SRM VALLIAMMAI ENGINEERING COLLEGE
(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OFELECTRONICS & COMMUNICATION ENGINEERING

QUESTION BANK

SUBJECT : EC6451 - ELECTROMAGNETIC FIELDS

SEM / YEAR : IV/II

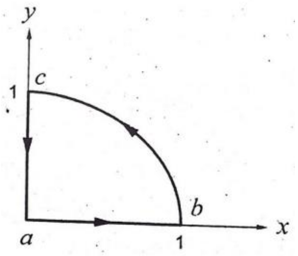
UNIT I INTRODUCTION

Electromagnetic model, Units and constants, Review of vector algebra, Rectangular, cylindrical and spherical coordinate systems, Line, surface and volume integrals, Gradient of a scalar field, Divergence of a vector field, Divergence theorem, Curl of a vector field, Stoke's theorem, Null identities, Helmholtz's theorem

PART - A

Q.No.	Questions	BT Level	Competence
1.	List the source quantities in the electromagnetic model.	BTL 1	Remembering
2.	Describe line, surface and volume charge density.	BTL 2	Understanding
3.	State divergence theorem.	BTL 1	Remembering
4.	Define Stokes theorem.	BTL 1	Remembering
5.	Name the universal constants in the electromagnetic model.	BTL 1	Remembering
6.	What are surface and volume integrals?	BTL 1	Remembering
7.	Give the relationship between potential and electric field intensity.	BTL 2	Understanding
8.	Identify the unit vector and its magnitude corresponding to the given vector $\boldsymbol{A}=5\,\hat{a}_x + \hat{a}_y + 3\,\hat{a}_z$.	BTL 3	Applying
9.	Estimate the distance between the given vectors ***A*** (1, 2, 3) and ***B*** (2, 1, 2).	BTL 6	Creating
10.	Outline the relationship between magnetic flux density and field density.	BTL 2	Understanding
11.	Calculate the values of universal constants of free space.	BTL 5	Evaluating
12.	Analyze a differential volume element in spherical coordinates (r, θ, φ) resulting from differential charges in the orthogonal coordinate systems.	BTL 4	Analyzing
13.	Specify the unit vector extending from the origin towards the point **G** (2,-2,-1).	BTL 3	Applying
14.	Compare orthogonal and non-orthogonal coordinate systems.	BTL 4	Analyzing
15.	Point out the role of vector algebra in electromagnetics.	BTL 2	Understanding

16.	Convert the point **P** (5, 1, 3) from Cartesian to spherical coordinates.	BTL 4	Analyzing
17.	Write the transformation between spherical and Cartesian coordinates.	BTL 1	Remembering
18.	Justify that electric field is conservative.	BTL 3	Applying
19.	Obtain the value of α if magnetic field **B** is a solenoid where $\mathbf{B}=25x\mathbf{a}_x+12y\mathbf{a}_y+\alpha z\mathbf{a}_z$.	BTL 6	Creating
20.	Assess the physical significance of curl of a vector field.	BTL 5	Evaluating
	PART - B		
1.	What is electromagnetics? Give detailed explanation on Electromagnetic model with corresponding units and constants. (13)	BTL 1	Remembering
2.	(i) Verify whether the vector field $\mathbf{E}= yz\,\hat{\mathbf{a}}_x + xz\,\hat{\mathbf{a}}_y + xy\,\hat{\mathbf{a}}_z$ is both solenoidal and irrotational. (7) (ii) Given $\mathbf{A} = 5\hat{\mathbf{a}}_x$ and $\mathbf{B}= 4\,\hat{\mathbf{a}}_y + t\,\hat{\mathbf{a}}_y$. Find t such that angle between **A** and **B** is 45^0. (6)	BTL 1	Remembering
3.	(i) Write short notes on scalar and vector field. (4) (ii)What is unit vector? Discuss on the mathematical operations with Vectors. (9)	BTL 1	Remembering
4.	Explain how a spherical coordinate system describes the position of the point in free space and its differential elements. (13)	BTL 1	Remembering
5.	(i) Summarize about the Dot product and cross product of vectors. State its properties and applications. (7) (ii)The three fields are given by $\mathbf{A} = 2\hat{\mathbf{a}}_x - \hat{\mathbf{a}}_z$, $\mathbf{B} = 2\hat{\mathbf{a}}_x - \hat{\mathbf{a}}_y + 2\hat{\mathbf{a}}_z$ and $\mathbf{C} = 2\hat{\mathbf{a}}_x - 3\hat{\mathbf{a}}_y + \hat{\mathbf{a}}_z$. Find the scalar and vector triple product. (6)	BTL 2	Understanding
6.	Obtain the expressions for differential area and volume element in cylindrical coordinate system. (13)	BTL 2	Understanding
7.	Analyze the geometrical position of the point in Cartesian coordinate system and obtain distance vector and differential elements. (13)	BTL 4	Analyzing
8.	Asses the spherical coordinates of **A** and Cartesian coordinates of **B** for the two given points **A**(x = 2, y = 1, z = 3) and **B**(ρ= 1, φ = 45^0, z = 2) (13)	BTL 3	Applying
9.	Given the two points **A** (x = 2, y = 3, z = -1) and **B** (r=4, θ=25^0, φ=120^0). Solve the spherical coordinates of **A** and Cartesian coordinates of **B**. (13)	BTL 3	Applying
10.	State and prove divergence theorem for a given differential volume element. (13)	BTL 2	Understanding
11.	Verify divergence theorem for the vector $\mathbf{A}= 4x\,\hat{\mathbf{a}}_x - 2y^2\,\hat{\mathbf{a}}_y + z^2\,\hat{\mathbf{a}}_z$ taken over the cube bounded between x=0,x=1, y=0 ,y=1 and z=0, z=1. (13)	BTL 4	Analyzing
12.	(i)Explain in detail line, surface and volume integral of vector function.(7) (ii)Express the rate of change of a scalar in a given direction in terms of its gradient and its properties. (6)	BTL 4	Analyzing
13.	(i)Verify the null identities using general orthogonal coordinates. (7) (ii) How do you explain the use of Helmholtz's theorem in electromagnetic engineering? (6)	BTL 5	Evaluating

14.	(i) Elaborate on curl of a vector and its significance. (7) (ii) State and prove Stokes theorem to relate line integral and surface integral (6)	BTL 6	Creating
PART - C			
1.	Evaluate divergence theorem for the given **D**= $2r\, z^2\, \hat{a}_r + r \cos^2\varphi\, \hat{a}_z$, where r =3 and z=5. (15)	BTL 5	Evaluating
2.	Express vector **B** in Cartesian and cylindrical systems .Given **B**= $10/r\, \hat{a}_r + r\cos\theta\, \hat{a}_\theta + \hat{a}_\varphi$, Then find **B** at (-3,4,0) and (5,π/2,-2) (15)	BTL 5	Evaluating
3.	Validate stokes theorem for a vector field **A** = $2r \cos\varphi\, a_r + r\, \hat{a}_\varphi$ in cylindrical coordinates for the contour shown in figure below. (15) 	BTL 6	Creating
4.	Estimate $\iint$ **F.n** ds using divergence theorem where **F**= $2xy\, \hat{a}_x + y^2\, \hat{a}_y + 4yz\, \hat{a}_z$, surface of the cube bounded by x=0,x=1, y=0 ,y=1 and z=0, z=1. (15)	BTL 6	Creating

UNIT II ELECTROSTATISTICS

Electric field, Coulomb's law, Gauss's law and applications, Electric potential, Conductors in static electric field, Dielectrics in static electric field, Electric flux density and dielectric constant, Boundary conditions, Capacitance, Parallel, cylindrical and spherical capacitors, Electrostatic energy, Poisson's and Laplace's equations, Uniqueness of electrostatic solutions, Current density and Ohm's law, Electromotive force and Kirchhoff's voltage law, Equation of continuity and Kirchhoff's current law

PART – A

Q.No	Questions	BT Level	Competence
1.	Define electric field intensity.	BTL 1	Remembering
2.	Write the statement of Coulomb’s law.	BTL 1	Remembering
3.	What is the difference between potential and potential difference?	BTL 1	Remembering
4.	Mention the two sources of electromagnetic fields.	BTL 1	Remembering
5.	Describe the relationship between electric field intensity and electric flux density.	BTL 1	Remembering
6.	State Gauss law.	BTL 2	Understanding
7.	Calculate the values of ***D*** at a distance r = 5m for the uniformly charged sphere of radius 2m with charge density of 20 nC/m^3.	BTL 3	Applying
8.	Give examples for uniform and non-uniform electric fields.	BTL 2	Understanding
9.	Explain the principle of Superposition as applied to an electric potential of a point.	BTL 2	Understanding

10.	List the properties of conductor and dielectric materials.	BTL 1	Remembering
11.	Describe about capacitance and capacitors.	BTL 2	Understanding
12.	Solve the energy stored in a 10 µF capacitor which has been charged to a voltage of 400V.	BTL 3	Applying
13.	How do you find the equivalent capacitance of two capacitors C_1 and C_2 connected in series?	BTL 3	Applying
14.	Obtain the relation between current and current density.	BTL 4	Analyzing
15.	Identify equation of Ohm's law in point form.	BTL 4	Analyzing
16.	Compare Poisson's and Laplace's equation.	BTL 4	Analyzing
17.	Evaluate the unique solution of electrostatic fields.	BTL 5	Evaluating
18.	Calculate the value of capacitance between two square plates having cross sectional area of 1 sq.cm separated by 1 cm placed in a liquid whose dielectric constant is 6 and the relative permittivity of free space is 8.854 pF/m.	BTL 5	Evaluating
19.	Formulate the current density of copper wire having conductivity of $5.8 * 10^7$ S/m and magnitude of electric field intensity **E** is 20V/m.	BTL 6	Creating
20.	Derive the continuity equation in integral and differential form.	BTL 6	Creating
	PART - B		
1.	Q_1 and Q_2 are the point charges located at (0,-4, 3) and (0, 1, 1).If Q1 is 2 nC, Find Q2 such that the force on test charge at (0,-3, 4) has no z component. (13)	BTL 1	Remembering
2.	(i)State and explain coulomb's law and deduce the vector form of force equation between the two point charges. (7) (ii) Write note on principle of Superposition as applied to charge distribution.	BTL 1	Remembering
3.	Obtain the formula for the electric field intensity of an infinite long straight line carrying uniform line charge density of ρ_L. (13)	BTL 4	Analyzing
4.	(i) State and prove Gauss law. (7) (ii) Obtain the point form of gauss law. (6)	BTL 1	Remembering
5.	Explain about any two applications of Gauss law with neat diagrams. (13)	BTL 2	Understanding
6.	Derive the expression for potential due to an electric dipole at any point P. Also find the electric field intensity and in terms of dipole moment. (13)	BTL 2	Understanding
7.	(i) Analyze about nature of dielectric material and polarization. (7) (ii)Determine the value of polarization and electric field intensity of homogeneous slab of lossless dielectric with electric susceptibility of 0.12 and electric flux density of $1.6 nC/m^2$. (6)	BTL 4	Analyzing
8.	Explain the importance of Poisson's and Laplace's equation in electromagnetics with necessary equations. (13)	BTL 2	Understanding
9.	Derive the boundary conditions of the normal and tangential components of electric field at the interface of two media with different dielectrics. (13)	BTL 3	Applying

10.	Formulate the expression for electrostatic energy required to assemble a group of charges at rest. (13)	BTL 3	Applying
11.	Derive the boundary conditions between conductor and dielectrics from the boundary conditions between conductor and free space. (13)	BTL 6	Creating
12.	(i) Write the equation of continuity in integral and differential form. (7) (ii) Discuss the point form of ohm's law and obtain the expression for resistance of a conductor. (6)	BTL 1	Remembering
13.	A cylindrical capacitor consists of an inner conductor of radius 'a' & an outer conductor whose inner radius is 'b'. The space between the conductors is filled with a dielectric permittivity ε_r & length of the capacitor is L. Estimate the value of the Capacitance. (13)	BTL 4	Analyzing
14.	Evaluate the expression for a parallel plate capacitor. Also derive the equation for composite parallel plate capacitor with dielectric boundary parallel and normal to the plates. (13)	BTL 5	Evaluating
	PART - C		
1.	Determine the expression for the electric field due to a charge circular ring of radius r placed in xy plane with center at origin having charge density of ρ_L C/m. Find **E** at the point (0, 0, 5) m from the circular ring of charge with radius 5 m lying in z = 0 plane with center at origin and having ρ_L = 10 nC/m. (15)	BTL 5	Evaluating
2.	(i) Derive the equation of potential due to point, line, and surface and volume charge and obtain the relation between **E** and **V**. (8) (ii) Given the potential V= (10 sin θ cosφ) /r^2. Find the electric flux density at (2, π/2, 0). (7)	BTL 5	Evaluating
3.	Obtain at point P the magnitudes of **V, E, E_t, E_N, D, D_N** and ρ_S of a potential field V= 100 e^{-5x} sin 3y cos4z volts. Let point P (0.1, π/12, π/24) be located at a conductor free space boundary. (15)	BTL 6	Creating
4.	(i) Determine the capacitance of general spherical capacitor, isolated sphere coated with dielectric. (10) (ii) For a conducting sphere of 2 cm in diameter, covered with a layer of polyethylene with ε_r = 2.26 and 3 cm thick, find the capacitance. (5)	BTL 6	Creating

UNIT III MAGNETOSTATICS

Lorentz force equation, Law of no magnetic monopoles, Ampere's law, Vector magnetic potential, Biot-Savart law and applications, Magnetic field intensity and idea of relative permeability, Magnetic circuits, Behaviour of magnetic materials, Boundary conditions, Inductance and inductors, Magnetic energy, Magnetic forces and torques

PART - A

Q.No	Questions	BT	Competence
1.	Define magnetic field and magnetic lines of force.	BTL 1	Remembering
2.	State Biot-Savart's law.	BTL 1	Remembering

3.	Describe Ampere's circuital law.	BTL 1	Remembering
4.	What is scalar magnetic potential?	BTL 1	Remembering
5.	Write about magnetic flux and flux density.	BTL 1	Remembering
6.	List the applications of Ampere's circuital law.	BTL 1	Remembering
7.	Point out the relation between magnetic flux density and magnetic field intensity.	BTL 2	Understanding
8.	Outline the concept of permeability and its unit.	BTL 2	Understanding
9.	Infer the Lorentz force equation for a moving charge?	BTL 2	Understanding
10.	Explain magnetic moment.	BTL 2	Understanding
11.	Identify the relationship between magnetic field intensity and magnetization.	BTL 3	Applying
12.	Classify the different types of magnetic materials.	BTL 3	Applying
13.	Derive the expression of force between two current elements.	BTL 3	Applying
14.	Express the self and mutual inductance.	BTL 4	Analyzing
15.	Examine the expression of energy stored in an inductor.	BTL 4	Analyzing
16.	Analyze the mutual inductance of two inductively tightly coupled coils with self-inductance of 25mH and 100mH.	BTL 4	Analyzing
17.	Find the energy stored in inductor having current of 3A flowing through the inductor of 100mH.	BTL 5	Evaluating
18.	Compute torque where magnetic field is $\mathbf{B}=0.2\ \hat{\mathbf{a}}_x + 0.4\ \hat{\mathbf{a}}_z$ Wb/m^2 and magnetic dipole moment is $\mathbf{M}=8*10^{-3}\ \hat{\mathbf{a}}_z$ Am^2.	BTL 5	Evaluating
19.	Explain the phenomenon of hysteresis with reference to ferromagnetic materials.	BTL 6	Creating
20.	Obtain the energy stored in a magnetic field in terms of field quantities.	BTL 6	Creating
	PART – B		
1.	From the Biot-Savart's law, write the expression for magnetic field intensity at a point P and distance R from the infinitely long straight current carrying conductor. (13)	BTL 1	Remembering
2.	Derive the equations for magnetic field intensity and magnetic flux density at the center of the square current loop using Biot-Savart's law. (13)	BTL 1	Remembering
3.	Write short notes on (i)Magnetic field due to current carrying conductors. (7) (ii)Law of non-magnetic monopoles. (6)	BTL 1	Remembering
4.	State about magnetization? Describe the classification of magnetic materials with examples. (13)	BTL 1	Remembering
5.	Determine the magnetic field intensity at the origin due to current element $\mathbf{Idl} = 3\pi\ (\hat{\mathbf{a}}_x + 2\ \hat{\mathbf{a}}_y + 3\hat{\mathbf{a}}_z)$ μA · m at (3,4,5)m in free space. (13)	BTL 5	Evaluating
6.	(i) Discuss about the force on a straight and long current carrying conductor placed in the uniform magnetic field. (7) (ii)Illustrate with diagram magnetic torque. (6)	BTL 2	Understanding

7.	(i) Using Biot-Savart's law, illustrate the magnetic field intensity on the axis of a circular loop of radius R carrying a steady current I. (7) (ii) A circular loop located on $x^2 + y^2 = 9$, $z = 0$ carries a direct current of 10 A along $\mathbf{a}_\varphi$. Calculate **H** at (0, 0, 4) and (0, 0,-4). (6)	BTL 2	Understanding
8.	Derive the expression for Ampere circuital law. Apply the law for any two applications with necessary illustrations. (13)	BTL 3	Applying
9.	(i)Derive the Maxwell's curl equation for magnetic field from Ampere circuital law. (7) (ii)Solve the magnetic field at a point P(0.01, 0, 0)m if current through a co-axial cable is 6A. which is along the z-axis and a=3mm, b=9mm, c=11mm.(6)	BTL 3	Applying
10.	Let **A**=(3y-z)ax+2xzay Wb/m in a region of free space. (i)Prove that $\nabla . \boldsymbol{A} = 0$ (5) (ii)At P(2,-1,3) find **A, B, H** and **J** (8)	BTL 4	Analyzing
11.	(i) Estimate the expression for inductance of a toroidal coil carrying current I, with N turns and the radius of toroid 'r'. (7) (ii) Formulate the expression for inductance of a coaxial cable. (6)	BTL 6	Creating
12.	Examine the magnetic field intensity within a magnetic material where (i)**M**=150A/m and $\mu=1.5\times10^{-5}$ H/m (7) (ii)**B**=300μT and χ_m=15. (6)	BTL 4	Analyzing
13.	Describe about the magnetic boundary condition at the interface between two magnetic medium and derive the necessary boundary conditions. (13)	BTL 2	Understanding
14.	A solenoid with N_1=2000, r_1=2 cm and l_1= 100cm is concentric within a second coil of N_2= 4000, r_2= 4cm and l_2=100cm.Calculate mutual inductance assuming free space conditions. (13)	BTL 4	Analyzing
	PART – C		
1.	(i) Distinguish magnetic scalar potential from the vector potential with necessary equations. (8) (ii) Calculate the magnetic flux density for a current distribution in free space, **A**= $(2x^2y+yz)\,\hat{\mathbf{a}}_x + (xy^2-xz^3)\,\hat{\mathbf{a}}_y-(6xyz-2x^2y^2)\,\hat{\mathbf{a}}_z$ Wb/m. (7)	BTL 5	Evaluating
2.	(i) At a point P(x, y, z) the components of vector magnetic potential $\vec{A}$ are given as $\mathbf{A_z}$ = (4x + 3y+2z), $\mathbf{A_y}$ = (5x +6y +3z) and $\mathbf{A_z}$ = (2x+3y+5z). Invent $\vec{B}$ at point P. (8) (ii) A solenoid has an inductance of 20mH. If the length of the solenoid is increased by two times and the radius is decreased to half of its original value, Compute the new inductance. (7)	BTL 5	Evaluating
3.	Region 1 is the semi-infinite space in which 2x-5y>0, while region 2 is defined by 2x-5y<0. Let μ_{r1}=3, μ_{r2}=4 and $\bar{\mathbf{H}}_1=30\bar{a}_x$ A/m. Calculate (a) $\lvert\bar{\mathbf{B}}_1\rvert$, (b) $\lvert\bar{\mathbf{B}}_{N1}\rvert$, (c) $\lvert\bar{\mathbf{H}}_{tan1}\rvert$, (d) $\lvert\bar{\mathbf{H}}_2\rvert$. (15)	BTL 6	Creating
4.	(i) A solenoid is 50 cm long, 2 cm in diameter and contains 1500 turns. The cylindrical core has a diameter of 2 cm and a relative permeability of 75. This coil is co-axial with second solenoid which is 50 cm long, 3 cm diameter and 1200 turns. Solve the inductance L for inner and outer solenoid. (8) (ii) Propose the solution for energy stored in the solenoid having 2m long and 10 cm in diameter and is wound with 4000 turns of wire, carrying a current of 8 A. (7)	BTL 6	Creating

UNIT IV TIME-VARYING FIELDS AND MAXWELL's EQUATIONS			
Faraday's law, Displacement current and Maxwell-Ampere law, Maxwell's equations, Potential functions, Electromagnetic boundary conditions, Wave equations and solutions, Time-harmonic fields			
1	State Lenz's law?	BTL 1	Remembering
2	What are the characteristics medium in which field exist?	BTL 1	Remembering
3	Write the Maxwell's expression for free space.	BTL 1	Remembering
4	Give the Maxwell's equation derived from faraday's law.	BTL 1	Remembering
5	Write about time varying field.	BTL 1	Remembering
6	Discuss phase velocity with expression.	BTL 2	Understanding
7	Infer the expression for induced emf when a moving closed path is placed in a time varying magnetic field.	BTL 1	Remembering
8	Summarize the differential form of Maxwell's Equation.	BTL 2	Understanding
9	Outline the difference between conduction current and displacement current.	BTL 2	Understanding
10	Illustrate the Maxwell's equation for a good conductor.	BTL 2	Understanding
11	Develop the expression for Maxwell's equation in integral form.	BTL 3	Applying
12	Identify the significance on displacement current.	BTL 3	Applying
13	Represent a phasor in rectangular and polar form.	BTL 3	Applying
14	Analyze on the materials in which both conduction and displacement current exist.	BTL 4	Analyzing
15	Point out on the phenomenon of electromagnetic induction.	BTL 4	Analyzing
16	Based on the magnitudes of current densities how to categorize conductor and dielectric materials?	BTL 4	Analyzing
17	Explain the significance of ratio of conduction current density and displacement current density.	BTL 5	Evaluating
18	Evaluate the modification in the equation of continuity due to inconsistency of ampere circuital law.	BTL 5	Evaluating
19	Obtain the retarded electric scalar potential and retarded magnetic vector potential.	BTL 6	Creating
20	Give the situations, when the rate of change of flux results in a non-zero value.	BTL 6	Creating
PART B			
1	(i) Electric flux density in a charge free region is given by $\mathbf{D}=10x\mathbf{a_x}+5y\mathbf{a_y}+kz\mathbf{a_z}\,\mu C/m^2$. Find the constant k. (7) (ii) If the magnetic field $\mathbf{H}=(3x\cos\beta+6y\sin\alpha)\,\mathbf{a_z}$, Find current density **J** if fields are invariant with time. (6)	BTL 1	Remembering

2	A circular loop of N turns of conducting wire lies in the XY plane with its center at the origin of magnetic field specified by **B**= B_0 Cos $(\pi r/2b)$ * Sin ωt $\mathbf{a_z}$ where, b is the radius of the loop and ω is the angular frequency. Find the emf induced in the loop. (13)	BTL 1	Remembering
3	(i) Express Maxwell's equation for harmonically varying fields. (7) (ii) In a given lossy dielectric medium, conduction current density J_c=0.02 sin10^9t (A/m^2). Find the displacement current density if σ=10^3 S/m and ε_r=6.5 (6)	BTL 1	Remembering
4	Derive the Maxwell's equation for a time varying are modified for time varying from fundamental laws of electric and magnetic fields. (13)	BTL 1	Remembering
5	Write in detail on retarded scalar and vector potential and derive the generalized wave equation. In free space. (13)	BTL 2	Understanding
6	Illustrate the integral and point form of Maxwell's equations for static fields. (13)	BTL 3	Applying
7	(i)Express the transformer EMF induced in a stationary closed path in a time varying B field. (7) (ii)Obtain the motional EMF induced in moving closed path in static B field.(6)	BTL 2	Understanding
8	Calculate the maximum emf induced in a coil of 4000 turns of radius of 12 cm rotating at 30rps in a magnetic field of 0.05 Wb/m^2. (13)	BTL 2	Understanding
9	(i)Demonstrate the detailed steps for the derivation of electromagnetic boundary conditions for a time varying fields. (7) (ii)Determine emf induced about the path r = 0.5, z = 0, t = 0. If **B** = 0.01sin377t T. (6)	BTL 3	Applying
10	(i)Illustrate with necessary fundamentals the equation of continuity of current in differential form. (7) (ii) Prove that modified ampere's law is consistent with the time varying field. (6)	BTL 3	Applying
11	Give the physical interpretation of Maxwell's first and second equations. (13)	BTL 4	Analyzing
12	In a region where $\varepsilon_r = \mu_r$ =1 and σ=0 let **A**=10^{-3} y cos3*10^8 t cosz $\mathbf{a_z}$ Wb/m and V=3*10^5 y sin 3*10^8 t sinz V. Find **E** and **H.** (13)	BTL 4	Analyzing
13.	Derive an expression for displacement current density an the physical significance of it. (13)	BTL 5	Evaluating
14	Do the fields **E**=E_m sinx sint $\mathbf{a_y}$ and **H**=(H_m /μ_0) cosx cost $\mathbf{a_z}$ satisfy Maxwell's equations? (13)	BTL 6	Creating
	PART C		
1	In a material for which σ=5S/m and ε_r = 1, the electric field intensity is E= 250 sin10^{10}t V/m. Estimate the conduction and displacement current densities, and the frequency at which both have equal magnitudes. (15)	BTL 6	Creating

2	The unit vector 0.48 $\hat{a}_x$ – 0.6 $\hat{a}_y$ + 0.64 $\hat{a}_z$ is directed from region 2 (ε_{r2} = 2.5, μ_{r2} =2, σ_2 = 0) towards region 1 (ε_{r1} = 4, μ_{r1} =10, σ_1 = 0). If $\mathbf{H_1}$= (-100 $\hat{a}_x$ – 50 $\hat{a}_y$ + 200 $\hat{a}_z$) sin 400t A/m at the point p in region 1 adjacent to the boundary. Determine the amplitude at point P of $\mathbf{H}_{N1}$, $\mathbf{H}_{tan1}$, $\mathbf{H}_{N2}$, $\mathbf{H}_2$. (15)	BTL 5	Evaluating
3	Calculate β and **H** in a medium characterized by σ=0, μ= μ_0, ε=4 ε_0 and **E**=20 sin (10^8t-βz)$\mathbf{a_y}$ V/m.. (15)	BTL 5	Evaluating
4	Solve the value of k such that following pairs of field satisfies Maxwell's equation in the region where σ=0, σ_v=0 (i) $\bar{\mathbf{E}}$ =[kx-100t] $\bar{\mathbf{a}}_y$ V/m, $\bar{\mathbf{H}}$=[x+20t] $\bar{\mathbf{a}}_z$ A/m and μ=0.25H/m, ε=0.01F/m (8) (ii) $\bar{\mathbf{D}}$=5x$\bar{\mathbf{a}}_x$-2$\bar{\mathbf{a}}_y$+kz$\bar{\mathbf{a}}_z$ μC/m^2, $\bar{\mathbf{B}}$=2$\bar{\mathbf{a}}_y$ mT and μ=μ_0, ε=ε_0. (7)	BTL 6	Creating
UNIT V PLANE ELECTROMAGNETIC WAVES			
Plane waves in lossless media, Plane waves in lossy media (low-loss dielectrics and good conductors), Group velocity, Electromagnetic power flow and Poynting vector, Normal incidence at a plane conducting boundary, Normal incidence at a plane dielectric boundary.			
PART - A			
1	Define wavelength.	BTL 1	Remembering
2	State Poynting theorem.	BTL 1	Remembering
3	Describe the characteristics of uniform plane wave?	BTL 1	Remembering
4	What is meant by depth of penetration?	BTL 1	Remembering
5	Give the expressions for propagation constant, intrinsic impedance if a wave propagates in a lossy dielectric.	BTL 1	Remembering
6	Write down the significance of loss tangent.	BTL 1	Remembering
7	Demonstrate intrinsic impedance of free space.	BTL 2	Understanding
8	Point out the difference between attenuation constant and phase constant.	BTL 2	Understanding
9	Infer about general wave equation in terms of electric and magnetic fields.	BTL 2	Understanding
10	Explain the significance of pointing vector?	BTL 2	Understanding
11	Identify the relationship between average power density and amplitude of electric field.	BTL 3	Applying
12	Construct the expressions for instantaneous, average and complex Poynting vector.	BTL 3	Applying
13	Derive the expression for transmission and reflection coefficient for normal incidence at plane conducting boundary.	BTL 3	Applying
14	Express the values of skin depth for a plane wave propagating through the dielectric with attenuation constant of 0.2887 Np/m.	BTL 4	Analyzing
15	Examine the significance of intrinsic impedance.	BTL 4	Analyzing
16	Analyze the wave equation in phasor form.	BTL 4	Analyzing
17	Find the expression for the intrinsic impedance, attenuation constant and phase constant for good conducting medium.	BTL 5	Evaluating
18	Compute propagation constant in free space for a wave with 100MHz.	BTL 5	Evaluating
19	Express Poynting theorem in point form and integral form.	BTL 6	Creating
20	Develop the expressions for Standing wave ratio when the amplitudes of reflected and incident waves are equal.	BTL 6	Creating

PART – B			
1	Starting from the Maxwell's equation derive homogenous vector Helmholtz's equation in phasor form. (13)	BTL 1	Remembering
2	Find the wave equation for the electric and magnetic fields for free space conditions. (13)	BTL 1	Remembering
3	Write short notes on uniform plane waves and derive the wave equation. (13)	BTL 1	Remembering
4	(i) State and prove Poynting theorem. (8) (ii)Describe the Poynting vector, average power and instantaneous power. (5)	BTL 1	Remembering
5	A uniform plane wave $\mathbf{E_y}$=10 sin ($2\pi * 10^{8t} - \beta x$) $\mathbf{\hat{a}_y}$ is travelling in x directon in free space. Determine Phase constant, Phase velocity, Expression for $\mathbf{H_z}$. Assume $\mathbf{E_z} = 0 = \mathbf{H_y}$. (13)	BTL 5	Evaluating
6	Explain the condition under which the magnitude of the reflection coefficient equals that of the transmission coefficient for a uniform wave at normal incidence on an interface between two lossless dielectric medium. (13)	BTL 2	Understanding
7	Demonstrate the equations for a plane wave incident normally on a plane dielectric boundary. (13)	BTL 2	Understanding
8	A uniform plane wave in a lossless medium with intrinsic impedance η_1 is incident normally onto another lossless medium with intrinsic impedance η_2 through a plane boundary. Develop the expressions for the time average power densities. (13)	BTL 3	Applying
9	In free space, $\mathbf{E}$= 50 cos ($\omega t- \beta z$) $\mathbf{\hat{a}_x}$ V/m. Solve for the average power crossing a circular area of radius 2.5 m in the plane Z=0. Assume $E_m = H_m \eta_0$ and $\eta_0 = 120\pi\Omega$. (13)	BTL 3	Applying
10	Determine and summarize the intrinsic impedance, wavelength, attenuation, phase and propagation constant for electromagnetic waves in any medium.(13)	BTL 4	Analyzing
11	Derive the electromagnetic wave equation in phasor form with necessary equations. (13)	BTL 4	Analyzing
12	Illustrate the power flow in a coaxial cable using Poynting theorem. (13)	BTL 2	Understanding
13	Examine the expressions for the transmission and reflection coefficients at the interface of two media for normal incidence. (13)	BTL 4	Analyzing
14	Estimate the frequency of a wave and the conductivity of the medium for a uniform plane wave travelling at a velocity of $2.5*10^5$ m/s having a wavelength of 0.25 mm in a non-magnetic good conductor. (13)	BTL 6	Creating
PART – C			
1	A 6580 MHz uniform plane is propagating in a material medium of ε_r =2.25. If the amplitude of electric field intensity of a losseless medium is 500 V/m. Calculate the phase constant, Propagation constant, velocity , wavelength and intrinsic impedance. Also find the amplitude of magnetic field intensity. (15)	BTL 5	Evaluating

2	(i) Determine α, β and the wavelength of a material for a 9 GHz wave propagating through a material that has a dielectric constant of 2.4 and loss tangent of 0.005. (10) (ii)Calculate the skin depth for a medium with conductivity 100 $\mho/m$, relative permeability of 2 and relative permittivity of 3A at 1 GHz. (5)	BTL 5	Evaluating
3	Determine the amplitudes of reflected and transmitted fields (electric and magnetic both) at the interface of two regions, if $\mathbf{E_i}$ = 1.5 mV/m in region 1 for which ε_{r1} = 8.5, μ_r = 1 and σ =0 and region 2 is a free space. (15)	BTL 6	Creating
4	(i) Calculate the skin depth and wave velocity at 2 MHz in aluminum with conductivity 40 MS/m and μ_r = 1. (10) (ii) A plane wave propagating in free space has a peak electric field of 750mV/m. Estimate the average power through a square area of 12cm on a side perpendicular to the direction of propagation. (5)	BTL 6	Creating