SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF

ELECTRONICS AND COMMUNICATION ENGINEERING

QUESTION BANK

III SEMESTER

EC3365 - ELECTROMAGNETIC FIELDS

Regulation – 2023

(Common to ECE & EEE)

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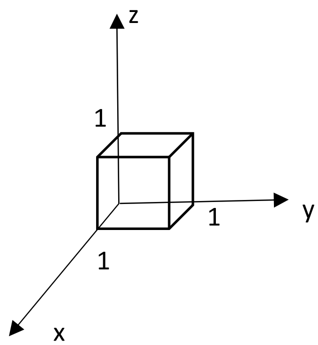
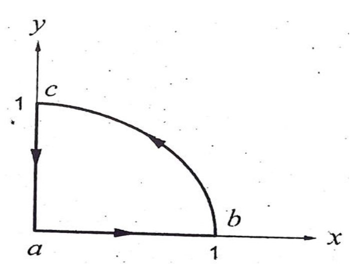
SUBJECT : EC3365 - ELECTROMAGNETIC FIELDS

SEM / YEAR: III/II

UNIT I - INTRODUCTION				
Electromagnetic model, Units and constants, Vector algebra, Orthogonal coordinate systems and transformations: Cartesian, cylindrical and spherical coordinates, 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, Laplacian of a Scalar, Null identities, Helmholtz's theorem.				
PART A				
Q.No	**Questions**	**CO**	**BT Level**	**Competence**
1.	List the source quantities in the electromagnetic model.	1	BTL 1	Remembering
2.	State divergence theorem.	1	BTL 1	Remembering
3.	Define Stokes theorem.	1	BTL 1	Remembering
4.	Name the universal constants in the electromagnetic model.	1	BTL 1	Remembering
5.	What are surface and volume integrals?	1	BTL 1	Remembering
6.	Relate the transformation between spherical and Cartesian coordinates.	1	BTL 1	Remembering
7.	Summarize line, surface and volume charge density.	1	BTL 2	Understanding
8.	Express the relationship between potential and electric field intensity.	1	BTL 2	Understanding
9.	Outline the relationship between magnetic flux density and field density.	1	BTL 2	Understanding
10.	Point out the role of vector algebra in electromagnetics.	1	BTL 2	Understanding
11.	Identify the unit vector and its magnitude corresponding to the given vector $\boldsymbol{A}=5\,\mathbf{a_x} + \mathbf{a_y} + 3\,\mathbf{a_z}$.	1	BTL 2	Understanding
12.	Specify the unit vector extending from the origin towards the point **G** (2, -2,-1).	1	BTL 1	Remembering
13.	Justify that electric field is conservative.	1	BTL 2	Understanding
14.	Analyze a differential volume element in spherical coordinates (r, θ, φ) resulting from differential charges in the orthogonal coordinate systems.	1	BTL 2	Understanding

15.	Compare orthogonal and non-orthogonal coordinate systems.		1	BTL 2	Understanding
16.	Convert the point **P** (5, 1, 3) from Cartesian to spherical coordinates.		1	BTL 1	Remembering
17.	Interpret the physical significance of curl of a vector field.		1	BTL 1	Remembering
18.	Calculate the values of universal constants of free space.		1	BTL 2	Understanding
19.	Estimate the distance between the given vectors A (1, 2, 3) and B(2, 1, 2).		1	BTL 2	Understanding
20.	Obtain the value of α if magnetic field B is a solenoid where **B**=25x$\mathbf{a_x}$+12y$\mathbf{a_y}$+ α z$\mathbf{a_z}$.		1	BTL 2	Understanding
21.	How can a vector field be expressed as the gradient of scalar field?		1	BTL 1	Remembering
22.	Write down the expression for differential volume element in terms of spherical coordinates.		1	BTL 2	Understanding
23.	What is del operator? How is it used in curl, gradient and divergence?		1	BTL 1	Remembering
24.	Define infinitesimal volume element in spherical polar coordinates.		1	BTL 1	Remembering
PART B					
1.	What is electromagnetics? Give detailed explanation on Electromagnetic model with corresponding units and constants.	(16)	1	BTL 3	Applying
2.	(i) Verify whether the vector field E= yz $\mathbf{a_x}$ + xz $\mathbf{a_y}$ + xy $\mathbf{a_z}$ is both solenoidal and irrotational. (ii) Given A =5$\mathbf{a_x}$ and B= 4 $\mathbf{a_x}$ + t $\mathbf{a_y}$. Find t such that angle between A and B is 45 degree.	(8) (8)	1	BTL 4	Analyzing
3.	Express vector **B** in Cartesian and cylindrical systems. Given **B**= 10/r $\mathbf{a_r}$ + r cosθ $\mathbf{a_\theta}$ + $\mathbf{a_\varphi}$, then find **B** at (-3,4,0) and (5, π/2, -2).	(16)	1	BTL 3	Applying
4.	Explain how a spherical coordinate system describes the position of the point in free space and its differential elements.	(16)	1	BTL 4	Analyzing
5.	(i) Summarize about the Dot product and cross product of vectors. State its properties and applications. (ii)The three fields are given by A = 2$\mathbf{a_x}$ – $\mathbf{a_z}$, B = 2$\mathbf{a_x}$ – $\mathbf{a_y}$+2$\mathbf{a_z}$ and C = 2$\mathbf{a_x}$ – 3$\mathbf{a_y}$ + $\mathbf{a_z}$. Find the scalar and vector triple product.	(8) (8)	1	BTL 3	Applying
6.	Obtain the expressions for differential area and volume element in cylindrical coordinate system.	(16)	1	BTL 4	Analyzing
7.	State and prove divergence theorem for a given differential volume element.	(16)	1	BTL 4	Analyzing
8.	Estimate 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 = 450, z = 2).	(16)	1	BTL 4	Analyzing
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**.	(16)	1	BTL 3	Applying

10.	Analyze the geometrical position of the point in Cartesian coordinate system and obtain distance vector and differential elements.	(16)	1	BTL 4	Analyzing
11.	Check the divergence theorem using the function $V = y^2\hat{\imath} + (2xy + z^2)\hat{\jmath} + (2yz)\hat{k}$ and unit cube situated at the origin. 	(16)	1	BTL 4	Analyzing
12.	(i) Explain in detail line, surface, and volume integral of vector function. (ii) Express the rate of change of a scalar in a given direction in terms of its gradient and its properties.	(8) (8)	1	BTL 3	Applying
13.	(i) Examine the null identities using general orthogonal coordinates. (ii) Summarize the use of Helmholtz's theorem in electromagnetic engineering.	(8) (8)	1	BTL 3	Applying
14.	(i) Convert the given rectangular coordinates A (2,3,1) into the corresponding cylindrical coordinates. (ii) Find the volume of a circular cylinder of radius r=3cm which is concentric with the z-axis and extends between z=-2cm and z=2cm.	(8) (8)	1	BTL 3	Applying
15.	Verify the stokes theorem for a vector field **A** = 2r cosφ $\mathbf{a_r}$ + $r^2\mathbf{a_\varphi}$ in cylindrical coordinates for the contour shown in figure below 	(16)	1	BTL 4	Analyzing
16.	(i) Obtain the expression for the volume of a sphere of radius a from the differential volume. (ii) Compare the various differential elements of coordinate systems.	(8) (8)	1	BTL 3	Applying
17.	Verify the divergence theorem for the vector field **E** =2r$\mathbf{a_r}$ in spherical coordinate system.	(16)	1	BTL 4	Analyzing

UNIT II ELECTROSTATIC FIELD				
Coulombs law, Electric field intensity, Gauss law and applications, Electric scalar potential, Conductors in static electric field, Dielectrics in static electric field, Electric flux density, dielectric constant and dielectric strength, Boundary conditions for electrostatic fields, Capacitance, Parallel plate capacitor, Electrostatic energy, Poisson's and Laplace's equations, Current density and Ohm's law, Continuity equation.				
PART A				
Q.No	**Questions**	**CO**	**BT Level**	**Competence**
1.	Define electric field intensity.	2	BTL 1	Remembering
2.	Write the statement of Coulomb's law.	2	BTL 1	Remembering
3.	State Gauss law.	2	BTL 1	Remembering
4.	If the charge density in a surface area $100cm^2$ is $20nC/cm^2$, find the total charges enclosed by the surface.	2	BTL 2	Understanding
5.	What is the difference between potential and potential difference?	2	BTL 2	Understanding
6.	Use a vector operator to write an expression relating electric field intensity and electric potential.	2	BTL 1	Remembering
7.	Summarize the principle of Superposition as applied to an electric potential of a point.	2	BTL 1	Remembering
8.	What is a conservative law?	2	BTL 1	Remembering
9.	How would you relate the electric field intensity and electric flux density?	2	BTL 2	Understanding
10.	List the properties of conductor and dielectric materials.	2	BTL 1	Remembering
11.	Give examples for uniform and non-uniform electric fields.	2	BTL 1	Remembering
12.	Analyze the boundary conditions of the Electric field	2	BTL 2	Understanding
13.	Differentiate the terms capacitance and capacitors.	2	BTL 2	Understanding
14.	Calculate the values of $\boldsymbol{D}$ at a distance r = 5m for the uniformly charged sphere of radius 2m with charge density of 20 nC/m^3.	2	BTL 2	Understanding
15.	Solve the energy stored in a 10 μF capacitor which has been charged to a voltage of 400V.	2	BTL 2	Understanding
16.	How do you find the equivalent capacitance of two capacitors C_1 and C_2 connected in series?	2	BTL 2	Understanding
17.	Estimate the value of a capacitance if two conducting plates of area $100cm^2$ each are separated by a distance of 10cm with air as a dielectric medium between the plates.	2	BTL 2	Understanding
18.	State point form of Ohm's law.	2	BTL 1	Remembering
19.	Compare Poisson's and Laplace's equation.	2	BTL 2	Understanding

20.	A Parallel plate capacitor has a charge of 10^{-3}C on each plate while the potential difference between the plates is 1000V. Calculate the value of capacitance.		2	BTL 1	Remembering
21.	Obtain the relation between current and current density.		2	BTL 2	Understanding
22.	Formulate the current density of copper wire having conductivity of 5.8 x 10^7 S/m and magnitude of electric field intensity **E** is 20V/m.		2	BTL 2	Understanding
23.	Generalize the continuity equation in integral and differential form.		2	BTL 1	Remembering
24.	Write Laplace equation and its applications.		2	BTL 1	Remembering
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.	(16)	2	BTL 3	Applying
2.	(i)State and explain coulomb's law and deduce the vector form of force equation between the two-point charges. (ii) Write notes on principle of Superposition as applied to charge distribution.	(8) (8)	2	BTL 4	Analyzing
3.	Apply Coulomb's law to obtain the formula for the electric field intensity of an infinite long straight line carrying uniform line charge density of ρ_L C/m.	(16)	2	BTL 3	Applying
4.	Determine the electric field due to a charged circular ring of radius 'r' placed in xy-plane with center at the origin and charge density ρ_L C/m is uniformly distributed along the circumference	(16)	2	BTL 3	Applying
5.	(i) State and prove Gauss law. (ii) Obtain the point form of gauss law.	(8) (8)	2	BTL 4	Analyzing
6.	Explain any two applications of Gauss law with neat diagrams.	(16)	2	BTL 4	Analyzing
7.	The flux density within the cylindrical volume bounded by r = 5m, z=0 and z= 2m is given by $\mathbf{D} = 30e^{-r}\,\mathbf{a_r} - 2z\mathbf{a_z}$ C/m^2. What is the total outward flux crossing the surface of the cylinder?	(16)	2	BTL 3	Applying
8.	Obtain 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.	(16)	2	BTL 3	Applying
9.	(i)Apply Gauss law and determine the Poisson's equation and state the condition to obtain Laplace equation. (ii) Verify that the given potential field satisfies the Laplace's equation $V = 2x^2 - 3y^2 + z^2$.	(8) (8)	2	BTL 3	Applying
10.	At point P compute the magnitudes of **V, E, $\mathbf{E_t}$, $\mathbf{E_N}$, D, $\mathbf{D_N}$** 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	(16)	2	BTL 4	Analyzing
11.	With necessary diagrams develop the boundary conditions of the normal and tangential components of electric field at the interface of two media with different dielectrics.	(16)	2	BTL 3	Applying

12.	Derive the equation for composite parallel plate capacitor with dielectric boundary parallel and normal to the plates.	(16)	2	BTL 4	Analyzing
13.	Let A= 120 cm^2, d=5mm and ε_r=12 for a parallel plate capacitor (i) Calculate the capacitance & after connecting a 40V battery across the capacitor calculate E,D,Q and total stored energy. (ii) The source is now removed, and the dielectric is carefully withdrawn from between the plates. Again, calculate E, D, Q and the energy and what is voltage between the plates?	(8) (8)	2	BTL 4	Analyzing
14.	Deduce the expression for electrostatic energy required to assemble a group of charges rest.	(16)	2	BTL 4	Analyzing
15.	(i) Find the total current in a circular conductor of radius 4 mm if the current density varies according to J = $(10^4/r)$ A/m^2. (ii) Calculate the capacitance of a parallel plate capacitor having a mica dielectric, ε_r=6, a plate area of 10 $inch^2$, and a separation of 0.01inch.	(8) (8)	2	BTL 3	Applying
16.	(i) Derive the capacitance of a parallel plate capacitor. (ii) A parallel plate capacitor having area of 1 m^2, distance between the plate 0.01 m, thickness of the wood is 0.002 m. The ε_r of wood is 6 times that of air. Calculate the capacitance of the system.	(8) (8)	2	BTL 3	Applying
17.	(i) Write the equation of continuity in integral and differential form. (ii) Discuss the point form of ohm's law and obtain the expression for resistance of a conductor.	(8) (8)	2	BTL 4	Analyzing

UNIT III MAGNETOSTATIC FIELD

Lorentz force equation, Biot-Savart law and applications, Ampere's circuital law and applications, Vector magnetic potential, Gauss law for magnetic fields, Magnetic flux Density and Field intensity, Magnetization and permeability, Magnetic forces, Torque and Magnetic moment, Boundary conditions for magnetostatic fields, Magnetic circuits, Inductance, self-inductance, mutual inductance, inductance of solenoid and toroid, Magnetic energy.

PART A

Q.No	Questions	CO	BT Level	Competence
1.	Write the Lorentz force equation for a moving charge.	3	BTL 1	Remembering
2.	How would you describe Ampere's circuital law?	3	BTL 2	Understanding
3.	Express magnetic field intensity H in all the regions if cylindrical conductor carriers a direct current I and its radius is 'R' m.	3	BTL 2	Understanding
4.	List the applications of Ampere's circuital law.	3	BTL 1	Remembering
5.	What is vector magnetic potential?	3	BTL 1	Remembering

6.	Compute the magnetic flux density in vector form for the given vector magnetic potential ***A*** =10/($x^2+y^2+z^2$) $\hat{\mathbf{a}}_x$.		3	BTL 2	Understanding
7.	State Biot-Savart's law.		3	BTL 1	Remembering
8.	Define magnetic field and magnetic lines of force.		3	BTL 1	Remembering
9.	Outline the characteristics of magnetic flux and flux density.		3	BTL 2	Understanding
10.	Point out the relation between magnetic flux density and magnetic field intensity.		3	BTL 2	Understanding
11.	A long straight wire carries a current I = 1 amp. At what distance is the magnetic field **H**= 1 A/m.		3	BTL 2	Understanding
12.	Summarize the concept of permeability and its unit.		3	BTL 1	Remembering
13.	Outline the phenomenon of hysteresis with reference to ferromagnetic materials.		3	BTL 1	Remembering
14.	Interpret the relationship between magnetic field intensity and magnetization.		3	BTL 1	Remembering
15.	What is relative permeability of material?		3	BTL 1	Remembering
16.	Compare the self inductance and mutual inductance.		3	BTL 2	Understanding
17.	Examine the expression of energy stored in an inductor.		3	BTL 2	Understanding
18.	Obtain the expression of H for a solenoid having N turns of finite length d.		3	BTL 2	Understanding
19.	Analyze the mutual inductance of two inductively tightly coupled coils with self-inductance of 25mH and 100mH.		3	BTL 2	Understanding
20.	Find the energy stored in inductor having current of 3A flowing through the inductor of 100mH.		3	BTL 2	Understanding
21.	In terms of field quantities, write the energy stored in a magnetic field.		3	BTL 1	Remembering
22.	Identify the expression of force between two current elements.		3	BTL 1	Remembering
23.	Compute torque where magnetic field is **B**=0.2 $\hat{\mathbf{a}}_x$ + 0.4 $\hat{\mathbf{a}}_z$ Wb/m^2 and magnetic dipole moment is **M**=8x10^{-3} $\hat{\mathbf{a}}_z$ Am^2.		3	BTL 2	Understanding
24.	Define magnetic dipole moment.		3	BTL 1	Remembering
PART B					
1.	Apply Ampere's law to an infinite current sheet in the z = 0 plane with uniform current density J = J_y $\hat{a}_y$ A/ m. Considering the Amperian path as rectangular path around the origin and compute the Magnetic field Intensity.	(16)	3	BTL 3	Applying
2.	Determine the expression for Ampere circuital law. Apply the law for any two applications with necessary illustrations.	(16)	3	BTL 4	Analyzing
3.	(i)Write the expression for magnetic field from Ampere circuital law.	(8)	3	BTL 3	Applying

	(ii)Determine the magnetic field at a point P (0.01, 0, 0) m if current through a co-axial cable is 6 A. which is along the z-axis and a=3mm, b=9mm, c=11mm.	(8)			
4.	A coaxial cable with radius of inner conductor a, inner radius of outer conductor b and outer radius c carries a current I at inner conductor and I in the outer conductor. Analyze and sketch the variance of $\vec{H}$ against r for (i) $r < a$ (ii)$a < r < b$ (iii)$b < r < c$ (iv)$r > c$.	(16)	3	BTL 4	Analyzing
5.	In cylindrical coordinates $\mathbf{A} = 50r^2\mathbf{a_z}$ Wb/m is a vector magnetic potential, in a free space. Find **H**, **B**, **J** and using **J** compute the total current I crossing the surface $0 \le r \le 1$, $0 \le \phi \le 2$ and $z = 0$.	(16)	3	BTL 3	Applying
6.	Obtain the equations for magnetic field intensity and magnetic flux density at the center of the square current loop using Biot-Savart's law	(16)	3	BTL 3	Applying
7.	(i) At a point P (x, y, z) the components of vector magnetic potential $\vec{A}$ are given as $A_x = (4x + 3y+2z)$, $A_y =(5x +6y +3z)$ and $A_z = (2x+3y+5z)$. Determine $\vec{B}$ at point P. (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.	(8) (8)	3	BTL 4	Analyzing
8.	Apply Biot Savart law to find the magnetic field intensity at the origin due to current element $Idl = 3\pi(\hat{\mathbf{a}}_x + 2\,\hat{\mathbf{a}}_y + 3\hat{\mathbf{a}}_z)$ µAm at (3,4,5)m in free space.	(16)	3	BTL 3	Applying
9.	(i) Using Biot-Savart's law, derive the magnetic field intensity on the axis of a circular loop of radius R carrying a steady current I. (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).	(8) (8)	3	BTL 3	Applying
10.	Let $\mathbf{A}=(3y-z)\,\mathbf{a_x}+2xz\,\mathbf{a_y}$ Wb/m in a region of free space. (i)Prove that $\nabla.\boldsymbol{A} = 0$ (ii)At P (2, -1,3) find **A, B, H** and **J**	(8) (8)	3	BTL 4	Analyzing
11.	Region 1 is the semi-infinite space in which 2x-5y>0, while region 2 is defined by 2x-5y<0. Let $\mu_{r1}=3$, $\mu_{r2}=4$ and $\overline{H}_1=30\overline{a}_x$ A/m. Calculate, (a) $\lvert\overline{\mathbf{B}}_1\rvert$, (b) $\lvert\overline{\mathbf{B}}_{N1}\rvert$, (c) $\lvert\overline{\mathbf{H}}_{tan1}\rvert$, (d) $\lvert\overline{\mathbf{H}}_2\rvert$.	(16)	3	BTL 4	Analyzing
12.	(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. Find the inductance L for inner and outer solenoid. (ii) Obtain the solution for energy stored in the solenoid having	(8)	3	BTL 3	Applying

	2m long and 10 cm in diameter and is wound with 4000 turns of wire, carrying a current of 8 A.	(8)			
13.	(i)Deduce the expression for inductance of a toroidal coil carrying current I, with N turns and the radius of toroid 'r'. (ii)Formulate the expression for inductance of a solenoid.	(8) (8)	3	BTL 4	Analyzing
14.	(i)Express a general expression for the magnetic flux density ***B*** at any point along the axis of a long solenoid. (ii)A circular loop located on $x^2 + y^2 = 9$, $z = 0$ carries a direct current of 10 A along a_φ. Calculate **H** at (0,0,4) and (0,0,-4).	(8) (8)	3	BTL 3	Applying
15.	Examine the magnetic field intensity within a magnetic material where **M**=150 A/m and $\mu=1.5\times10^{-5}$ H/m and **B**=300µT and $\chi_m=15$.	(16)	3	BTL 4	Analyzing
16.	Describe about the magnetic boundary condition at the interface between two magnetic medium and derive the necessary boundary conditions.	(16)	3	BTL 4	Analyzing
17.	A rectangular loop in the xy-plane with sides b1 and b2 carrying a current I lies in an uniform magnetic field $\mathbf{B} = B_x \mathbf{a_x} + B_y \mathbf{a_y} + B_z \mathbf{a_z}$. Determine the force on the loop.	(16)	3	BTL 3	Applying

UNIT IV – TIME-VARYING FIELDS AND MAXWELL's EQUATIONS

Faraday's law, Transformer and Motional Electromotive Forces, Displacement current, Maxwell equations in integral and differential form, Potential functions, Electromagnetic boundary conditions, Poynting vector and theorem, Electromagnetic power flow in coaxial cable.

PART A

Q.No	Questions	CO	BT Level	Competence
1.	State Lenz's law.	4	BTL 1	Remembering
2.	List out the characteristics medium in which EMF exist.	4	BTL 2	Understanding
3.	Write the Maxwell's expression for free space.	4	BTL 1	Remembering
4.	Point out the Maxwell's equation derived from faraday's law.	4	BTL 1	Remembering
5.	Define Poynting theorem.	4	BTL 1	Remembering
6.	State Faraday's law.	4	BTL 1	Remembering
7.	Express phase velocity with necessary equation.	4	BTL 1	Remembering
8.	State Faraday's law for a moving charge in a constant magnetic field.	4	BTL 2	Understanding
9.	Summarize the differential form of Maxwell's Equation.	4	BTL 2	Understanding

10.	What is the difference between conduction current and displacement current?		4	BTL 2	Understanding
11.	Illustrate the Maxwell’s equation for a good conductor.		4	BTL 1	Remembering
12.	What is meant by transformer e.m.f. ?		4	BTL 1	Remembering
13.	Write the expression for Maxwell’s equation in integral form.		4	BTL 1	Remembering
14.	Mention the significance on displacement current.		4	BTL 1	Remembering
15.	Identify the relationship between average power density and amplitude of electric field.		4	BTL 2	Understanding
16.	Write Electromagnetic Boundary Conditions.		4	BTL 1	Remembering
17.	Distinguish between conduction current and displacement current.		4	BTL 2	Understanding
18.	Write the phenomenon of electromagnetic induction.		4	BTL 1	Remembering
19.	Based on the magnitudes of current densities how to categorize conductor and dielectric materials?		4	BTL 2	Understanding
20.	Formulate the significance of ratio of conduction current density and displacement current density.		4	BTL 2	Understanding
21.	Analyze the modification in the equation of continuity due to inconsistency of ampere circuital law.		4	BTL 2	Understanding
22.	Find the displacement current density for field $\vec{E} = 300 \sin 10^9 t$ V/m.		4	BTL 2	Understanding
23.	Obtain the retarded electric scalar potential and retarded magnetic vector potential.		4	BTL 2	Understanding
24.	Express Poynting theorem in point form and integral form.		4	BTL 2	Understanding
	PART B				
1.	Illustrate the inconsistency of Ampere’s circuital law for time varying fields, and what is the remedial solution proposed by Maxwell? Also derive the differential form representation of all the four Maxwell’s equations.	(16)	4	BTL 4	Analyzing
2.	Calculate β and **H** in a medium characterized by $\sigma=0$, $\mu=\mu_0$, $\varepsilon=4\varepsilon_0$ and **E**=20 sin ($10^8t-\beta z$) a_y V/m.	(16)	4	BTL 3	Applying
3.	(i) Electric flux density in a charge free region is given by $D=10xa_x+5ya_y+kza_z \mu C/m^2$. Find the constant k. (ii) If the magnetic field H= ($3x\cos\beta+6y\sin\alpha$) a_z, Determine the current density **J** if fields are invariant with time.	(8) (8)	4	BTL 3	Applying

4.	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 $B= B_0 \cos(\pi r/2b) * \sin \omega t\ a_z$ where, b is the radius of the loop and ω is the angular frequency. Find the emf induced in the loop.	(16)	4	BTL 3	Applying
5.	(i) If $\bar{\mathbf{D}}=20x\bar{a}_x-15y\bar{a}_y+kz\bar{a}_z\ \mu C/m^2$, find the value of k to satisfy maxwell's equations for region $\rho_v=0, \sigma=0$. (ii) In a given lossy dielectric medium, conduction current density $\mathbf{J}_c=0.02\sin 10^9 t\ (A/m^2)$. Find the displacement current density if $\sigma=10^3$ S/m and $\varepsilon_r=6.5$	(8) (8)	4	BTL 3	Applying
6.	Derive the Maxwell's equation for a time varying are modified for time varying from fundamental laws of electric and magnetic fields.	(16)	4	BTL 4	Analyzing
7.	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.	(16)	4	BTL 3	Applying
8.	(i) Find the transformer EMF induced in a stationary closed path in a time varying B field? (ii) Obtain the motional EMF induced in moving closed path in static B field.	(8) (8)	4	BTL 3	Applying
9.	Explain about the electromagnetic power flow in coaxial cable	(16)	4	BTL 3	Applying
10.	State and prove Poynting theorem and derive the expression for Poynting vector**.**	(16)	4	BTL 4	Analyzing
11.	Illustrate the integral and point form of Maxwell's equations for static fields.	(16)	4	BTL 4	Analyzing
12.	(i) Deduce the detailed steps for the derivation of electromagnetic boundary conditions for a time varying fields. (ii) Determine EMF induced about the path r = 0.5, z = 0, t = 0. If $\mathbf{B} = 0.01\sin 377t$.	(8) (8)	4	BTL 3	Applying
13.	In a region where $\varepsilon_r = \mu_r = 1$ and $\sigma = 0$ let $\mathbf{A}=10^{-3}\ y \cos 3*10^8\ t \cos z\ a_z$ Wb/m and $V=3*10^5\ y \sin 3*10^8\ t \sin z$ V. Find **E** and **H.**	(16)	4	BTL 3	Applying
14.	(i) The conduction current flowing through a wire with conductivity $\sigma = 3 \times 10^7 S/m$ and the relative permeability $\varepsilon_r = 1$ is given by $I_c= 3\sin wt$ mA. If $\omega = 10^8$ rad/s find the displacement current. (ii) An electric field in a medium which is source free is given by $E = 1.5\cos(10^8 t - \beta z)\widehat{a_x}$ V/m. Find the **B**, **H** and **D**. Assume $\varepsilon_r = 1, \mu_r = 1, \sigma = 0$.	(8) (8)	4	BTL 4	Analyzing
15.	The unit vector $0.48\ \hat{a}_x - 0.6\ \hat{a}_y + 0.64\ \hat{a}_z$ is directed from region 2 ($\varepsilon_{r2} = 2.5, \mu_{r2} = 2, \sigma_2 = 0$) towards region 1 ($\varepsilon_{r1} = 4, \mu_{r1} = 10, \sigma_1 = 0$).If $H1= (-100\ \hat{a}_x - 50\ \hat{a}_y + 200\ \hat{a}_z) \sin 400t$ A/m at the point p in region 1 adjacent to the boundary. Determine the amplitude at point P of : (i) H_{N1} & H_{tan1} (ii) H_{N2} & H_{tan2}	(8) (8)	4	BTL 4	Analyzing

16.	In free space, $E= 50 \cos (\omega t- \beta z)\ \hat{a}_x$ V/m. Find 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 $\eta_0 =120\pi\Omega$.	(16)	4	BTL 4	Analyzing
17.	Solve the value of k such that following pairs of field satisfies Maxwell's equation in the region where $\sigma=0$, $\sigma_v=0$ (i) $\bar{\mathbf{E}} =[kx-100t]\ \bar{a}_y$ V/m, $\bar{\mathbf{H}}=[x+20t]\ \bar{a}_z$ A/m and $\mu=0.25$H/m, $\varepsilon=0.01$F/m (ii) $\bar{\mathbf{D}}=5x\bar{a}_x-2\bar{a}_y+kz\bar{a}_z\ \mu C/m^2$, $\bar{\mathbf{B}}=2\bar{a}_y$ mT and $\mu=\mu_0$, $\varepsilon=\varepsilon_0$.	 (8) (8)	4	BTL 4	Analyzing

UNIT V - UNIFORM PLANE WAVES				
Uniform Plane wave propagation in free space, dielectrics and good conductors. Group velocity, Wave polarization, Normal incidence and Oblique incidence at a plane conducting boundary, Normal incidence and Oblique incidence at a plane dielectric boundary.				
PART A				
Q.No	**Questions**	**CO**	**BT Level**	**Competence**
1.	What is meant by wavelength?	5	BTL 1	Remembering
2.	Define Group velocity.	5	BTL 1	Remembering
3.	Describe the characteristics of uniform plane wave?	5	BTL 1	Remembering
4.	State depth of penetration.	5	BTL 1	Remembering
5.	Give the expressions for propagation constant, intrinsic impedance if a wave propagates in a lossy dielectric.	5	BTL 1	Remembering
6.	Mention the significance of loss tangent.	5	BTL 1	Remembering
7.	What is Brewster Angle?	5	BTL 1	Remembering
8.	For a uniform plane wave incident normally at the interface between two dielectrics, define reflection coefficient and transmission coefficient in terms of intrinsic impedance?	5	BTL 1	Remembering
9.	Write about the intrinsic impedance of free space & its value.	5	BTL 1	Remembering
10.	Point out the difference between attenuation constant and phase constant.	5	BTL 1	Remembering
11.	State the general wave equation in terms of electric and magnetic fields.	5	BTL 1	Remembering
12.	Illustrate the cross product of E and H in uniform Plane waves.	5	BTL 1	Remembering
13.	Calculate the velocity of a plane wave in a lossless medium having a relative permittivity of 4 and a relative permeability of 1.2.	6	BTL 2	Understanding

14.	Find the characteristics impedance of the medium whose relative permittivity and relative permeability is 1.		6	BTL 2	Understanding
15.	Derive the expression for transmission and reflection coefficient for normal incidence at plane conducting boundary.		5	BTL 2	Understanding
16.	Express the values of skin depth for a plane wave propagating through the dielectric with attenuation constant of 0.2887 Np/m.		6	BTL 2	Understanding
17.	Examine the significance of intrinsic impedance.		5	BTL 2	Understanding
18.	Analyze the wave equation in phasor form.		5	BTL 2	Understanding
19.	A uniform plane wave at a frequency of 3 MHZ is incident normally from free space $\sigma = 10^{-3}$ S/m and $\varepsilon_r = 6$. Find out whether the medium is lossy dielectric or a good conductor or semiconductor?		6	BTL 2	Understanding
20.	A sinusoidal electrical intensity of amplitude 250 V/m and frequency 2 GHz exists in a lossy dielectric medium that has a relative permittivity of 2.5 and loss tangent of 0.002. Find the effective conductivity of the lossy medium.		6	BTL 2	Understanding
21.	Formulate the expression for the intrinsic impedance, attenuation constant and phase constant for good conducting medium.		5	BTL 2	Understanding
22.	Can a magnetic field exist in a good conductor if it is static or time varying? Explain.		5	BTL 2	Understanding
23.	Compute propagation constant in free space for a wave with 100MHz.		6	BTL 2	Understanding
24.	Develop the expressions for Standing wave ratio when the amplitudes of reflected and incident waves are equal.		5	BTL 2	Understanding
	PART B				
1.	A 6580 MHz uniform plane is propagating in a material medium of $\varepsilon_r = 2.25$. If the amplitude of electric field intensity of a lossless medium is 500 V/m. Calculate the phase constant, Propagation constant, velocity, wavelength and intrinsic impedance. Also find the amplitude of magnetic field intensity.	(16)	6	BTL 3	Applying
2.	(i) Estimate 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. (ii) Calculate the skin depth for a medium with conductivity $100\ \mho/m$, relative permeability of 2 and relative permittivity of 3 at 1 GHz.	(10) (6)	6	BTL 3	Applying
3.	Starting from the Maxwell's equation derive homogenous vector Helmholtz's equation in phasor form.	(16)	5	BTL 4	Analyzing
4.	Derive the wave equation for the electric and magnetic fields for free space conditions.	(16)	5	BTL 4	Analyzing
5.	Describe the intrinsic impedance of uniform plane waves in lossy dielectric and lossy conductor.	(16)	5	BTL 4	Analyzing
6.	Illustrate the reflection coefficient of normal incidence at a plane dielectric boundary.	(16)	5	BTL 4	Analyzing

7.	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.	(16)	5	BTL 4	Analyzing
8.	Express the equations for a plane wave incident normally on a plane dielectric boundary.	(16)	5	BTL 4	Analyzing
9.	E and H waves travelling in free space are normally incident on the interface with a perfect dielectric with $\varepsilon_r = 3$. Compute the magnitudes of incident, reflected and transmitted E and H waves at the interface.	(16)	6	BTL 3	Applying
10.	A 300 MHz uniform Plane propagates through fresh water for which $\varepsilon_r = 78$, $\mu_r = 1$ and $\sigma = 0$. Calculate attenuation constant, Phase Constant, Wavelength, Intrinsic impedance.	(16)	6	BTL 3	Applying
11.	Derive the expressions for the attenuation constant, phase constant and intrinsic impedance for a uniform plane wave in a good conductor.	(16)	5	BTL 4	Analyzing
12.	A uniform plane wave $E_y = 10 \sin (2\pi * 10^{8t} - \beta x)\, \hat{a}_y$ is travelling in x direction in free space. Determine i) Phase constant ii) Phase velocity iii) Expression for H_z. Assume $E_z = H_y = 0$.	(16)	6	BTL 3	Applying
13.	A uniform plane wave of 200 MHz, traveling in a free space impinges normally on a large block of material having $\varepsilon_r = 4$, $\mu_r = 9$, $\sigma = 0$. Calculate transmission and reflection coefficients at the interface.	(16)	6	BTL 3	Applying
14.	A 2MHz wave propagates in a medium characterized by $\mu_r = 1.6, \in_r = 25.$ and conductivity $\sigma = 2.5\ s/m$.The electric field intensity in the region is given by $\vec{E} = 0.1e^{-az}\cos(2\pi ft - \beta z)\hat{\imath}$ V/m. Determine the attenuation constant, propagation constant, intrinsic impedance, phase velocity, skin depth, and wave length of the wave.	(16)	6	BTL 3	Applying
15.	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.	(16)	6	BTL 4	Analyzing
16.	The Electric field intensity of a linearly polarized uniform plane wave propagating in the '+z' direction in sea water is $\vec{E} = 100\cos(10^7\pi t)\,\hat{\imath}$ volts/meter at $z = 0, \mu_r = 1, \in_r = 72, \sigma = 4\ s/m$. Determine the attenuation constant, phase constant, intrinsic impedance, phase velocity, skin depth, and wave length of the wave. Find the distance at which the amplitude of $\vec{E}$ is 1% of its value at z=0.	(16)	6	BTL 3	Applying
17.	Evaluate 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 $\varepsilon_{r1} = 8.5$, $\mu_r = 1$ and $\sigma = 0$ and region 2 is a free space.	(16)	6	BTL 4	Analyzing