equations for free space in integral form and point form for time varying field	(13)	BTL3	**Applying**	**CO4**
13.	(i)A circular loop of wire is placed in a uniform magnetic field of flux density 0.5wb/m^2. The wire has 200turns 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^o 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	**Creating**	**CO4**
15.	In free space, $H = 0.2\cos(\omega t - \beta x)\overrightarrow{a_x}$ 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 σ =10^3 mho/m and ε_r = 6.5.	(13)	BTL6	**Creating**	**CO4**
17.	The magnetic field intensity in free space is given as $H = H_0 \sin\theta\overrightarrow{a_y}$ A/m, where $\theta = \omega t - \beta z$ and β is a constant quantity. Determine the displacement current density.	(13)	BTL4	**Analysing**	**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**	**Evaluating**	**CO4**
2.	Obtain the expression for energy stored in the magnetic field and develop the expression for magnetic energy density.	**(15)**	**BTL 6**	**Creating**	**CO4**
3.	State and prove boundary conditions by the application of Maxwell's equations.	**(15)**	**BTL 5**	**Evaluating**	**CO4**
4.	Show that the ratio of the amplitudes of the conduction current density and displacement current density is $\sigma/\omega\epsilon$.Find the current amplitude ratio if the applied field is $E = E_m e^{-\frac{t}{\lambda}}$ where λ is real.	**(15)**	**BTL 5**	**Evaluating**	**CO4**
5.	The conduction current flowing through a wire with conductivity $\sigma = 3\times10^7$ s/m and relative permeability $\varepsilon_r = 1$ is given by $I_c = 3\sin\omega t(mA)$. If $\omega = 10^8 rad/\sec$.Find the displacement current.	**(15)**	**BTL 6**	**Creating**	**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	Competence	
1.	Define intrinsic impedance.		BTL2	**Understanding**	**CO5**
2.	Describe the properties of uniform plane wave		BTL2	**Understanding**	**CO5**
3.	State the Poynting Theorem.		BTL2	**Understanding**	**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	**Analysing**	**CO5**
6.	What is the relationship between E and H or brief about intrinsic impedance for a dielectric medium		BTL2	**Understanding**	**CO5**
7.	What are Helmholtz equations or represent equation of electromagnetic wave in the phasor form?		BTL1	**Remembering**	**CO5**
8.	A plane wave travelling in air is normally incident on a block of paraffins with ε_r =2.3. Find the reflection coefficient.		BTL3	**Applying**	**CO5**
9.	What is phase velocity?		BTL1	**Remembering**	**CO5**
10.	If a plane wave is incident normal from medium 1 to medium 2, write the reflection and transmission coefficients.		BTL4	**Analysing**	**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	**Applying**	**CO5**
13.	Define skin depth or depth of penetration of a conductor.		BTL1	**Remembering**	**CO5**
14.	Determine the skin depth of copper at 60 Hz with 5.8 X 10^7 s/m. Given μ= 1.		BTL3	**Applying**	**CO5**
15.	Define linear, elliptical, and circular polarization?		BTL1	**Remembering**	**CO5**
16.	Define snell's law of refraction.		BTL1	**Remembering**	**CO5**
17.	Mention the Practical Importance of Skin Depth.		BTL1	**Remembering**	**CO5**
18.	Describe the propagation constant.		BTL2	**Understanding**	**CO5**
19.	Determine voltage reflection coefficient at the load end of a transmission.		BTL3	**Applying**	**CO5**
20.	State the properties of uniform plane wave.		BTL6	**Creating**	**CO5**
21.	State the pointing theorem.		BTL1	**Remembering**	**CO5**
22.	Define a wave.		BTL2	**Understanding**	**CO5**
23.	Can a magnetic field exist in a good conductor if it is static or time varying? Explain.		BTL3	**Applying**	**CO5**
24.	Find the skin depth at a frequency of 2 MHz is a aluminium where σ = 38.2 M s/m and μ_r = 1.		BTL6	**Creating**	**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	**Applying**	**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 ε_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	**Applying**	**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	**Applying**	**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-0.1πz)V/m. What is the velocity of propagation? ii)Derive the Poynting theorem and state its significance.	**(13)**	BTL4	**Analysing**	**CO5**
8.	(i)Derive pointing theorem from Maxwells equation and explain . (ii) A uniform plane wave propagation in a medium has $E = 2e^{-\alpha z}\sin(10^8 t - \beta z)a_y$ V/m. If the medium is characterized by ε_r =1 ,μ_r=20 and σ =3S/m, Evaluate α, β and H.	**(6)** **(7)**	BTL5	**Evaluate**	**CO5**
9.	Obtain an expression for electromagnetic wave propagation in lossy dielectrics	**(13)**	BTL6	**Creating**	**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 ε_r =2.2 .Find the reflection coefficient	**(9)** **(4)**	BTL2	**Understanding**	**CO5**
11.	Describe the concept of electromagnetic wave propagation in a linear, isotropic, homogeneous, lossy dielectric medium.	**(13)**	BTL2	**Understanding**	**CO5**
12.	i) Find the velocity of a plane wave in a lossless medium having ε_r =5 and μ_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	**Applying**	**CO5**
13.	Define polarization. What are the different types of wave polarization? Explain them with mathematical expression.	**(13)**	BTL1	**Remembering**	**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	**Analysing**	**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 σ = 5.8 x 10^7 mho/m.	**(13)**	BTL5	**Evaluate**	**CO5**
16.	A 10 MHz plane wave travelling in free space has an amplitude E_0 = 50 µV/m. What is the average and peak energy density of the wave?	**(13)**	BTL6	**Creating**	**CO5**
17.	A uniform plane wave in a medium having $\sigma = 10^{-3}$ s/m, $\varepsilon = 80\varepsilon_0$ and $\mu = \mu_0$ 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	**Applying**	**CO5**
	PART C				
1.	A free space- silver interface has E(incident)=100V/m on the free space side. The frequency is 15MHz and the silver constants are ε_r $-\mu_r$ =1 ,σ =61.7MS/m. Evaluate E(reflected) and E(transmitted) at the interface.	**(15)**	BTL6	**Creating**	**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 σ=61.7MS/m, μ_r =1.the free space E wave has a frequency f=1.5MHz and an amplitude of 1.0V/m at the interface it is given by E(0,t) =1.0sin 2πft a_y (V/m).Analyse the wave and predict magnetic wave H(z,t) at z>0.	**(15)**	BTL4	**Analysing**	**CO5**
3.	Assume that E and H waves, travelling in free space, are normally incident on the interface with a perfect dielectric with ε_r=3.Evaluate the magnitudes of incident, reflected and transmitted E and H waves at the interface.	**(15)**	BTL5	**Evaluating**	**CO5**
4.	A plane wave propagating through a medium ε_r=8 , μ_r =2 has E=0.5 $\sin(10^8 t - \beta z)\vec{a_z}$ v/m. Determine i) wave impedance, ii)Wave velocity iii)β iv) H field .	**(15)**	BTL3	**Applying**	**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 $\varepsilon_r = \mu_r$ =1 and σ = 1.26 M S/m. Determine H_r and H_i and depth of penetration of H_i.	**(15)**	BTL6	**Creating**	**CO5**

COURSE OUTCOMES:

1. Ability to understand the basic mathematical concepts related to electromagnetic vector fields
2. Ability to understand the basic concepts about electrostatic fields, electrical potential, energy density and their applications
3. Ability to acquire the knowledge in magneto static fields, magnetic flux density, vector potential and its applications
4. Ability to understand the different methods of emf generation and Maxwell’s equations
5. Ability to understand the basic concepts electromagnetic waves and characterizing parameters