JEPPIAAR ENGINEERING COLLEGE

Jeppiaar Nagar, Rajiv Gandhi Salai – 600 119

DEPARTMENT OF

ELECTRONICS AND COMMUNICATION ENGINEERING

QUESTION BANK

IV SEMESTER

EC6403 – Electromagnetic Fields

Theory Regulation – 2013

Academic Year 2017 – 18

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SUBJECT: EC6403 – ELECTROMAGENTIC FIELDS

YEAR /SEM : II /IV

UNIT I STATIC ELECTRIC FIELD				
Vector Algebra, Coordinate Systems, Vector differential operator, Gradient, Divergence, Curl, Divergence theorem, Stokes theorem, Coulombs law, Electric field intensity, Point, Line, Surface and Volume charge distributions, Electric flux density, Gauss law and its applications, Gauss divergence theorem, Absolute Electric potential, Potential difference, Calculation of potential differences for different configurations. Electric dipole, Electrostatic Energy and Energy density.				
PART – A				
Q.No.	**Questions**	**BT Level**	**Competence**	**PO**
1.	Define Gradient.	BTL 1	Remembering	PO1
2.	Define Divergence theorem :	BTL 1	Remembering	PO1
3.	Define Absolute potential.	BTL 1	Remembering	PO1
4.	State coulombs law.	BTL 1	Remembering	PO1
5.	What is an electric dipole? Write down the potential due to a n electric dipole.	BTL 1	Remembering	PO1
6.	State Gauss law for electric fields	BTL 1	Remembering	PO1
7.	Name few applications of Gauss law in electrostatics.	BTL 1	Remembering	PO1
8.	Define linear charge density.	BTL 1	Remembering	PO1
9.	Define Unit Vector?	BTL 1	Remembering	PO1
10.	Define Scalar or Dot Product.	BTL 1	Remembering	PO1
11.	Define Cross or Vector product.	BTL 1	Remembering	PO1
12.	Define Coordinate system and give its types.	BTL 1	Remembering	PO1
13.	Give the conversion of spherical to Cartesian.	BTL 2	Understanding	PO2
14.	Give the conversion of Cartesian to spherical.	BTL 2	Understanding	PO2
15.	Give the conversion of cylindrical to Cartesian and Cartesian to cylindrical.	BTL 2	Understanding	PO2
16.	Define Curl.	BTL 1	Remembering	PO1
17.	Define Divergence.	BTL 1	Remembering	PO1
18.	State stokes theorem.	BTL 1	Remembering	PO1
19.	Define electric field intensity.	BTL 1	Remembering	PO1
20.	What are the types of integral related to electromagnetic theory?	BTL 1	Remembering	PO1
21.	What is physical significance of divergence?	BTL 1	Remembering	PO1
22.	State the conditions for a field to be a) solenoidal b) irrotational.	BTL 1	Remembering	PO1
23.	Define electric flux.	BTL 1	Remembering	PO1
24.	Define electric flux density.	BTL 1	Remembering	PO1
25.	Define potential.	BTL 1	Remembering	PO1
26.	Define potential difference.	BTL 1	Remembering	PO1
27.	Give the relation between electric field intensity and electric flux density.	BTL 2	Understanding	PO2
28.	Give the relationship between potential gradiant and electric field.	BTL 2	Understanding	PO2
29.	What is the physical significance of div D ?	BTL 1	Remembering	PO1
30.	Define current density .	BTL 1	Remembering	PO1
PART – B				
1.	State and prove Gauss law and explain applications of Gauss law. **(13)**	BTL 1	Remembering	PO1, PO2
2.	Define the potential difference and electric field. Give the relation between potential and field intensity. Derive an expression for potential due to infinite uniformly charged line and also derive potential due to electric dipole. **(13)**	BTL 1	Remembering	PO1, PO2
3.	Derive an expression for the energy stored and energy density in a	BTL 4	Analyzing	PO1, PO2

	capacitor. **(13)**			
4.	State and explain Stokes theorem b) Divergence theorem c) The electric flux density **(13)**	BTL 1	Remembering	PO1
5.	State and explain Curl, Gradient and Divergence also find the potential due to an electric dipole. **(13)**	BTL 1	Remembering	PO1
6.	Explain three co-ordinate systems. **(13)**	BTL 1	Remembering	PO1
7.	Find the electric field due to n-charges, and also establish the relation between potential and electric field. **(13)**	BTL 3	Applying	PO2
8.	Given two points A(x=2, y=3, z= -1) and B(r=4, =25, = 120) Find both spherical coordinates and Cartesian coordinates for A and B. Also find curl H for (2rcos ar – 4r sin + 3az). **(13)**	BTL 3	Applying	PO2, PO3
9.	A circular disc of radius 'a' m is charged uniformly with a charge density of σ c/ m^2.Find the Electric field at a point 'h' m from the disc along its axis. **(13)**	BTL 3	Applying	PO2, PO3
10.	Derive an expression for the electric field intensity at any point due to a uniformly charged sheet with density rs c/ m^2 **(13)**	BTL 4	Analyzing	PO2
11.	Derive the expression for potential due to an electric dipole at any point P. Also find electric field intensity at the same point. **(13)**	BTL 4	Analyzing	PO2
	PART-C			
1.	Two point charges 1.5nC at (0,0,0.1) and -1.5nC at (0,0,-0.1) are in free space. Treat the two charges as a dipole at the origin and calculate the potential at P(0.3,0,0.4). **(15)**	BTL 5	Evaluating	PO4
2.	Apply gauss law to find charge enclosed in hollow sphere whose surface is uniformly charged. Formulate the equation for potential due to a system of point charges. **(15)**	BTL 5	Evaluating	PO2
3.	Validate stokes theorem for a vector field $\overline{F}= r^2\cos\varphi a_{\overline{r}} + z \sin\varphi a_{\overline{z}}$ and the path L defined by 0≤r≤3 , 0≤φ≤45· and z=0. **(15)**	BTL 6	Creating	PO3
4.	**(i)** Predict the potential difference between the points A and B which are at a distance of 0.5 m and 0.1 m respectively from a negative charge of $20*10^{-10}$ coulomb, ε_0 =8.854 pF/m. **(8)** **(ii)** If three charges 3μC, 4μC and 5μC are located at (0,0,0) , (2,-1,3) and (0,4,-2) respectively. Find the potential at (1,0,1) assuming zero potential at infinity. **(7)**	BTL 6	Creating	PO4
	UNIT II CONDUCTORS AND DIELECTRICS			
	Conductors and dielectrics in Static Electric Field, Current and current density, Continuity equation, Polarization, Boundary conditions, Method of images, Resistance of a conductor, Capacitance, Parallel plate, Coaxial and Spherical capacitors, Boundary conditions for perfect dielectric materials, Poisson's equation, Laplace's equation, Solution of Laplace equation, Application of Poisson's and Laplace's equations.			
	PART – A			
Q.No.	**Questions**	**BT Level**	**Competence**	**PO**
1.	What is the practical application of method of images?	BTL 1	Remembering	PO1
2.	Define capacitance and capacitors?	BTL 1	Remembering	PO1
3.	Distinguish between conduction and displacement currents.	BTL 1	Remembering	PO1
4.	Write the equation for energy stored in electrostatic field in terms of field quantities.	BTL 1	Remembering	PO1
5.	What is Polarization of Dielectrics? .	BTL 1	Remembering	PO1
6.	Express laplace equation in Cartesian coordinate system	BTL 2	Understanding	PO1
7.	Express laplace equation in cylindrical coordinate system.	BTL 2	Understanding	PO1
8.	Express laplace equation in spherical coordinate system.	BTL 2	Understanding	PO1
9.	Define resistance of a conductor.	BTL 1	Remembering	PO1
10.	Write the poisson's and laplace equation.	BTL 1	Remembering	PO1
11.	Write the relation between perfect conductor and electrostatic field.	BTL 1	Remembering	PO1
12.	Define current density.	BTL 1	Remembering	PO1
13.	What are the boundary conditions for electric field at the perfect dielectric conductor interface?	BTL 1	Remembering	PO1
14.	What is meant by displacement current?	BTL 1	Remembering	PO1
15.	What are dielectrics?	BTL 1	Remembering	PO1
16.	Define Boundary conditions.	BTL 1	Remembering	PO1
17.	Write the boundary conditions at the interface between two perfect dielectrics.	BTL 1	Remembering	PO1,PO2

18.	Distinguish between conduction and displacement currents.	BTL 4	Analyzing	PO1,PO2
19.	What is method of images?	BTL 1	Remembering	PO1
20.	When is method of images used?	BTL 1	Remembering	PO1
21.	What is Polarization?	BTL 1	Remembering	PO1
22.	Write down the expression for capacitance between two parallel plates.	BTL 1	Remembering	PO1
23.	What are the significant physical differences between Poisson's and Laplace's Equations?	BTL 1	Remembering	PO1
24.	How is electric energy stored in a capacitor?	BTL 5	Evaluating	PO1
25.	What meaning would you give to the capacitance of a single conductor?	BTL 1	Remembering	PO1
26.	State point form of ohms law.	BTL 1	Remembering	PO1
27.	Define surface charge density.	BTL 1	Remembering	PO1
28.	Obtain Poisson's equation from Gauss's law?	BTL 1	Remembering	PO1,PO2
29.	What are the significant physical differences between Poisson's and Laplace's Equations?	BTL 1	Remembering	PO1
30.	Define relaxation time.	BTL 1	Remembering	PO1
31.	Define dielectric strength of material and give its unit.	BTL 1	Remembering	PO1
32.	State the difference between Poisson's equation and Laplace's equation.	BTL 1	Remembering	PO1
33.	Write the equation of continuity.	BTL 1	Remembering	PO1
	PART – B			
1.	(i)Derive an expression for capacitance of co-axial cable. **(8)** (ii) State the relationship between polarization and electric field intensity. **(5)**	BTL 1	Remembering	PO1,PO2
2.	(i) Derive the boundary conditions of the normal and tangential components of electric field at the Inter face of two media with different dielectrics. **(8)** (ii) Deduce the expression for joint capacitance of two capacitors C1 and C2 when connected in series and parallel. **(5)**	BTL 1	Remembering	PO1,PO2
3.	Derive an expression for the capacitance of a spherical capacitor with conducting shells of radius a and b. **(13)**	BTL 1	Remembering	PO1,PO2
4.	(i)Find the expression for the cylindrical capacitance using Laplace equation. **(8)** (ii)Derive the relationship between current density & charge density. **(8)**	BTL 1	Remembering	PO1,PO2
5.	(i)Explain the properties of Conductor and Dielectric **(8)** (ii)Write the equation of continuity in integral and differential form. **(5)**	BTL 2	Understanding	PO1,PO2
6.	(i)Explain Poisson's and Laplace's equation. **(5)** (ii)Given the potential field, V = (50sinθ/r2) V, in free space, determine whether V satisfies Laplace's eqn. **(8)**	BTL 2	Understanding	PO1,PO2
7.	(i)Find the total current in a circular conductor of radius 4 mm if the current density varies according to J = (104/r) A/m2. **(8)** (ii)Calculate the capacitance of a parallel plate capacitor having a mica dielectric, εr=6, a plate area of 10 inch2 , and a separation of 0.01inch. **(5)**	BTL 3	Applying	PO1,PO2
8.	(i)A capacitor with two dielectrics as follows: Plate area 100 cm2, dielectric 1 thickness = 3 mm, εr1=3dielectric 2 thickness = 2 mm, εr2=2. If a potential of 100 V is applied across the plates, evaluate the capacitance and the energy stored. **(7)** (ii) Estimate the capacitance of a conducting sphere of 2 cm in diameter, covered with a layer of polyethylene with ε1=2.26 and 3cm thick. **(6)**	BTL 5	Evaluating	PO2,PO3
	PART – C			
1.	**(i)** Two concentric metal spherical shells of radii a and b are separated by weakly conducting material of conductivity σ. If they are maintained at a potential difference V, what current flows from one to the other? What is the resistance between the shells? Measure the resistance if b >> a. **(8)** **(ii)** A metallic sphere of radius 10 cm has a surface charge density of 10 nC/m^2. Calculate the energy stored in the system. **(7)**	BTL 5	Evaluating	PO2,PO3

2.	Formulate the energy required to assemble a uniform sphere of charge with radius b and volume charge density ρ C/m^3. **(15)**	BTL 6	Creating	PO2,PO3
UNIT III STATIC MAGNETIC FIELDS				
Biot-Savart Law, Magnetic field Intensity, Estimation of Magnetic field Intensity for straight and circular conductors, Ampere's Circuital Law, Point form of Ampere's Circuital Law, Stokes theorem, Magnetic flux and magnetic flux density, The Scalar and Vector Magnetic potentials, Derivation of Steady magnetic field Laws.				
PART – A				
Q.No.	**Questions**	**BT Level**	**Competence**	**PO**
1.	Define scalar magnetic Potential.	BTL 1	Remembering	PO1
2.	Define vector magnetic Potential.	BTL 1	Remembering	PO1
3.	State Ampere's circuital law.	BTL 1	Remembering	PO1
4.	A current of 3A flowing through an inductor of 100mh. What is the energy stored in inductor?	BTL 3	Applying	PO3
5.	Write the relation between magnetic flux and Magnetic flux density.	BTL 1	Remembering	PO1
6.	In a ferromagnetic material ($\mu= 4.5\mu_0$), the magnetic flux density is $B = 10ya_x wb/m^2$. Calculate the magnetization vector($\mu_0 = 4\pi x\ 10^{-7} H/m$).	BTL 3	Applying	PO3
7.	What is the energy stored in a magnetic field in terms of field quantities?	BTL 1	Remembering	PO1
8.	State Biot Savart Law.	BTL 1	Remembering	PO1
9.	What is Magnetic Field?	BTL 1	Remembering	PO1
10.	What are Magnetic Lines of Force?	BTL 1	Remembering	PO1
11.	State Stoke Theorem.	BTL 1	Remembering	PO1
12.	What is the fundamental difference between static electric and magnetic field lines?	BTL 1	Remembering	PO1
13.	State Kirchoff's Flux law.	BTL 1	Remembering	PO1
14.	State Kirchoff's MMF law.	BTL 1	Remembering	PO1
15.	What is Magnetization?	BTL 1	Remembering	PO1
16.	Define Magnetic flux density.	BTL 1	Remembering	PO1
17.	Define Magnetic field Intensity.	BTL 1	Remembering	PO1
18.	What is rotational and irrotational vector field?	BTL 1	Remembering	PO1
19.	Give the application of Stoke's theorem.	BTL 2	Understanding	PO2
20.	Write down the magnetic boundary conditions.	BTL 1	Remembering	PO1
21.	Define Magnetic dipole.	BTL 1	Remembering	PO1
22.	Define magnetization.	BTL 1	Remembering	PO1
23.	What is the relation between relative permeability and susceptibility?	BTL 1	Remembering	PO1
24.	What are the different types of magnetic materials	BTL 1	Remembering	PO1
25.	Define mmf?	BTL 1	Remembering	PO1
26.	What is the relation between magnetic flux density and magnetic field Intensity.	BTL 1	Remembering	PO1
27.	What is magnetic dipole moment.	BTL 1	Remembering	PO1
28.	Define Magnetic Flux Density.	BTL 1	Remembering	PO1
29.	Write down the formula for magnetic field intensity due to infinite long straight conductor. What are equi potential surfaces?	BTL 1	Remembering	PO1
30.	Describe what are the sources of electric field and magnetic field?	BTL 2	Understanding	PO1
PART – B				
1.	(i) Find the magnetic flux density for the infinite currenct sheet in the xy plane with current density K = Kyay A/m current. **(8)** (ii) Derive the equation to find the force between the two current elements. **(5)**	BTL 2	Understanding	PO1,PO2
2.	Derive the expression for magnetic field intensity and magnetic flux density due to finite and infinite line **(13)**	BTL 4	Analyzing	PO1,PO2
3.	Derive an expression for magnetic field due to infinitely long coaxial cable. **(13)**	BTL 4	Analyzing	PO1,PO2
4.	Derive an expression for magnetic field intensity due to a linear conductor of infinite length carrying current I at a distant point P. Assume R to be the distance between conductor and point P, Use Biot Savarts law. And also derive the expression for magnetic field intensity on the axis of circular wire of radius 'a' carrying current I. (13)	BTL 4	Analyzing	PO1,PO2

5.	Using Ampere circuital law determine the magnetic field intensity due to a infinite long wire carrying a current I, also if a differential current element Idz is located at the origin of free space, obtain the expression for vector magnetic field potential due to the current element and hence find the magnetic field intensity at the point. **(13)**	BTL 1	Remembering	PO1,PO2
6.	Explain the concepts of scalar magnetic potential and vector magnetic potential? Find the maximum torque on an 85 turns rectangular coil with dimension (0.2x0.3) m carrying a current of 5 Amps in a field B = 6.5T **(13)**	BTL 2	Understanding	PO1,PO2
7.	Derive the expressions for magnetic field intensity and magnetic flux density due to circular coil. **(13)**	BTL 4	Analyzing	PO1,PO2
8.	Derive the magnetic field intensity developed in a circular loop carrying steady current I in a uniform field. Using Ampere circuital law derive the magnetic field intensity due to a co-axial cable carrying a steady current I. **(13)**			PO1,PO2
9.	State Ampere's circuital law and explain any two applications of Ampere's Circuital law. **(13)**	BTL 1	Remembering	PO1,PO2
10.	Derive the magnetic field intensity developed in a square loop carrying current I in a uniform field. Also State Lorentz force equation for a moving charge and explain its applications. **(13)**	BTL 4	Analyzing	PO1,PO2
PART – C				
1.	(i) Find the expression of induction for the co-axial **(8)** (ii) propose the salient points to be noted when the boundary conditions are applied. **(7)**	BTL 1	Remembering	PO1,PO2
2.	Derive the magnetic boundary condition at the interface between two magnetic medium. **(15)**	BTL 4	Analyzing	PO1,PO2
3.	Validate the expression which relates the current density J, Magnetic Flux density B and Magnetic vector potential A. Demonstrate the expression with the supporting laws. **(15)**	BTL 5	Evaluating	PO1,PO2
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. Estimate and sketch the variance of H against r for (i) r <a (ii)a < r <b (iii)b < r < c (iv)r > c. **(15)**	BTL 5	Evaluating	PO1,PO2

UNIT IV MAGNETIC FORCES AND MATERIALS

Force on a moving charge, Force on a differential current element, Force between current elements, Force and torque on a closed circuit, The nature of magnetic materials, Magnetization and permeability, Magnetic boundary conditions involving magnetic fields, The magnetic circuit, Potential energy and forces on magnetic materials, Inductance, Basic expressions for self and mutual inductances, Inductance evaluation for solenoid, toroid, coaxial cables and transmission lines, Energy stored in Magnetic field.

PART - A

Q.No.	Questions	BT Level	Competence	PO
1.	Differentiate conduction current and displacement.	BTL 4	Analyzing	PO1
2.	Mention the properties of uniform plane wave.	BTL 1	Remembering	PO1
3.	Define phase velocity.	BTL 1	Remembering	PO1
4.	State Faraday's law of induction.	BTL 1	Remembering	PO1
5.	Define pointing vector.	BTL 1	Remembering	PO1
6.	State Faraday's law for a moving charge in a constant magnetic field.	BTL 1	Remembering	PO1
7.	What are the Maxwell's equations for free space medium? In a medium, the electric field intensity E = 10sin(1000t-10x)a_3V/m. calculate the displacement current density (ϵ_r = 80, ϵ_0 = 8.854 x10^{-12}F/m).	BTL 1	Remembering	PO1
8.	State Faraday's law for moving charge in a constant magnetic field.	BTL 1	Remembering	PO1
9.	State poynting theorem.	BTL 1	Remembering	PO1
10.	What is called as intrinsic impedance?	BTL 1	Remembering	PO1
11.	Define propagation constant.	BTL 1	Remembering	PO1
12.	Give the difficulties in FDM.	BTL 2	Understanding	PO2
13.	Explain the steps in finite element method.	BTL 2	Understanding	PO1
14.	What is called skin effect?	BTL 1	Remembering	PO1
15.	What is Normal Incidence?	BTL 1	Remembering	PO1
16.	What is called attenuation constant?	BTL 1	Remembering	PO1

17.	What is phase constant?	BTL 1	Remembering	PO1
18.	How voltage maxima and minima are separated?	BTL 1	Remembering	PO1
19.	What is the major drawback of finite difference method?	BTL 1	Remembering	PO1
20.	State Faraday's law for a moving charge in a constant magnetic field.	BTL 1	Remembering	PO1
21.	Define a wave.	BTL 1	Remembering	PO1
22.	What is method of images?	BTL 1	Remembering	PO1
23.	When is method of images used?	BTL 1	Remembering	PO1
24.	Define power density.	BTL 1	Remembering	PO1
25.	What is the significant feature of wave propagation in an imperfect dielectric ?	BTL 1	Remembering	PO1
26.	Define loss tangent.	BTL 1	Remembering	PO1
27.	Define reflection and transmission coefficients.	BTL 1	Remembering	PO1
28.	Define transmission coefficients.	BTL 1	Remembering	PO1
29.	Explain the steps in finite element method.	BTL 2	Understanding	PO1
30.	State Maxwell's fourth equation.	BTL 1	Remembering	PO1
31.	State Maxwell's Third equation.	BTL 1	Remembering	PO1
32.	State the principle of superposition of fields.	BTL 1	Remembering	PO1
	PART - B			
1.	i)Explain magnetic boundary conditions with neat sketch **(8)** ii) Derive an expression for inductance of a solenoid with N turns and l metre length carrying a current of I amperes. **(5)**	BTL 4	Analyzing	PO1,PO2
2.	(i) Derive the expression for force on a moving charge in a magnetic field and Lorentz force equation **(8)** (ii) Derive the inductance of a toroid. **(5)**	BTL 4	Analyzing	PO1,PO2
3.	(i) Derive the expression for inductance of a solenoid. Calculate the inductance of solenoid, 8cm in length, 2 cm in radius, having μr = 100 and 1000 turns. **(8)** (ii) Give the comparison between magnetic and electric circuits. **(5)**	BTL 4	Analyzing	PO1,PO2
4.	i) Derive an expression for energy density in inductor **(5)** i) Derive an expression for the force between two current carrying wires. Assume that the currents are in the same direction. **(8)**	BTL 4	Analyzing	PO1,PO2
5.	(i) An iron ring of relative permeability 100 is wound uniformly with two coils of 100 and 400 turns of wire. The cross section of the ring is 4 cm2. The mean circumference is 50 cm. Calculate a) the self-inductance of each of the two coils. b) The mutual inductance. c) The total inductance when the two the coils are connected in series with flux in the same sense. d) The total inductance when the coils are connected in series with flux in the opposite sense. **(7)** (ii) Show that inductance of the cable is L=μl/2π lnb/a) H **(6)**	BTL 3	Applying	PO1,PO2
6.	(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. **(7)** (ii) Propose the solution for energy stored in the solenoid having 50cm long and 5 cm in diameter and is wound with 2000 turns of wire, carrying a current of 10 A. **(6)**	BTL 6	Creating	PO3,PO4
	PART C			
1.	(i) Find the expression of induction for the co-axial **(8)** (ii) propose the salient points to be noted when the boundary conditions are applied. **(7)**			
2.	i) Derive an expression for a torque on a closed rectangular loop carrying current. **(8)** ii) 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 is coil is co-axial with a second solenoid, also 50 cm long, but 3 cm diameter and 1200 turns. Calculate L for the inner solenoid and L for the outer solenoid. **(7)**	BTL 4	Analyzing	PO1,PO2
3.	Derive the magnetic boundary condition at the interface between two magnetic medium. **(15)**	BTL 4	Analyzing	PO1,PO2

4.	(i)valuate the expression for force between parallel conductors. **(8)** (ii)Two wires carrying current in the same direction of 3A and 6A are placed with their axes 5 cm apart, free space permeability μ_0= 4π x10^{-7} H/m. Estimate the force between them in N/m length. **(7)**	BTL 5	Evaluating	PO3,PO4
5.	**(i)** Illustrate magnetic circuit with a sketch and hence formulate the expression for its reluctance. **(10)** **(ii)** Find inductance per unit length of a co axial cable if radius of inner and outer conductor are 1mm and 3mm respectively. Assume μ_r=1. **(5)**	BTL 6	Creating	PO3,PO4
6.	Propose the concept of mutual inductance between straight long wire and a square loop and explain. **(15)**	BTL 6	Creating	PO3,PO4
UNIT V TIME VARYING FIELDS AND MAXWELL'S EQUATIONS				
Fundamental relations for Electrostatic and Magneto static fields, Faraday's law for Electromagnetic Induction, Transformers, Motional Electromotive forces, Differential form of Maxwell's equations, Integral form of Maxwell's equations, Potential functions, Electromagnetic boundary conditions, Wave equations and their solutions, Pointing's theorem, Time harmonic fields, Electromagnetic Spectrum.				
PART - A				
Q.No.	**Questions**	**BT Level**	**Competence**	**PO**
1.	Differentiate conduction current and displacement.	BTL 4	Analyzing	PO1
2.	Mention the properties of uniform plane wave.	BTL 1	Remembering	PO1
3.	Define phase velocity.	BTL 1	Remembering	PO1
4.	State Faraday's law of induction.	BTL 1	Remembering	PO1
5.	Define pointing vector.	BTL 1	Remembering	PO1
6.	State Faraday's law for a moving charge in a constant magnetic field.	BTL 1	Remembering	PO1
7.	What are the Maxwell's equations for free space medium?	BTL 1	Remembering	PO1
8.	In a medium, the electric field intensity E = 10sin(1000t-10x)a_3V/m. calculate the displacement current density (ϵ_r = 80, ϵ_0 = 8.854 x10^{-12}F/m).	BTL 3	Applying	PO3
9.	State Faraday's law for moving charge in a constant magnetic field.	BTL 1	Remembering	PO1
10.	State poynting theorem.	BTL 1	Remembering	PO1
11.	What is called as intrinsic impedance?	BTL 1	Remembering	PO1
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13.	Give the difficulties in FDM.	BTL 1	Remembering	PO2
14.	Explain the steps in finite element method.	BTL 1	Remembering	PO1
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16.	What is Normal Incidence?	BTL 1	Remembering	PO1
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18.	What is phase constant?	BTL 1	Remembering	PO1
19.	How voltage maxima and minima are separated?	BTL 1	Remembering	PO1
20.	What is the major drawback of finite difference method?	BTL 1	Remembering	PO1
21.	State Faraday's law for a moving charge in a constant magnetic field.	BTL 1	Remembering	PO1
22.	Define a wave.	BTL 1	Remembering	PO1
23.	What is method of images?	BTL 1	Remembering	PO1
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25.	Define power density.	BTL 1	Remembering	PO1
26.	What is the significant feature of wave propagation in an imperfect dielectric ?	BTL 1	Remembering	PO1
27.	Define loss tangent.	BTL 1	Remembering	PO1
28.	Define reflection and transmission coefficients.	BTL 1	Remembering	PO1
29.	Define transmission coefficients.	BTL 1	Remembering	PO1
30.	Explain the steps in finite element method.	BTL 1	Remembering	PO1
31.	State Maxwell's fourth equation.	BTL 1	Remembering	PO1
PART B				
1.	Discuss about the propagation of the plane waves in free space and in a homogeneous material. **(13)**	BTL 2	Understanding	PO1
2.	Starting from Maxwells equation derive the equation for E field in the form of wave in free space. **(13)**	BTL 4	Analyzing	PO1,PO2
3.	Explain the condition and propagation of uniform plane wave in good conductors and derive the wave constants. **(13)**	BTL 2	Understanding	PO1

4.	Derive the Maxwell's equation in differential and integral **(13)**	BTL 4	Analyzing	PO1,PO2
5.	Discuss the pointing vector and pointing theorem? Also derive the ampere circuital law. Derive general field relations for time varying electric and magnetic fields using Maxwell's equation. **(13)**	BTL 2	Understanding	PO1
6.	What is the physical significance of the pointing vector? And explain it in detail? Derive the expression for total power flow in coaxial cable? **(13)**	BTL 1	Remembering	PO1
7.	Explain briefly about the motional emf and derive an expression for it? **(13)**	BTL 2	Understanding	PO1
8.	Define faradays laws. What are the different ways of emf generation? Explain with governing equation and suitable example for each? Also derive the differential and integral form of faradays law. **(13)**	BTL 1	Remembering	PO1
9.	(i)Derive the relationship between electric and magnetic fields? **(6)** (ii) Explain complex, average and instantaneous poynting vector. **(7)**	BTL 4	Analyzing	PO1,PO2
10.	Explain complex, average and instantaneous poynting vector.	BTL 2	Understanding	PO1
	PART C			
1.	With relevant examples explain in detail the practical application of electromagnetic fields **(15)**	BTL 4	Analyzing	PO1,PO2
2.	.i) Explain the following poynting vector, average power and instantaneous power **(8)** ii) Derive expression for poynting vector. **(7)**	BTL 4	Analyzing	PO1,PO2

QUESTION BANK

SUBJECT : EC6403 - ELECTROMAGNETIC FIELDS

SEM / YEAR:IV/II

UNIT I STATIC ELECTRIC FIELD

Vector Algebra, Coordinate Systems, Vector differential operator, Gradient, Divergence, Curl, Divergence theorem, Stokes theorem, Coulombs law, Electric field intensity, Point, Line, Surface and Volume charge distributions, Electric flux density, Gauss law and its applications, Gauss divergence theorem, Absolute Electric potential, Potential difference, Calculation of potential differences for different configurations. Electric dipole, Electrostatic Energy and Energy density.

PART A

1. Define Gradient. [May 2017]

It is denoted as A x B.It is a vector whose magnitude is equal to the product of magnitudes of two vectors multiplied by the sine angle between them and direction perpendicular to plane containing A and B. A x B = AB sin Φ 0 ≤ Φ ≤ Π Where A = A , B = B and Φ is the angle between two vectors.

Gradient of the scalar field *V* is a vector that represents both the magnitude and direction of the maximum space rate of increase of this scalar field .

In Cartesian coordinates: In cylindrical coordinates:

$$\nabla = \frac{\partial}{\partial x}\hat{a}_x + \frac{\partial}{\partial y}\hat{a}_y + \frac{\partial}{\partial z}\hat{a}_z$$

$$\nabla = \frac{\partial}{\partial \rho}\hat{a}_\rho + \frac{1}{\rho}\frac{\partial}{\partial \phi}\hat{a}_\phi + \frac{\partial}{\partial z}\hat{a}_z$$

In spherical coordinates:

$$\nabla = \frac{\partial}{\partial r}\hat{a}_r + \frac{1}{r}\frac{\partial}{\partial \theta}\hat{a}_\theta + \frac{1}{r\sin\theta}\frac{\partial}{\partial \phi}\hat{a}_\phi$$

2. Define Divergence theorem : [MAY 2016, May 2017]

Divergence theorem states that the volume integral of the divergence of vector field is equal to the net outward flux of the vector through the closed surface that bounds the volume. Mathematically, $\int_V \nabla \cdot \vec{A} dv = \oint_S \vec{A} \cdot d\vec{s}$

3. Define Absolute potential. [NOV 2016]

The work done in moving a unit charge from infinity (or from reference point at which potential is zero) to the point under the consideration against E is called absolute potential of that point.

4. State coulombs law. [NOV 2016]

Coulombs law states that the force between any two point charges is directly Proportional to the product of their magnitudes and inversely proportional to the square of the distance between them. It is directed along the line joining the two charges. $F=Q_1Q_2 / 4\pi\epsilon r^2 a_r$

5. What is an electric dipole? Write down the potential due to a n electric dipole. [MAY 2016, NOV 2015]

A pair of equal and opposite charges separated by a small distance is known as electric dipole.

Potential due to and electric dipole is $V = \frac{Q}{4\pi\varepsilon_0}\frac{d\cos\theta}{r^2}$

6. Name few applications of Gauss law in electrostatics. [NOV 2015]

Gauss law is applied to find the electric field intensity from a closed surface.(e.g)Electric field can be determined for shell, two concentric shell or cylinders etc.

7. State Gauss law for electric fields [APRIL 2015]

The total electric flux passing through any closed surface is equal to the total charge enclosed by that surface.

8. Define linear charge density. [APRIL 2015]

It is the charge per unit length.

9. What is static electric field?

The electric field produced by static electric charge is time invariant i.e. it does not vary with time, so called as static electric field.

10. Define vector.

A quantity that has direction as well as magnitude is called a vector. EG: Force, Velocity, and Acceleration.

11. Define sclar.

Scalars are quantities characterized by magnitude only and algebraic sign. EG: Temperature, Mass,Volume and Energy.

12. Define Unit Vector?

A Vector which has magnitude unity and defining the same direction as given vector.

13. Give the properties of Vectors.

1)Vector addition obeys commutative law $A + B = B + A$

2) Vector addition obeys associative law $A + (B + C) = (A + B) + C$

3) - A is also a vector. It has same magnitude; its direction is 1800 away from Direction of A. $A – B = A + (- B)$

14. Define Scalar or Dot Product.

$A.B = AB\cos \Phi$ $0 \le \Phi \le \Pi$ where A = A and B = B and Φ angle between two vectors. It is denoted as A.B It is the product of magnitudes of A and B and the cosine of the angle between them.

15. Define Cross or Vector product.

It is denoted as A x B.It is a vector whose magnitude is equal to the product of magnitudes of two vectors multiplied by the sine angle between them and direction perpendicular to plane containing A and B. $A \times B = AB \sin \Phi$ $0 \le \Phi \le \Pi$ Where A = A , B = B and Φ is the angle between two vectors.

16. Define Coordinate system and give its types.

A system in which a vector can be described by its length, direction ,projections, angles or components is Coordinate system. There are three types in coordinate system.

a) Rectangular coordinate system: x, y, z

b) Cylindrical coordinate system: r, Φ, z

c) Spherical coordinate system: r, Θ, Φ

17. Give the conversion of spherical to Cartesian.

The vectors which lie in the same plane are called co-planar vectors.

Given (r, Θ, Φ)

$x = r \sin \Theta \cos \Phi$

$y = r \sin \Theta \sin \Phi$

$z = r \cos \Theta$

18. What are co-planar vector?

The vectors which lie in the same plane are called co-planar vectors.

19. State Distance formula?

Distance formula give the distance between the two points representing tips of the vector.

20. What is separation of vector?

The distance vector is also called as separation vector. Distance vector is nothing but the length of the vector.

21. What is separation of vector?

The distance vector is also called as separation vector. Distance vector is nothing but the length of the vector.

22. Give the conversion of Cartesian to spherical.

Given (x , y , z)

r = √x2 + y2 + z2 r ≥ 0

Θ = cos-1(z / r) 0 ≤ Θ ≤ Π

Φ = tan-1(y/x) 0 ≤ Φ ≤ 2 Π

23. Give the conversion of cylindrical to Cartesian and Cartesian to cylindrical.

cylindrical to Cartesian Cartesian to cylindrical.

Given (r, Φ, z) Given (x,y,z)

x = r cos Φ; r = √x2 + y2

y = r sin Φ; Φ= tan-1(y/x)

z = z ; z = z

24. Define Curl.

In Cartesian coordinates:

$$\nabla\times\vec{A} = \begin{vmatrix} \hat{a}_x & \hat{a}_y & \hat{a}_z \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ A_x & A_y & A_z \end{vmatrix}$$

In cylindrical coordinates:

$$\nabla\times\vec{A} = \frac{1}{\rho}\begin{vmatrix} \hat{a}_\rho & \rho\hat{a}_\phi & \hat{a}_z \\ \frac{\partial}{\partial \rho} & \frac{\partial}{\partial \phi} & \frac{\partial}{\partial z} \\ A_\rho & \rho A_\phi & A_z \end{vmatrix}$$

:

In spherical coordinates:

$$\nabla\times\vec{A} = \frac{1}{r^2\sin\theta}\begin{vmatrix} \hat{a}_r & r\hat{a}_\theta & r\sin\theta\hat{a}_\phi \\ \frac{\partial}{\partial r} & \frac{\partial}{\partial \theta} & \frac{\partial}{\partial \phi} \\ A_r & rA_\theta & r\sin\theta A_\phi \end{vmatrix}$$

25. Define Divergence.

It is the spatial derivative of a vector field. The dot product of Del and any vector is called divergence .D = ∂Dx/∂x +∂Dy/∂y+ ∂Dz/∂z

In Cartesian coordinates:

$$\nabla\cdot\vec{A} = \frac{\partial A_x}{\partial x} + \frac{\partial A_y}{\partial y} + \frac{\partial A_z}{\partial z}$$

In cylindrical coordinates:

$$\nabla\cdot\vec{A} = \frac{1}{\rho}\frac{\partial(\rho A_\rho)}{\partial \rho} + \frac{1}{\rho}\frac{\partial A_\phi}{\partial \phi} + \frac{\partial A_z}{\partial z}$$

In spherical coordinates:

$$\nabla\cdot\vec{A} = \frac{1}{r^2}\frac{\partial(r^2 A_r)}{\partial r} + \frac{1}{r\sin\theta}\frac{\partial(\sin\theta A_\theta)}{\partial \theta} + \frac{1}{r\sin\theta}\frac{\partial A_\phi}{\partial \phi}$$

26. State stokes theorem.

The line integral of a vector around a closed path is equal to the surface integral of the normal component of its curl over any surface bounded by the path. H.dl = (ΔxH) ds

27. Define electric field intensity.

Electric field intensity is defined as the electric force per unit positive charge. E =F/ Q

28. What are the types of integral related to electromagnetic theory?

1. Line integral 2. Surface integral 3. Volume integral

29. What is a point charge?

Point charge is one whose maximum dimension is very small in comparison with any other length.

30. Define surface charge.

	Define surface charge If the charge is distributed uniformly over a two dimensional surface then it is called surface charge.	
31.	**Define line charge.** If the charge is uniformly distributed along a line, it is called line charge. The line may be finite or infinite.	
32.	**Define volume charge.** Define volume charge If the charge is distributed uniformly over a volume then it is called as a volume charge	
33.	**Define surface charge density.** It is denoted as is defined as charge per unit area ρS = total charge/total area in C/m^2.	
34.	**Define volume charge density.** It is denoted as v and is defined as charge per unit volume ρV = total charge/total volume in C/m^3.	
35.	**What is physical significance of divergence?** Divergence of current density gives net outflow of current per unit volume. Divergence of flux density gives net outflow per unit volume. In general, divergence of any field density gives net outflow of that field per unit volume	
36.	**State the conditions for a field to be a) solenoidal b) irrotational.** a) Divergence of the field has to be zero. b) Curl of the field has to be zero.	
37.	**Define electric flux.** The lines of electric force is electric flux.	
38.	**Define electric flux density.** Electric flux density is defined as electric flux per unit area.	
39.	**Define potential.** Potential at any point is defined as the work done in moving a unit positive charge from infinity to that point in an electric field. $V=Q / 4\pi\epsilon r$	
40.	**Define potential difference.** Potential difference is defined as the work done in moving a unit positive charge from one point to another point in an electric field.	
41.	**Give the relation between electric field intensity and electric flux density.** $D=\epsilon E$ C/m^2	
42.	**Give the relationship between potential gradiant and electric field.** $E= - \Delta V$	
43.	**What is the physical significance of div D ?** The divergence of a vector flux density is electric flux per unit volume leaving a small volume. This is equal to the volume charge density.	
44.	**Define current density .** Current density is defined as the current per unit area. $J= I/A$ Amp/m^2	
45.	**Define the term electrostatics.** It is the study of the effect of electric charges which are static or rest.	
46.	**What is Potential Gradient?** The rate of change of potential with respect to the distance is called potential gradient.	
	PART – B	
1.	State and prove Gauss law and explain applications of Gauss law. " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-55,65.	**(13)**
2	.Define the potential difference and electric field. Give the relation between potential and field intensity. Derive an expression for potential due to infinite uniformly charged line and also derive potential due to electric dipole.	**(13)**

	" Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-40
3.	Derive an expression for the energy stored and energy density in a capacitor. **(13)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-72.
4.	State and explain Stokes theorem b) Divergence theorem c) The electric flux density **(13)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-72
5.	State and explain Curl, Gradient and Divergence also find the potential due to an electric dipole. **(13)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-72
6.	Explain three co-ordinate systems. **(13)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-20
7.	Find the electric field due to n-charges, and also establish the relation between potential and electric field. **(13)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-84
8.	Given two points A(x=2, y=3, z= -1) and B(r=4, =25, = 120) Find both spherical coordinates and Cartesian coordinates for A and B. Also find curl H for (2rcos ar – 4r sin + 3az). **(13)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-20.
9.	A circular disc of radius 'a' m is charged uniformly with a charge density of σ c/ m^2.Find the Electric field at a point 'h' m from the disc along its axis. **(13)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-45
10.	Derive an expression for the electric field intensity at any point due to a uniformly charged sheet with density rs c/ m^2 **(13)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-44
11.	Derive the expression for potential due to an electric dipole at any point P. Also find electric field intensity at the same point. **(13)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-106
	PART-C
1.	Two point charges 1.5nC at (0,0,0.1) and -1.5nC at (0,0,-0.1) are in free space. Treat the two charges as a dipole at the origin and calculate the potential at P(0.3,0,0.4). **(15)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-91.
2.	Apply gauss law to find charge enclosed in hollow sphere whose surface is uniformly charged. Formulate the equation for potential due to a system of point charges. " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-62. **(15)**
3.	Validate stokes theorem for a vector field $\bar{F}= r^2\cos\varphi a_{\bar{r}} + z \sin\varphi\, a_{\bar{z}}$ and the path L defined by $0\leq r\leq 3$, $0\leq\varphi\leq 45^\circ$ and z=0. **(15)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-246
4.	Predict the potential difference between the points A and B which are at a distance of 0.5 m and 0.1 m respectively from a negative charge of $20*10^{-10}$ coulomb, ε_0 =8.854 pF/m. **(8)** If three charges 3μC, 4μC and 5μC are located at (0,0,0) , (2,-1,3) and (0,4,-2) respectively. Find the potential at (1,0,1) assuming zero potential at infinity. " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-85 **(7)**
	UNIT II CONDUCTORS AND DIELECTRICS
	Conductors and dielectrics in Static Electric Field, Current and current density, Continuity equation, Polarization, Boundary conditions, Method of images, Resistance of a conductor, Capacitance, Parallel plate, Coaxial and Spherical capacitors, Boundary conditions for perfect dielectric materials, Poisson's equation, Laplace's equation, Solution of Laplace equation, Application of Poisson's and Laplace's equations.
	PART – A
1.	**What is the practical application of method of images? [APR 2017]** It is suitable to determine V, E, D and ρ_s due to the charges in the presence of conductors
2.	**Define capacitance and capacitors? [APR 2017]** The ratio of the magnitude of the total charge on any one of the two conductors and potential difference between conductors

is called the capacitance.

3. Distinguish between conduction and displacement currents. [APR 2017]

The current through a resistive element is termed as conduction current whereas the current through a capacitive element is termed as displacement current.

4. Write the equation for energy stored in electrostatic field in terms of field quantities. [APR 2017]

$W_E = \frac{1}{2} CV^2 J$

5. What is Polarization of Dielectrics? .[MAY 2016]

Polarization of dielectric means, when an electron cloud has a centre separated from the nucleus. This forms an electric dipole. The dipole gets aligned with the applied field.

6. Express laplace equation in Cartesian coordinate system[MAY 2016]

Laplace equation $\nabla^2 V = 0$ In Cartesian coordinate system $\frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2} = 0$

7. Express laplace equation in cylindrical coordinate system. [MAY 2016]

$$\nabla^2 V = 0$$

In cylindrical coordinate system, $\frac{1}{\rho}\frac{\partial}{\partial \rho}\left(\rho \frac{\partial V}{\partial \rho}\right) + \frac{1}{\rho^2}\left(\frac{\partial^2 V}{\partial \Phi^2}\right) + \frac{\partial^2 V}{\partial z^2} = 0$

8. Express laplace equation in spherical coordinate system. [MAY 2016]

$$\nabla^2 V = 0$$

In sphericall coordinate system, $\nabla^2 V = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2 \frac{\partial V}{\partial r}\right) + \frac{1}{r^2 \sin\theta}\frac{\partial}{\partial \theta}\left(\sin\theta \frac{\partial V}{\partial \theta}\right) + \frac{1}{r^2 \sin^2\theta}\frac{\partial^2 V}{\partial \phi^2} = 0$

9. Define resistance of a conductor. [NOV 2016.]

The ratio of potential difference between the two ends of the conductors to the current flowing through it is resistance of the conductor.

10. Write the poisson's and laplace equation.[NOV 2016]

Poisson's equation is $\nabla^2 V = - \rho / \epsilon$

$\frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2}$

where ρ – volume charge density Є – permittivity of the medium

∇^2 – laplacian operator Laplace equation is $\nabla^2 V = 0$

$\frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2} = 0$

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∇^2 – laplacian operator Laplace equation is $\nabla^2 V = 0$

$$\frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2} = 0$$

13. Write the relation between perfect conductor and electrostatic field. [APR 2015]

The electric field on the surface of a perfect conductor is orthogonal (i.e., normal) to the conductor

14. Define current density.[APR 2015]

Current density is defined as the current per unit area.

$J = I/A$ Amp/m^2

15. What are the boundary conditions for electric field at the perfect dielectric conductor interface? [NOV 2015]

(i) the tangential component of electric field is continuous i.e $E_{t1} = E_{t2}$

(ii) the normal component of electric flux is continuous i.e $D_{n1} = D_{n2}$

16. What is meant by displacement current?[May2014]

Displacement current is nothing but the current flowing through capacitor.

$J = D / t$

17. What are dielectrics?

Dielectrics are materials that may not conduct electricity through it but on applying electric field induced charges are produced on its faces .The valence electron in atoms of a dielectric are tightly bound to their nucleus

18. Define Boundary conditions.

The conditions existing at the boundary of the two media when field passes from one medium to other are called boundary conditions.

19. Write the boundary conditions at the interface between two perfect dielectrics.

i)The tangential component of electric field is continuous (i.e.) $E_{t1}=E_{t2}$

ii)The normal component of electric flux density is continuous (i.e.) $D_{n1}=D_{n22}$

20. Distinguish between conduction and displacement currents.

The current through a resistive element is termed as conduction current whereas the current through a capacitive element is termed as displacement current.

21. What is method of images?

The replacement of the actual problem with boundaries by an enlarged region or with image charges but no boundaries is called the method of images.

22. When is method of images used?

Method of images is used in solving problems of one or more point charges in the presence of boundary surfaces.

23. What is Polarization?

The applied field *E* shifts the charges inside the dielectric to induce the electric dipoles. This process is called Polarization.

24. Write down the expression for capacitance between two parallel plates.

$$C = \frac{\epsilon_0 \epsilon_r A}{D} \text{ F}$$

25. What are the significant physical differences between Poisson's and Laplace's Equations?

Poisson's and Laplace's equations are useful for determining the electrostatic potential V in regions whose boundaries are known. When the region of interest contains charges poisons equation can be used to find the potential. When the region is free from charge Laplace equation is used to find the potential.

26. How is electric energy stored in a capacitor?

In a capacitor, the work done in charging a capacitor is stored in the form of electric energy.

27. What meaning would you give to the capacitance of a single conductor?

A single conductor also possesses capacitance. It is a capacitor whose one plate is at infinity.

28.	**State point form of ohms law.** Point form of ohms law states that the field strength within a conductor is proportional to the current density	
29.	**Define surface charge density.** It is the charge per surface area.	
30.	**Obtain Poisson's equation from Gauss's law?** Gauss law in point form is ▼.D = ρ where D – electric flux density ρ - volume charge density but D = Є E therefore Є ▼.E = ρ ▼. E = ρ/ Є but E = - ▼V = - ▼ . ▼V = ρ/ Є ▼2V = - ρ/ Є This is poisson's equation	
31.	**What are the significant physical differences between Poisson's and Laplace's Equations?** Poisson's and Laplace's equations are useful for determining the electrostatic potential V in regions whose boundaries are known. When the region of interest contains charges poisons equation can be used to find the potential. When the region is free from charge Laplace equation is used to find the potential	
32.	**Define relaxation time.** time τ is defined as the time required by the charge density to decay to 36.8% of its initial value.	
33.	**Define dielectric strength of material and give its unit.** The maximum electric field intensity that a dielectric material can withstand with out breakdown is the dielectric strength of the material. Its unit is V/m.	
34.	**State the difference between** The relaxation **Poisson's equation and Laplace's equation.** Laplace's equation. $\nabla^2 V = 0$ Poisson's equation. $\nabla \cdot \nabla V = \nabla^2 V = -\frac{\rho_v}{\varepsilon}$	
35.	**Write the equation of continuity.** $I \iint J.ds = -\frac{dQ}{dt}$	
36.	**Find the energy stored in the 20pf parallel plate capacitor with plate separation of 2cm. the magnitude of electric field in the capacitor is 1000v/m.** V = E d = $1000 \times 2 \times 10^{-2}$ Energy scored in a capacitor W = ½ CV^2 = ½ x 20^{-12} x 1000 x 2 x 10^{-2} =4 x 10^{-9}ws	
	PART – B	
1.	(i)Derive an expression for capacitance of co-axial cable. " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-125 (ii) State the relationship between polarization and electric field intensity. " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-55,65.	**(8)** **(5)**
2.	(i) Derive the boundary conditions of the normal and tangential components of electric field at the Inter face of two media with different dielectrics. " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-143. (ii) Deduce the expression for joint capacitance of two capacitors C1 and C2 when connected in series and parallel. " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-150.	**(8)** **(5)**
3.	Derive an expression for the capacitance of a spherical capacitor with conducting shells of radius a and b. " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-150.	**(13)**
4.	(i)Find the expression for the cylindrical capacitance using Laplace equation. " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-181. (ii)Derive the relationship between current density & charge density. " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-116.	**(8)** **(8)**
5.	(i)Explain the properties of Conductor and Dielectric	**(8)**

" Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-123.

(ii)Write the equation of continuity in integral and differential form. **(5)**
" Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-122.

6. i)Explain Poisson's and Laplace's equation. **(5)**
" Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-194.

(ii)Given the potential field, V = (50sinθ/r2) V, in free space, determine whether V satisfies Laplace's eqn. **(8)**
" Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-211.

7. (i)Find the total current in a circular conductor of radius 4 mm if the current density varies according to J = (104/r) A/m2. **(8)**
" Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-120.

(ii)Calculate the capacitance of a parallel plate capacitor having a mica dielectric, εr=6, a plate area of 10 inch2 , and a separation of 0.01inch. **(5)**
" Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-154.

8. (i)A capacitor with two dielectrics as follows: Plate area 100 cm2, dielectric 1 thickness = 3 mm, εr1=3dielectric 2 thickness = 2 mm, εr2=2. If a potential of 100 V is applied across the plates, evaluate the capacitance and the energy stored. **(7)**
" Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-211.

(ii) Estimate the capacitance of a conducting sphere of 2 cm in diameter, covered with a layer of polyethylene with ε1=2.26 and 3cm thick. **(6)**
" Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-211.

PART – C

(iii) Two concentric metal spherical shells of radii a and b are separated by weakly conducting material of conductivity σ. If they are maintained at a potential difference V, what current flows from one to the other? What is the resistance between the shells? Measure the resistance if b >> a**.** **(8)**
" Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-120.

A metallic sphere of radius 10 cm has a surface charge density of 10 nC/m^2. Calculate the energy stored in the system. **(7)**
" Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-120.

2. Formulate the energy required to assemble a uniform sphere of charge with radius b and volume charge density ρ C/m^3. **(15)**
" Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-120

UNIT III STATIC MAGNETIC FIELDS

Biot-Savart Law, Magnetic field Intensity, Estimation of Magnetic field Intensity for straight and circular conductors, Ampere's Circuital Law, Point form of Ampere's Circuital Law, Stokes theorem, Magnetic flux and magnetic flux density, The Scalar and Vector Magnetic potentials, Derivation of Steady magnetic field Laws.

PART – A

1. Define scalar magnetic Potential. [MAY 2016, APR2015]

The scalar magnetic potential Vm can be defined for source free region where *J* i.e. current density is zero.

2. **Define vector magnetic Potential. [MAY 2016, APR2015]**

The vector magnetic potential A is defined such that curl of vector magnetic potential is the flux density.

B = ∇. X A

3. State Ampere's circuital law. [NOV2016]

The line integral of magnetic field intensity H around a closed path is exactly equal to the direct current enclosed by that path.

4. A current of 3A flowing through an inductor of 100mh. What is the energy stored in inductor? [MAY 2016]

Energy stored in magnetic field $W = ½ LI^2 = 0.5 X 9 X 100 X 10^{-3} = 0.45J$

5. Write the relation between magnetic flux and Magnetic flux density. [APR 2015]

B=ø/A , ø/ is magnetic flux, B is magnetic flux density

6. In a ferromagnetic material ($\mu= 4.5\mu_0$), the magnetic flux density is $B = 10ya_x wb/m^2$. Calculate the magnetization vector($\mu_0 = 4\pi x 10^{-7}$H/m). [NOV 2015]

	$B = \mu H$ $H = (10yax \times 10^{-3}) / (45 \times 4\pi \times 10^{-7}) = 1768.38a_x$
7.	**What is the energy stored in a magnetic field in terms of field quantities?[NOV 2015]** Energy stored in magnetic field $W = ½ LI^2$
8.	**State Biot Savart Law.[NOV 2015]** The Biot Savart law states that, the magnetic field intensity *dH* produced at a point p due to a differential current element IdL is, 1) Proportional to the product of the current I and differential length dL. 2) The sine of the angle between the element and the line joining point p to the element and 3) Inversely proportional to the square of the distance R between point p and the element
9.	**What is Magnetic Field?** The region around a magnet within which influence of the magnet can be experienced is called Magnetic Field.
10.	**What are Magnetic Lines of Force?** The existence of Magnetic Field can be experienced with the help of compass field. Such a field is represented by imaginary lines around the magnet which are called Magnetic Lines of Force**.**
11.	**State Stoke Theorem.** The line integral of F around a closed path L is equal to the integral of curl of F over the open surface S enclosed by the closed path L. H.dl = (ΔxH) ds
12.	**What is the fundamental difference between static electric and magnetic field lines?** There is a fundamental difference between static electric and magnetic field lines. The tubes of electric flux originate and terminate on charges, whereas magnetic flux tubes are continuous.
13.	**State Kirchoff's Flux law**. It states that the total magnetic flux arriving at any junction in a magnetic circuit is equal to the magnetic flux leaving that junction. Using this law, parallel magnetic circuits can be easily analyzed.
14.	**State Kirchoff's MMF law.** Kirchoff's MMF law states that the resultant MMF around a closed magnetic circuit is equal to the algebraic sum of products of flux and reluctance of each part of the closed circuit.
15.	**Define Magnetic flux density.** The total magnetic lines of force i.e. magnetic flux crossing a unit area in a plane at right angles to the direction of flux is called magnetic flux density. Unit Wb/m2.
16.	**Define Magnetic field Intensity.** Magnetic Field intensity at any point in the magnetic field is defined as the force experienced by a unit north pole of one Weber strength, when placed at that point. Unit: N/Wb**.**
17.	**What is rotational and irrotational vector field?** If curl of a vector field exists then the field is called rotational. For irrotational vector field, the curl vanishes i.e. curl is zero.
18.	**Give the application of Stoke's theorem.** The Stoke's theorem is applicable for the open surface enclosed by the given closed path. Any volume is a closed surface and hence application of Stoke's theorem to a closed surface which enclosed certain volume produces zero answer.
19.	**Write down the magnetic boundary conditions. [Nov2010]** a)The normal components of flux density B is continuous across the boundary. Bn1 = Bn2 b)The tangential component of field intensity H is continuous across the boundary Ht1 = Ht2
20.	**Define Magnetic dipole. [NOV 2003]** A small bar magnet with pole strength m and length l may be trated as small bar magnet. A small current carrying loop is

	called a magnetic dipole.
21.	**Define magnetization.[AU-NOV,06]** It is defined as ratio of magnetic dipole moment to unit volume. M = Magnetic dipole moment = m Volume V
22.	**What is the relation between relative permeability and susceptibility? [MAY2012]** μA = 1 + Xm where μA - relative permeability Xm - susceptibility
23.	**What are the different types of magnetic materials [AU-NOV,2008/APR 08]** According to their behaviour ,magnetic materials are classified as diamagnetic ,paramagnetic and ferromagnetic materials.
24.	**Define mmf?** Magneto motive force of a magnetic circuit is equal to the line integral of magnetic field H around the closed circuit. Mmf = ∫ H.dl = NI amp-turns.
25.	**What is the relation between magnetic flux density and magnetic field Intensity.** B = μ H Where B - Magnetic flux density (Tesla) H - Magnetic Field Intensity (A/m) μ0 - Permeability of free space μr - Relative permeability of medium
26.	**What is magnetic dipole moment. [NOV 07, MAY 09]** Magnetic dipole moment is the product of current and area of loop. Its direction is normal to loop M = IA Where M is magnetic dipole moment I is the current A is the area .
27.	**Define Magnetic Flux Density.** It is flux per unit area B = f/A Wb/m2 or Tesla. f - Flux (Wb) A - Area (m2)
28.	**Write down the formula for magnetic field intensity due to infinite long straight conductor.** $H = \frac{I}{2\pi r}$a∅
29.	**What are equi potential surfaces?** An equi potential surface is a surface in which the potential energy at every point is of the same value.
30.	**Describe what are the sources of electric field and magnetic field?** Stationary charges produce electric field that are constant in time, hence the term electrostatics. Moving charges produce magnetic fields hence the term magnetostatics.

PART – B

1.(i)	Find the magnetic flux density for the infinite currenct sheet in the xy plane with current density K = Kyay A/m current. **(8)** “ Engineering Electromagnetics ’’ by “WilliamH.Hayt.JA Buck” page No-.268 (ii) Derive the equation to find the force between the two current elements. **(5)** “ Engineering Electromagnetics ’’ by “WilliamH.Hayt.JA Buck” page No-.265
2.	Derive the expression for magnetic field intensity and magnetic flux density due to finite and infinite line **(13)** “ Engineering Electromagnetics ’’ by “WilliamH.Hayt.JA Buck” page No-.237
3.	Derive an expression for magnetic fiel due to infinitely long coaxial cable. **(13)** “ Engineering Electromagnetics ’’ by “WilliamH.Hayt.JA Buck” page No-.237
4.	Derive an expression for magnetic field intensity due to a linear conductor of infinite length carrying current I at a distant point P. Assume R to be the distance between conductor and point P, Use Biot Savarts law. And also derive the expression for magnetic field intensity on the axis of circular wire of radius ‘a’ carrying current I. (13) “ Engineering Electromagnetics ’’ by “WilliamH.Hayt.JA Buck” page No-.237
5.	Using Ampere circuital law determine the magnetic field intensity due to a infinite long wire carrying a current I, also if a differential current element Idz is located at the origin of free space, obtain the expression for vector magnetic field potential due to the current element and hence find the magnetic field intensity at the point. **(13)** “ Engineering Electromagnetics ’’ by “WilliamH.Hayt.JA Buck” page No-.239
6.	Explain the concepts of scalar magnetic potential and vector magnetic potential? Find the maximum torque on an 85 turns rectangular coil with dimension (0.2x0.3) m carrying a current of 5 Amps in a field B = 6.5T **(13)** “ Engineering Electromagnetics ’’ by “WilliamH.Hayt.JA Buck” page No-.240

7. Derive the expressions for magnetic field intensity and magnetic flux density due to circular coil. **(13)**
“ Engineering Electromagnetics ’’ by “WilliamH.Hayt.JA Buck” page No-.218

8. Derive the magnetic field intensity developed in a circular loop carrying steady current I in a uniform field. Using Ampere circuital law derive the magnetic field intensity due to a co-axial cable carrying a steady current I. **(13)**
“ Engineering Electromagnetics ’’ by “WilliamH.Hayt.JA Buck” page No-.239

9. State Ampere’s circuital law and explain any two applications of Ampere’s Circuital law. **(13)**
“ Engineering Electromagnetics ’’ by “WilliamH.Hayt.JA Buck” page No-.232

10. Derive the magnetic field intensity developed in a square loop carrying current I in a uniform field. Also State Lorentz force equation for a moving charge and explain its applications. **(13)**
“ Engineering Electromagnetics ’’ by “WilliamH.Hayt.JA Buck” page No-.239

PART – C

1. (i) Find the expression of induction for the co-axial **(8)**
“ Engineering Electromagnetics ’’ by “WilliamH.Hayt.JA Buck” page No-.308

(ii) propose the salient points to be noted when the boundary conditions are applied. **(7)**
“ Engineering Electromagnetics ’’ by “WilliamH.Hayt.JA Buck” page No-.297

2. Derive the magnetic boundary condition at the interface between two magnetic medium. **(15)**
“ Engineering Electromagnetics ’’ by “WilliamH.Hayt.JA Buck” page No-.297

3. Validate the expression which relates the current density J, Magnetic Flux density B and Magnetic vector potential A. Demonstrate the expression with the supporting laws. **(15)**
“ Engineering Electromagnetics ’’ by “WilliamH.Hayt.JA Buck” page No-.251

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. Estimate and sketch the variance of H against r for (i) r <a (ii)a < r <b (iii)b < r < c (iv)r > c. **(15)**
“ Engineering Electromagnetics ’’ by “WilliamH.Hayt.JA Buck” page No-.308

UNIT IV MAGNETIC FORCES AND MATERIALS

Force on a moving charge, Force on a differential current element, Force between current elements, Force and torque on a closed circuit, The nature of magnetic materials, Magnetization and permeability, Magnetic boundary conditions involving magnetic fields, The magnetic circuit, Potential energy and forces on magnetic materials, Inductance, Basic expressions for self and mutual inductances, Inductance evaluation for solenoid, toroid, coaxial cables and transmission lines, Energy stored in Magnetic field.

PART – A

1. Define skin depth. [APR 2017]

The electric current flows mainly at the "skin" of the conductor, between the outer surface and a level called the skin depth. The skin effect causes the effective resistance of the conductor to increase at higher frequencies where the skin depth is smaller, thus reducing the effective cross-section of the conductor.

2. Define dielectric strength. [APR 2017]

Of an insulating material, the maximum electric field that a pure material can withstand under ideal conditions without breaking down (i.e., without experiencing failure of its insulating properties).

3. of 25 mh and 100 mh. [NOV 2016]

$$M = k\sqrt{L_1 L_2}, \qquad 0 \le k \le 1$$

4. Give the expression for Lorentz force equation. [NPV 2016]

Lorentz force equation relates mechanical force to the electrical force. It is given as the total force on a moving charge in the presence of both electric and magnetic fields.F = qE + qv × B.

5. Mention the force between two current elements. [MAY 2016]

$F= \mu I I_1 / 2\pi R$

6. Differentiate diamagnetic, paramagnetic and ferromagnetic material. [MAY 2016]

Diamagnetism refers to materials that are not affected by a magnetic field.

7. In a ferromagnetic material ($\mu= 4.5\mu_0$), the magnetic flux density is $B = 10ya_x wb/m^2$. Calculate the magnetization

	vector(μ_0 =4πx 10^{-7}H/m). [NOV 2015] B = μH H = (10yax x 10^{-3}) / (45 x 4π x 10 $^{-7}$) = 1768.38a_x.
8.	**What is the energy stored in a magnetic field in terms of field quantities? [MAY 2015, NOV 2015]** Energy stored in magnetic field W = ½ LI^2
9.	**What is Magnetization?** The field produced due to the movement of bound charges is called Magnetization represented by *M*
10.	**Define Reluctance.** Reluctance R is defined as the ratio of the magneto motive force to the total flux. *R=em/Φ* And it is measured as Ampere-turn/Weber.
11.	**Define Magnetic dipole moment.** The Magnetic dipole moment of a current loop is defined as the product of current through the loop and the area of the loop, directed normal to the current loop.
12.	**Define self inductance.** Self inductance is defined as the rate of total magnetic flux linkage to the current through the coil.
13.	**What are Magnetic Lines of Force?** The existence of Magnetic Field can be experienced with the help of compass field. Such a field is represented by imaginary lines around the magnet which are called Magnetic Lines of Force.
14.	**Define Inductance.** In general, inductance is also referred as self inductance as the flux produced by the current flowing through the coil links with the coil itself.
15.	**What is fringing effect?** If there is an air gap in between the path of the magnetic flux, it spreads and bulges out. This effect is called fringing effect
16.	**Define Mutual inductance.** The mutual inductance between the two coils is defined as the ratio of flux linkage of one coil to the current in other coil. Thus the mutual inductance between circuit 1 and circuit 2 is given by μ12= N2Φ12 .H / I1
17.	**Distinguish between solenoid and toroid.** Solenoid is a cylindrically shaped coil consisting of a large number of closely spaced turns of insulated wire wound usually on a non magnetic frame. If a long slender solenoid is bent into the form of a ring and there by closed on itself it becomes a toroid.
18.	**Write the expression for inductance of a toroid?** L = μN2A/(2πR) H
19.	**Write the expression for inductance of a solenoid?** L = μN2A/ l H 12
20.	**Write the expression for inductance of a coaxial cable?** L = μd/2π ln (b/a) H
21.	**State Kirchoff's MMF law.** Kirchoff's MMF law states that the resultant mmf around a closed magnetic circuit is equal to the algebraic sum of products of flux and reluctance of each part of the closed circuit. For closed magnetic circuit, Σ*MMF* = Σφ*R*.
22.	**Define Moment of force.** The Moment of a force or torque about a specified point is defined as the vector product of the moment arm *R vector and force vector*. It is measured in Nm.
23.	**Distinguish between solenoid and toroid.**

Solenoid is a cylindrically shaped coil consisting of a large number of closely spaced turns of insulated wire wound usually on a non magnetic frame. If a long slender solenoid is bent into the form of a ring and there by closed on itself it becomes a toroid.

24. Give the relation between μ *and H* in tangential component.

The tangential component of *H* are continuous, while tangential component of *B* are discontinuous at the boundary, with the condition that the boundary is current free.

25. Give the relation between μ *and H* in normal component. [NOV/DEC 2014] [MAY/JUNE2012]

The tangential component of *H* are not continuous at the boundary. The field strengths in two media are inversely proportional to their relative permeabilities.

26. What is permeability?

In magnetostatics, the *B and H* are related to each other through the property of the region in which current carrying conductor is placed. It is called permeability denoted as μ . It is the ability with which the current carrying conductor forces the magnetic flux through the region around it.

27. What are boundary conditions?

The conditions of the magnetic field existing at the magnetic field existing at the boundary of the two media when the magnetic field passes from one medium to other are called boundary conditions

28. Write down the magnetic boundary conditions.

i) The normal components of flux density B is continuous across the boundary.

ii) The tangential component of field intensity is continuous across the boundary.

29. Give the force on a current element. [NOV/DEC 2011] [MAY/JUNE2010]

$dF = BIdl \sin\theta$

31. Define magnetic moment.

Magnetic moment is defined as the maximum torque per magnetic induction of flux density. $m=IA$

32. State Gauss law for magnetic field.

The total magnetic flux passing through any closed surface is equal to zero. $B.ds = 0$

33. State Lenz law.

Lenz's law states that the induced emf in a circuit produces a current which opposes the change in magnetic flux producing it.

34. Define magnetic field strength.

The magnetic field strength (H) is a vector having the same direction as magnetic flux density. $H=B/\mu$

35. Give the expression for torque experienced by a current carrying loop situated in a magnetic field. [NOV/DEC 2011] [MAY/JUNE2013]

$T = IAB \sin\theta$

36. What is torque on a solenoid?

$T = NIAB \sin\theta$

37. Explain the conservative property of electric field.

The work done in moving a point charge around a closed path in a electric field is zero. Such a field is said to be conservative.

38. Write the expression for field intensity due to a toroid carrying a filamentary current I

$H=NI / 2\pi R$

39. Write poisson's and laplace 's equations. [MAY/JUNE2007]

Poisson's eqn:

$\Delta 2\ V= - \rho v / \varepsilon$

Laplace's eqn: $\Delta V= 0$

1PART - B

1.	i)Explain magnetic boundary conditions with neat sketch	**(8)**

	" Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.281 ii) Derive an expression for inductance of a solenoid with N turns and l metre length carrying a current of I amperes. **(5)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.293	
2.	(i) Derive the expression for force on a moving charge in a magnetic field and Lorentz force equation **(8)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.260 (ii) Derive the inductance of a toroid. **(5)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.292	
3.	(i) Derive the expression for inductance of a solenoid. Calculate the inductance of solenoid, 8cm in length, 2 cm in radius, having μr = 100 and 1000 turns. **(8)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.292 (ii) Give the comparison between magnetic and electric circuits. **(5)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.284	
4.	i) Derive an expression for energy density in inductor **(5)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.306 i) Derive an expression for the force between two current carrying wires. Assume that the currents are in the same direction. **(8)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.280	
5.	(i) An iron ring of relative permeability 100 is wound uniformly with two coils of 100 and 400 turns of wire. The cross section of the ring is 4 cm2. The mean circumference is 50 cm. Calculate a) the self-inductance of each of the two coils. b) The mutual inductance. c) The total inductance when the two the coils are connected in series with flux in the same sense. d) The total inductance when the coils are connected in series with flux in the opposite sense. **(7)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.308 (ii) Show that inductance of the cable is L=μl/2π lnb/a) H **(6)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.308	
6.	(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. **(7)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.308 (ii) Propose the solution for energy stored in the solenoid having 50cm long and 5 cm in diameter and is wound with 2000 turns of wire, carrying a current of 10 A. **(6)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.306	
	PART C	
1.	(i) Find the expression of induction for the co-axial **(8)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.308 (ii) propose the salient points to be noted when the boundary conditions are applied. **(7)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.297	
2.	i) Derive an expression for a torque on a closed rectangular loop carrying current. **(8)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.283 ii) 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 is coil is co-axial with a second solenoid, also 50 cm long, but 3 cm diameter and 1200 turns. Calculate L for the inner solenoid and L for the outer solenoid. **(7)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.308	
3.	Derive the magnetic boundary condition at the interface between two magnetic medium. **(15)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.297	
4.	(i)valuate the expression for force between parallel conductors. **(8)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.280 (ii)Two wires carrying current in the same direction of 3A and 6A are placed with their axes 5 cm apart, free space permeability $\mu_0 = 4\pi \times 10^{-7}$ H/m. Estimate the force between them in N/m length. **(7)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.280	
5.	Illustrate magnetic circuit with a sketch and hence formulate the expression for its reluctance. **(10)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.288	

Find inductance per unit length of a co axial cable if radius of inner and outer conductor are 1mm and 3mm respectively. Assume μ_r=1. **(5)**

" Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.308

6. Propose the concept of mutual inductance between straight long wire and a square loop and explain. **(15)**

" Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.308

UNIT V TIME VARYING FIELDS AND MAXWELL'S EQUATIONS

Fundamental relations for Electrostatic and Magneto static fields, Faraday's law for Electromagnetic Induction, Transformers, Motional Electromotive forces, Differential form of Maxwell's equations, Integral form of Maxwell's equations, Potential functions, Electromagnetic boundary conditions, Wave equations and their solutions, Pointing's theorem, Time harmonic fields, Electromagnetic Spectrum.

PART - A

1. Differentiate conduction current and displacement. [APRIL 2017]

The current flowing through the resistor is known as **conduction current** and it obeys Ohm's law, while the current flowing through the capacitor

2. Mention the properties of uniform plane wave. [APRIL 2017]

i) At every point in space ,the electric field E and magnetic field H are perpendicular to each other.

ii)The fields vary harmonically with time and at the same frequency everywhere in space

3. Define phase velocity. NOV 2016

The phase velocity of a wave is the rate at which the phase of the wave propagates in space. This is the speed at which the phase of any one frequency component of the wave travels.

$$v_p = \frac{\omega}{\beta} = \lambda f = \frac{1}{\sqrt{\mu\varepsilon}}$$

4. State Faraday's law of induction. MAY 2016

Electromagnetic Induction state that whenever a conductor are placed in a varying magnetic field emf are induced which is called induced emf, if the conductor circuit are closed current are also induced which is called induced current.

5. Define pointing vector. [APRIL/MAY2015, MAY 2016]

The vector product of electric field intensity and magnetic field intensity at a point is a measure of the rate of energy flow per unit area at that point.

6. State Faraday's law for a moving charge in a constant magnetic field. [APR 2015]

Electromagnetic Induction state that whenever a conductor are placed in a varying magnetic field emf are induced which is called induced emf, if the conductor circuit are closed current are also induced which is called induced current.

7. What are the Maxwell's equations for free space medium? [NOV 2015]

$$\nabla \bullet \overrightarrow{D} = 0$$

$$\nabla \bullet \overrightarrow{B} = 0$$

$$\nabla \times \overrightarrow{E} = -\frac{\partial B}{\partial t} - \frac{\partial}{\partial t}(\mu_0 H)$$

$$\nabla \times \overrightarrow{H} = \frac{\partial D}{\partial t} = \varepsilon_0 \frac{\partial E}{\partial t}$$

8. In a medium, the electric field intensity E = 10sin(1000t-10x)a_3V/m. calculate the displacement current density (ϵ_r = 80, ϵ_0 = 8.854 x10^{-12}F/m). [NOV 2015]

$$D = \varepsilon E = 80 \times 8.854 \times 10^{-12} \times 10 \sin(1000t - 10x) ay$$

$$J_D = \frac{\partial D}{\partial t} = \frac{\partial[7.083 \times 10^{-9}}{\partial t} \sin(1000t - 10x) a\vec{y}$$

9.	**State Faraday's law for moving charge in a constant magnetic field. [APR 2015]** $\oint_C \vec{E}.d\vec{l} = -\frac{\partial}{\partial t}\oint_S \vec{B}.d\vec{s}$ (integral form) $\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$ (point form)
10.	**State poynting theorem. [APR 2015]** The net power flowing out of a given volume is equal to the time rate of decrease of the the energy stored within the volume- conduction losses.
11.	**What is called as intrinsic impedance?** The ratio of amplitudes of *E(electric field) and H (magnetic field)* of the waves in either direction is called intrinsic impedance of the material in which wave is travelling. It is denoted by η .
12.	**Give the difficulties in FDM.** FDM is difficult to apply for problems involving irregular boundaries and non homogeneous material properties.
13.	**Explain the steps in finite element method.** i) Discrimination of the solution region into elements. ii) Generation of equations for fields at each element iii) Assembly of all elements iv) Solution of the resulting system
14.	**What is called skin effect?** For the frequencies in the microwave range, the skin depth or depth of penetration is very small for good conductors and all the fields and currents may be considered as confined to a thin layer near the surface of the conductor. This thin layer is nothing but the skin of the conductor and hence it is called skin effect.
15.	**What is Normal Incidence?** When a uniform plane wave incidences normally to the boundary between the media, then it is known as normal incidence.
16.	**What is called attenuation constant? [APRIL/MAY2010]** When a wave propagates in the medium, it gets attenuated. The amplitude of the signal reduces. This is represented by attenuation constant α . It is measured in neper per meter (NP/m). But practically it is expressed in decibel (dB).
17.	**What is phase constant?** When a wave propagates, phase change also takes place. Such a phase change is expressed by a phase constant β . It is measured in radian per meter (rad/m).
18.	**How voltage maxima and minima are separated?** In general voltage minima are separated by one half wavelength. Also the voltage maxima are also separated by one half wave length.
19.	**What is the major drawback of finite difference method?** The major drawback of finite difference method is its inability to handle curved boundaries accurately.
20.	**State Faraday's law for a moving charge in a constant magnetic field. APR 2015** Electromagnetic Induction state that whenever a conductor are placed in a varying magnetic field emf are induced which is called induced emf, if the conductor circuit are closed current are also induced which is called induced current.
21.	**Define a wave.** If a physical phenomenon that occurs at one place at a given time is reproduced at other places at later times , the time delay being proportional to the space separation from the first location then the group of phenomena constitutes a wave.
22.	**What is method of images?** The replacement of the actual problem with boundaries by an enlarged region or with image charges but no

	boundaries is called the method of images.	
23.	**When is method of images used?** Method of images is used in solving problems of one or more point charges in the presence of boundary surfaces.	
24.	**Define power density.** The power density is defined as the ratio of power to unit area. Power density=power/unit area.	
25.	**What is the significant feature of wave propagation in an imperfect dielectric ?** The only significant feature of wave propagation in an imperfect dielectric compared to that in a perfect dielectric is the attenuation undergone by the wave.	
26.	**Define loss tangent**. Loss tangent is the ratio of the magnitude of conduction current density to displacement current density of the medium.	
27.	**Define reflection and transmission coefficients.** Reflection coefficient is defined as the ratio of the magnitude of the reflected field to that of the incident field.	
28.	**Define transmission coefficients.** Transmission coefficient is defined as the ratio of the magnitude of the transmitted field to that of incident field.	
29.	**Explain the steps in finite element method. [APRIL/MAY2014]** i) Discretisation of the solution region into elements ii) Generation of equations for fields at each element iii) Assembly of all elements iv) Solution of the resulting system	
30.	**State Maxwell's fourth equation. [APRIL/MAY2011]** The net magnetic flux emerging through any closed surface is zero.	
31.	**State Maxwell's Third equation.** The total electric displacement through the surface enclosing a volume is equal to the total charge within the volume.	
32.	**State the principle of superposition of fields. [APRIL/MAY2010]** The total electric field at a point is the algebraic sum of the individual electric field at that point.	
33.	**Define propagation constant.** Propagation constant is a complex number $\gamma = \alpha + j\beta$, where γ is propagation constant	

	PART B	
1.	Discuss about the propagation of the plane waves in free space and in a homogeneous material. " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.396	**(13)**
2.	Starting from Maxwells equation derive the equation for E field in the form of wave in free space. " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.396	**(13)**
3.	Explain the condition and propagation of uniform plane wave in good conductors and derive the wave constants. " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.396	**(13)**
4.	Derive the Maxwell's equation in differential and integral " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.317	**(13)**
5.	Discuss the pointing vector and pointing theorem? Also derive the ampere circuital law. Derive general field relations for time varying electric and magnetic fields using Maxwell's equation. " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.415	**(13)**
6.	What is the physical significance of the pointing vector? And explain it in detail? Derive the expression for total power flow in coaxial cable? " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.413	**(13)**
7.	Explain briefly about the motional emf and derive an expression for it?	**(13)**

	" Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.306
8.	Define faradays laws. What are the different ways of emf generation? Explain with governing equation and suitable example for each? Also derive the differential and integral form of faradays law. **(13)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.306
9.	(i)Derive the relationship between electric and magnetic fields? **(6)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.322 (ii) Explain complex, average and instantaneous poynting vector. **(7)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-415.
10.	Explain complex, average and instantaneous poynting vector. **(13)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.365
	PART C
1.	With relevant examples explain in detail the practical application of electromagnetic fields **(15)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.322
2.	.i) Explain the following poynting vector, average power and instantaneous power **(8)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.415 ii) Derive expression for poynting vector. **(7)** " Engineering Electromagnetics '' by "WilliamH.Hayt.JA Buck" page No-.415

COURSE DELIVERY PLAN-THEORY

Faculty Name : Mrs.V.Nanammal	**Programme/Branch:B.E/ECE**
Academic Year:2017-2018	**Year/Semester/Batch:II/IV/2016-2020**
Subject Code/Subject Name: EC6403 /Electromagnetic Fields	**Regulation:2013**

A. Details of the relevant POs & PSOs supported by the course	
PO1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and electronics engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO II	Promote excellence in professional career and higher education by gaining knowledge in the field of Electronics and Communication Engineering
PSO III	Understand social needs and environmental concerns with ethical responsibility to become a successful professional.

B. Details of COs Mapping with PO/PSOs identified for the course

Course Outcome	**Course Description**	**Program Outcomes/Program Specific Outcome**														
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C404.1	**To infer** field potentials due to static electric fields.	3	3	3	3	-	3	-	-	1	1	-	1	-	2	2
C404.2	**To Describe** how the materials are affected due to electric fields.	3	2	2	2	-	2	-	-	-	1	-	1	-	1	1
C404.3	**To Analyze** the field due to static magnetic fields.	3	3	2	2	-	2	-	-	-	2	-	1	-	2	1
C404.4	**To Explain** how the materials are affected due to magnetic fields.	3	3	2	2	-	2	-	-	2	2	-	2	-	2	1
C404.5	**To Analyze** the Dynamic electromagnetic fields.	3	3	2	2	-	1	-	-	2	2	-	2	-	2	1

C. Syllabus of the course
UNIT I STATIC ELECTRIC FIELD **9** Vector Algebra, Coordinate Systems, Vector differential operator, Gradient, Divergence, Curl, Divergence theorem, Stokes theorem, Coulombs law, Electric field intensity, Point, Line, Surface and Volume charge distributions, Electric flux density, Gauss law and its applications, Gauss divergence theorem, Absolute Electric potential, Potential difference, Calculation of potential differences for different configurations. Electric dipole, Electrostatic Energy and Energy density.
UNIT II CONDUCTORS AND DIELECTRICS **9** Conductors and dielectrics in Static Electric Field, Current and current density, Continuity equation, Polarization, Boundary conditions, Method of images, Resistance of a conductor, Capacitance, Parallel plate, Coaxial and Spherical capacitors, Boundary conditions for perfect dielectric materials, Poisson's equation, Laplace's equation, Solution of Laplace equation, Application of Poisson's and Laplace's equations.
UNIT III STATIC MAGNETIC FIELDS **9** Biot-Savart Law, Magnetic field Intensity, Estimation of Magnetic field Intensity for straight and circular conductors, Ampere's Circuital Law, Point form of Ampere's Circuital Law, Stokes theorem, Magnetic flux and magnetic flux density, The Scalar and Vector Magnetic potentials, Derivation of Steady magnetic field Laws.
UNIT IV MAGNETIC FORCES AND MATERIALS **9** Force on a moving charge, Force on a differential current element, Force between current elements, Force and torque on a closed circuit, The nature of magnetic materials, Magnetization and permeability, Magnetic boundary conditions involving magnetic fields, The magnetic circuit, Potential energy and forces on magnetic materials, Inductance, Basic expressions for self and mutual inductances, Inductance evaluation for solenoid, toroid, coaxial cables and transmission lines, Energy stored in Magnetic fields.
UNIT V TIME VARYING FIELDS AND MAXWELL'S EQUATIONS **9** Fundamental relations for Electrostatic and Magnetostatic fields, Faraday's law for Electromagnetic Induction, Transformers, Motional Electromotive forces, Differential form of Maxwell's equations, Integral form of Maxwell's equations, Potential functions, Electromagnetic boundary conditions, Wave equations and their solutions, Poynting's theorem, Time harmonic fields, Electromagnetic Spectrum.

D. Content Beyond Syllabus:

F. Delivery Resources:
Text Book(s): 1. William H Hayt and Jr John A Buck, "Engineering Electromagnetics", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008 2. Sadiku MH, "Principles of Electromagnetics", Oxford University Press Inc, New Delhi, 2009.
Reference Book(s): 1. David K Cheng, "Field and Wave Electromagnetics", Pearson Education Inc, Delhi, 2004. 2. John D Kraus and Daniel A Fleisch, "Electromagnetics with Applications", Mc Graw Hill Book Co, 2005. 3. Karl E Longman and Sava V Savov, "Fundamentals of Electromagnetics", Prentice Hall of India, New Delhi, 2006. 4. Ashutosh Pramanic, "Electromagnetism", Prentice Hall of India, New Delhi, 2006.
On line learning materials (and Others if any): 1. 2.

UNIT I STATIC ELECTRIC FIELD

Topic to be Covered	Delivery Resources: Text Book with Pg.No	Reference Book (if any with Pg.No)	Online Resource (Web Link of the Specific Topic)	Delivery Method
Vector Algebra, Co-ordinate Systems	T1.P.No.			
Vector differential operator, Gradient, Divergence, Curl	T1.P.No.			
Divergence theorem, Coulomb's law	T1.P.No.			
Electric field intensity, Point, Line	T1.P.No.			
Electric flux density	T1.P.No.			
Gauss law and its applications	T1.P.No.			
Gauss divergence theorem	T1.P.No.			
Absolute Electric potential, Potential difference	T1.P.No.			

Calculation of potential differences for different configurations	T1.P.No.			
Electric dipole	T1.P.No.			
Electrostatic Energy and Energy density.	T1.P.No.			
Course Outcome: C414.1: To infer field potentials due to static electric fields.				
No of hours in the syllabus : 12				
No of hours planned : 12				
No of hours taught : 12				

UNIT II CONDUCTORS AND DIELECTRICS				
Topic to be Covered	Delivery Resources			Delivery Method
	Text Book with Pg.No	Reference Book (if any with Pg.No)	Online Resource (Web Link of the Specific Topic)	
Conductors and dielectrics in Static Electric Field	T1.P.No.			
Current and current density, Continuity equation,	T1.P.No.			
Polarization, Boundary conditions, Method of images	T1.P.No.			
Resistance of a conductor, Capacitance, Parallel plate	T1.P.No.			
Coaxial and Spherical capacitors,	T1.P.No.			
Boundary conditions for perfect dielectric materials,	T1.P.No.			
Poisson‟s equation	T1.P.No.			
Laplace‟s equation, Solution of Laplace equation,	T1.P.No.			
Application of Poisson‟s and Laplace‟s equations.	T1.P.No.			
Course Outcome: C404.2: To Describe how the materials are affected due to electric fields.				
No of hours in the syllabus : 12				
No of hours planned : 12				
No of hours taught : 12				

UNIT III STATIC MAGNETIC FIELDS				
Topic to be Covered	Delivery Resources			Delivery Method
	Text Book with Pg.No	Reference Book (if any with Pg.No)	Online Resource (Web Link of the Specific Topic)	
Biot -Savart Law,	T1.P.No.			
Magnetic field Intensity,	T1.P.No.			
Estimation of Magnetic field Intensity for straight and circular conductors,	T1.P.No.			
Ampere‟s Circuital Law	T1.P.No.			
Point form of Ampere‟s Circuital Law,	T1.P.No.			
Stokes theorem	T1.P.No.			
Magnetic flux and magnetic flux density,	T1.P.No.			
The Scalar and Vector Magnetic potentials	T1.P.No.			
Derivation of Steady magnetic field Laws.	T1.P.No.			
Course Outcome: C404.3: To Analyze the field due to static magnetic fields.				
No of hours in the syllabus : 12				
No of hours planned : 12				
No of hours taught : 12				

UNIT IV MAGNETIC FORCES AND MATERIALS				
Topic to be Covered	Delivery Resources			Delivery Method
	Text Book with Pg.No	Reference Book (if any with Pg.No)	Online Resource (Web Link of the Specific Topic)	
Force on a moving charge,	T1.P.No.			
Force on a differential current element	T1.P.No.			
Force between current elements	T1.P.No.			
Force and torque on a closed circuit,	T1.P.No.			
The nature of magnetic materials,	T1.P.No.			
Magnetization and permeability,	T1.P.No.			

Magnetic boundary conditions involving magnetic fields,	T1.P.No.			
The magnetic circuit,	T1.P.No.			
Potential energy and forces on magnetic materials	T1.P.No.			
Inductance,	T1.P.No.			
Basic expressions for self and mutual inductances,	T1.P.No.			
Inductance evaluation for solenoid, toroid	T1.P.No.			
coaxial cables and transmission lines	T1.P.No.			
Energy stored in Magnetic fields.	T1.P.No.			
Course Outcome: C404.4: To Explain how the materials are affected due to magnetic fields.				
No of hours in the syllabus : 12				
No of hours planned : 12				
No of hours taught : 12				

UNIT V TIME VARYING FIELDS AND MAXWELL'S EQUATIONS				
Topic to be Covered	Delivery Resources			Delivery Method
	Text Book with Pg.No	Reference Book (if any with Pg.No)	Online Resource (Web Link of the Specific Topic)	
Fundamental relations for Electrostatic and Magnetostatic fields	T1.P.No.			
Faraday‟s law for Electromagnetic induction,	T1.P.No.			
Transformers, Motional Electromotive forces,	T1.P.No.			
Differential form of Maxwell‟s equations, Integral form of Maxwell‟s equations,	T1.P.No.			
Potential functions, Electromagnetic boundary conditions,	T1.P.No.			
Wave equations and their solutions,	T1.P.No.			
Poynting‟s theorem,	T1.P.No.			
Time harmonic fields	T1.P.No.			
Electromagnetic Spectrum	T1.P.No.			
Course Outcome: C404.5: To Analyze the Dynamic electromagnetic fields.				
No of hours in the syllabus : 12				
No of hours planned : 12				
No of hours taught : 12				