Pandian Saraswathi Yadav Engineering College

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Question Bank

Subject Name/ Code : EC6403/ Electromagnetic Fields **Year/Sem:** II/IV

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UNIT- I
STATIC ELECTRIC FIELDS
PART-A (2 Marks)

1. What is a scalar quantity and vector quantity? **(Nov 2010)**
   A scalar is a quantity which has only magnitude. Eg: Mass, Time, temperature.
   A vector is a quantity which has both magnitude and its direction. Eg: Force, Velocity, Electric field etc.
2. What are the different sources of electromagnetic fields? **(May 2012)**
   Sources of electromagnetic fields are
   i) stationary closed path in a time varying field
   ii) Time varying closed path in a static field
   iii) Time varying closed path in a time varying field.
3. Write down expression for x, y, z in terms of spherical co-ordinates r, θ and Φ.
   $A_x=A_r\sin\theta\cos\varphi+ A_\theta\cos\theta\cos\varphi-A_\varphi\sin\varphi$
   $A_y=A_r\sin\theta\sin\varphi+ A_\theta\cos\theta\sin\varphi+A_{\varphi\cos}\varphi$
   $A_z=A_r\cos\theta- A_\theta\sin\varphi$
4. Give the relation between three coordinate systems. **(Nov 2010)**
   $\rho=\sqrt{x^2+y^2}$, $\phi=\tan^{-1}\frac{y}{x}$ z=z
   $r=\sqrt{x^2+y^2+z^2}$ $\theta=\tan^{-1}\frac{\sqrt{x^2+y^2}}{z}$ $\phi=\tan^{-1}\frac{y}{x}$
5. State divergence theorem. **(May 2009) (Nov 2006) (May 2012) (May 2011) (Nov 2010) (MAY 2010)**
   The divergence of $\overline{A}$ at a given point P is the outward flux per unit volume as the volume shrins about P. Div of $\overline{A}=\nabla.\overline{A}=\frac{\oint_s \overline{A}.d\overline{S}}{\Delta v}$
6. How is the unit vectors defined in three co ordinate systems?
   A unit vector $\overline{a}_n$ denotes the direction of the vector.
   Rectangular Coordinate Systems unit vectors are $\overline{a}_x, \overline{a}_y, \overline{a}_z$
   Cylindrical Coordinate Systems unit vectors are $\overline{a}_\rho, \overline{a}_\phi, \overline{a}_z$
   Spherical Coordinate Systems unit vectors are $\overline{a}_r, \overline{a}_\theta, \overline{a}_\varphi$
7. State coulombs' law? **(Nov 2009) (May 2008) (Nov 2011) (Nov 2010)**
   Coulomb's law states that the force F between two point charges Q1 and Q2 along the line joining them is directly proportional to the product Q1Q2 of the charges and inversely proportional to the square of the distance R between them.
   $$\overline{F}\alpha\frac{kq_1q_2}{R^2}$$
8. State gauss law?
   Gauss's law states that the total electric flux ϕ through any closed surface is equal to the total charge enclosed by that surface.

$$\varphi = Q_{enc}$$

$$\varphi = \oint_s \overline{D}.d\overline{S}$$

9. Express the divergence of a vector in the three system of orthogonal Co-ordination.

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

$$\nabla.\overline{A} = \frac{1}{\rho}\frac{\partial \rho A_\rho}{\partial \rho} + \frac{1}{\rho}\frac{\partial A_\varphi}{\partial \varphi} + \frac{\partial A_z}{\partial z}$$

$$\nabla.\overline{A} = \frac{1}{r^2}\frac{\partial r^2 A_r}{\partial r} + \frac{1}{r\sin\theta}\frac{\partial A_\theta \sin\theta}{\partial \theta} + \frac{1}{r\sin\theta}\frac{\partial A_\varphi}{\partial \varphi}$$

10. Define dipole and dipole element? **(Nov 2010)**

An electric dipole is formed when two point charges of equal magnitude but opposite sign are separated by a small distance 'd'.

Dipole moment $\hat{p} = Q\overline{d}$

11. Define electric flux and flux density? **(May 2012)**

Flux due to the electric field E can be calculated by using the general definition of flux

$$\overline{D} = \varepsilon_0 \overline{E}$$

Then flux $\varphi = \oint_s \overline{D}.d\overline{S}$

One line of electric flux emanates from +1C and terminated on -1C. The vector field $\overline{D}$ is called the electric flux density(c/m^2).

12. Define electric field and electric intensity? **(May 2010)**

The electric field is the distributed electric flux lines over the charges.

The electric field intensity $\overline{E}$ is the force per unit charge when placed in an electric field

13. Distinguish electric potential and potential difference? **(May 2012)**

The potential at any point is the potential difference between that point and a chosen point at which the potential is zero

Potential energy per unit charge is defined as the ratio between work done to total charge.

14. State point form of ohms law? **(Nov 2014)**

Point form of ohm's law states that the electric field strength within a conductor is proportional to the current density.

15. State stokes theorem **(May 2010) (Nov 2014) (Nov 2009) (May 2006) (Nov 2010)**

Stoke's theorem states that the circulation of a vector field $\overline{A}$ around a path L is equal to the surface integral of the curl of $\overline{A}$ over the open surface S bounded by L provided $\overline{A}$ and $\nabla \times \overline{A}$ are continuous on S.

16. Define electric scalar potential **(May 2010)**

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/4πЄr Volts

17. What is an electric dipole? And write down the potential due to an electric dipole. **(Nov 2010)**

An electric dipole is formed when two point charges of equal magnitude but opposite sign are separated by a small distance 'd'.

Dipole moment $\hat{p} = Q\overline{d}$

Potential due to electric dipole $V = \frac{p.\bar{a}_r}{4\pi\varepsilon r^2}$

18. Why gauss law cannot be applied to determine the electric field due to finite line charge? **(Nov 2010)**

    Gauss law cannot be applied to determine the electric field due to finite line charge because

    It can be applied only for Gaussian surface and the surface encloses the volume completely.

19. What is Gradient? **(May 2014) (May 2012)**

    The gradient of a scalar field V is a vector that represents both magnitude and the direction of the maximum space rate of increase V

    Gradient of rectangular system

$$\nabla\bar{A} = \frac{\partial Va_x}{\partial x} + \frac{\partial Va_y}{\partial y} + \frac{\partial Va_z}{\partial z}$$

20. A point charge 2nc is located at the origin. What is the value of potential at P (1, 0, and 0) m?
21. Find the dot product of the vectors A and B if A =2ax-3ay+4az, B= -ax+2ay+2az. **(Nov 2010)**
22. Represent point P (0, 1and 1) m given in Cartesian co-ordinates into spherical co-ordinates. **(Nov 2010) (May 2010)**
23. Represent point P (2, 3and 1) m given in Cartesian co-ordinates into cylindrical co-ordinates. **(Nov 2010)**
24. A vector field is given by the expression F = (1/R0 in spherical co ordinates. Determine f in Cartesian form at a point x=1, y=1, z=1 unit. **(May 2009)**
25. Determine the Gradient of the scalar field F = $5r^2$ + r sin **(May 2012)**

PART-B (16 Marks)

1. State and explain Curl, Gradient and Divergence also find the potential due to an electric dipole (16) **(Nov 2014)**
2. Check validity of the divergence and curl theorem considering the field D=2xy ax+x2ay c/m^2 and the rectangular parallel piped formed by the planes x=0,x=1,y=0,y=2 &z=0,z=3. (16) **(Nov 2010)**
3. Explain three co-ordinate systems in detail. (16)
4. A uniform line charge ρL =25Nc/m lies on the x=3m and y=4m in free space.Find the electric field intensity at a point (2, 3and 15) m. b. Given that potential V=10sinθcosΦ/r2 find the electric flux density D at (2, π/2,0) (16) **(Nov 2008)**
5. State and prove Gauss law and explain applications of Gauss law. (16) **(May 2009) (Nov 2006) (Nov 2014) (**Nov **2011)**
6. Define the potential difference and electric field. Give the relation between potential and field intensity. Also Derive an expression for potential due to infinite uniformly charged line and also derive potential due to electric dipole. (16) **(Nov 2010) (May 2014) (May 2012) (Nov 2009)**
7. A vector field D = [5r2/4] It is given in spherical co-ordinates. Evaluate both sides of divergence theorem for the volume enclosed between r=1&r=2. (16)
8. Given A= 2r cosΦ+Riφ in cylindrical co-ordinates .for the contour x=0 to 1, y= 0 to1, verify Stokes's theorem (16)
9. State and explain **(Nov 2008) (May 2009) (May 2014)**
    1. Stokes theorem

2. Divergence theorem
3. The electric flux density

10. Find the electric field due to n-charges, and also establish the relation between potential and electric field (16) **(Dec** 2009**)**
11. Derive an expression for the electric field intensity at any point due to a uniformly charged sheet with density r_s c/ m^2 **(Apr 2011) (Nov** 2011**)**
12. Derive the expression for potential due to an electric dipole at any point P. Also find electric field intensity at the same point (10) **(Dec** 2010**)**
13. A circular disc of radius 'a' m is charged uniformly with a charge density of σ c/ m2.find the Electric field at a point 'h' m from the disc along its axis. (16)
14. Given two points A(x=2, y=3, z= -1) and B(r=4, θ=25, ϕ= 120) find both spherical coordinates and Cartesian coordinates for A and B. Also find curl H for (2rcos ϕar – 4r sin ϕ + 3az). **(May 2010)**
15. A circular disc of radius a meter is charged uniformly with a charge of σ c/m. Find the electric field intensity at a point h meter from the disc along its axis. **(May 2010)(May 2009)(May 2014)**
16. State gauss law for the electric and magnetic fields. Derive its integral and differential forms. Make at least two conclusions?
17. Derive an expression for the electric field due to a straight and infinite uniformly charged wire of length 'L' meters and with a charge density of $+\rho$c/m at a point P which lies along the perpendicular bisector of wire. (16) **(May/ June 2013)(NOV/DEC2010) (Nov/Dec 2011) (Nov/ Dec 2009) (Nov /Dec 2006)**
18. (i) Find the electric field due to 'n' charges. (8) **(April/ May 2008)**

(ii) Establish the relationship between potential and electric field. (8) **(Nov/ Dec 2009)**

19. Describe any two applications of Gauss's Law. (8) **(Nov /Dec 2006)**

UNIT II
CONDUCTORS AND DIELCTRIC
PART-A (2 Marks)

1. Write the Poisson's and Laplace equations in all the three coordinates. Also mention its difference. **(Nov 2012) (Nov 2010) (May 2009) (May 2007) (Nov 2011)**

$$\text{Poisson's equation } \nabla^2 V = \frac{-\rho_v}{\varepsilon}$$

$$\text{Laplace Equation } \nabla^2 V = 0$$

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

$$\frac{1}{\rho}\frac{\partial}{\partial \rho}\rho\frac{\partial V}{\partial \rho} + \frac{1}{\rho^2}\frac{\partial^2 V}{\partial \varphi^2} + \frac{\partial V}{\partial z^2} = 0$$

$$\frac{1}{r^2}\frac{\partial}{\partial r}r^2\frac{\partial V}{\partial r} + \frac{1}{r^2\sin\theta}\frac{\partial}{\partial \theta}\sin\theta\frac{\partial V}{\partial \theta} + \frac{1}{r^2\sin^2\theta}\frac{\partial^2 V}{\partial \varphi^2} = 0$$

2. Obtain Poisson's equation from Gauss's law
   Poisson and Laplace equation easily derived from gauss law

$$\nabla . \cdot D = \nabla . \varepsilon E = \rho_v$$

$$E = -\nabla V$$

$$\nabla . \left(-\varepsilon E \right) = \rho_v$$

$$\nabla^2 V = -\frac{\rho_v}{\varepsilon}$$

3. What is displacement current? **(May 2014)**
   The displacement current is a result of time varying electric field. A typical example of such current is the current through a capacitor when an alternating voltage source is applied.

$$I_d = \int J_d . d\overline{S}$$

4. State the boundary conditions at the interface between two perfect dielectrics. **(May 2010) (Nov 2010)**
   Et undergoes no change on the boundary and it is said to be continuous across the boundary. Dn undergoes some changes on the boundary and it is said to be discontinuous across the boundary.

5. Define dielectric strength? **(May 2010)**
   The dielectric strength is the maximum electric field that a dielectric can tolerate or withstand without electrical break down.

6. Define B-H curve for classifying magnetic materials. **(Nov 2010) (May 2011)**
   The ratio between B and H may be constant for all values of H, especially in the cases of ferro magnetic materials. The characteristics curve showing the variation of flux density B and field intensity H is called magnetization curve.

7. Write the current continuity equation **(Nov 2008) (May 2012) (May 2011)**

$$\int J . d\overline{S} = -\frac{dQ}{dt}$$

8. Write the expression for energy stored in a conductor. **(Nov 2012)**

$$\text{Energy stored in a conductor } W = \frac{1}{2} \int DE . dV$$

9. What are the basic properties of a good conductor? **(Nov 2009)**
   A good conductor should have High conductance and zero resistance.
   A perfect conductor cannot contain an electric field within it.
10. What are the different types of magnetic materials?
    Diamagnetic material
    Ferro magnetic material
    Paramagnetic material
    Ferri magnetic material
    Super ferro magnetic material
11. Define Capacitance. **(May 2009) (Nov 2010)**

Capacitance C of the capacitor is defined as the ratio of the magnitude of the charge on one of the plates to the potential difference between them

C=Q/V

12. Write the expression for the energy density in electrostatic field?
    Electrostatic energy density We defined as

$$w_e = \frac{dW_E}{dv} = \frac{1}{2} \overline{D} \overline{E}$$

13. Express the value of capacitance for a coaxial cable?
    A coaxial capacitor is essentially a coaxial cable or coaxial cylinder capacitor. The

capacitance of a coaxial cable given as $C = \frac{2\pi\varepsilon L}{\ln\frac{b}{a}}$

14. What is meant by current density? **(Nov 2010)**

The current density at a given point is the current through a unit normal area at that point.

$$J = \sigma E$$

15. State the boundary conditions at the interface between dielectric and conductor?

No electric field exist within a conductor E=0 and $D_n = \rho_s$

16. State the principle of superposition of fields?

The principle states that if there are N charges Q1,Q2,...Qn located respectively at points with position vectors r1,r2...rN. the resultant force F on a charge Q located at point r is the vector sum of the forces exerted on Q by each charges Q1,Q2,... Qn.

17. Why the electrostatic potential is continuous at a boundary?

The Tangential component of E is continuous and the normal component of D is discontinuous at the boundary. So the electrostatic scalar potential is continuous at the boundary without any change.

PART-B (16 Marks)

1. Derive the boundary conditions of the normal and tangential components of electric field at the Inter face of two media with different dielectrics. (16) **(Nov 2008) (May 2014) (Nov 2014)**
2. Derive an expression for the energy stored and energy density in a capacitor. **(Nov 2014) (May 2009)**
3. Drive an expression for energy stored and energy density in an Electrostatic field (16) **(Nov 2014)**
4. a.Derive an expression for the capacitance of two wire transmission line. (8)
   b.Derive an expression for capacitance of co-axial cable. (8) **(May 2009) (Nov 2006)**
5. Find the expression for the cylindrical capacitance using Laplace equation. (16) **(Nov 2014)**
6. Derive an expression for the capacitance of a spherical capacitor with conducting shells of radius a and b. **(May 2009) (Nov 2006)**
7. Derive the expression for the continuity equation of current in differential form **(Nov 2011)**
8. Derive the expression for potential energy stored in the system of n-point charges. (16) **(Dec 2009)**
9. Derive an expression for Poisson and Laplace equations and also Derive an expression for the capacitance of parallel plate capacitor.**(May 2010) (Nov 2010) (May 2014)**
10. Solve the Laplace equation for the potential field in the homogenous region between the two concentric conducting spheres with radius a and b and v=0 at r=b and v=v_o at r=a; Find the capacitance between the two concentric spheres. (8) **(Apr 2011)**
11. A metallic sphere of radius 10cm has a surface charge density of 10nc. Calculate the energy stored in the system. And also state and explain the electric boundary conditions between two dielectrics with permittivity's e1 and e2 (16) **(Nov 2011)**
12. Derive the expression for the energy of a point charge distribution. Three point charges -1nc, 4nc, 3nc are located at (0, 0, and 0) (0, 0, and 1) (1, 0, and 0) respectively, Find the energy in the system. **(May 2010)**
13. Find the expression for the cylindrical capacitance using Laplace's equation. (16**) (Nov/ Dec 2009)**

14. Derive an expression for potential energy stored in the system of n point charges. (16) **(Nov/ Dec 2009)**

15. Derive an expression for the capacitance of a spherical capacitor consisting of two concentric spheres of radii a and b. (8) **(April/ May 2008)**

UNIT III

STATIC MAGNETIC FIELD
PART-A (2 Marks)

1. Define Lorentz law of force. **(Nov 2010)(Nov 2008) (May 2012)**
   The Lorentz force equation relates the mechanical force to electrical force. if the mass of the charged particle moving in E and B fields is m then

$$Fe = QE$$

$$Fm = Qu \times B$$

$$F = Fe + Fm$$

$$F = Q(E + u \times B)$$

2. State Biot-Savart Law. **(MAY 2010)(May 2009) (May 2006) (May 2014)(Nov 2009) (May 2008) (Nov 2011)**
   Biot- savart's law states that the differential magnetic field intensity dH produced a a point P by the differential current element Idl is proportional to the product Idl and the sine of the angle α between the element and the line joining P to the element and is inversely proportional to the square of the distance R between P and the element. $dH\alpha \frac{Idl\sin\alpha}{R^2}$

3. State Ampere's circuital law. **(Nov 2009) (Nov 2007) (May 2011) (Nov 2010)**
   Ampere's circuital law states that line integral of H rund a closed path is the same as the net current I_{enc} enclosed by the path.

$$\oint H.dL = I_{enc}$$

4. What is the difference between scalar and vector magnetic potential. **(Nov 2010)**
   Scalar potential associated with electrostatic field and vector magnetic potential associated with magnetic field.
5. List the applications of ampere's circuital law. **(May 2009)**
   It is used to find the magnetic field intensity due to infinitely long straight conductor, coaxial cable, toroid ad solenoid etc.,

6. What is magnetic dipole moment?
   The magnetic dipole moment is the product of current and area of the loop; its direction is normal to the loop.

$$m = ISa_n$$

7. Define magnetic vector potential. **(Nov 2014)**
   It is defined as that quantity whose curl gives the magnetic flux density
   Where A is the magnetic scalar potential

$$B = \nabla \times \overline{A}$$

$$A = \frac{\mu}{4\pi}\iiint \frac{J}{r} dr$$

8. Define flux density or energy density in a magnetic circuit? **(May 2012)**

Energy density, $W = \frac{1}{2}\overline{B}\overline{H}$

9. What is the relation between magnetic flux density and field intensity?

The magnetic flux density B and the field intensity H is related as

$$\overline{B} = \mu\overline{H}$$

10. Write down the magnetic boundary conditions? **(Nov 2010)**

Ht undergoes no change on the boundary and it is said to be continuous across the boundary.

Bn undergoes some changes on the boundary and it is said to be discontinuous across the boundary.

11. Give the force on a current element carrying 10A if the separation of two parallel plates is 1m? **(Nov 2010)**

9. Define magnetization vector? **(Nov 2011)**

The Magnetization M, in amperes per meter, is the magnetic dipole moment per unit volume

$$\overline{M} = \frac{\lim}{\Delta v \to 0} \frac{\sum_{k=1}^{N} m_k}{\Delta v}$$

10. Define magnetic field intensity **(Nov 2012) (May 2012)**

Magnetic field Intensity is defined as the change in enclosed current to the differential line along a path .

$$\overline{H} = \frac{dI}{dl}$$

If the charges are moving with constant velocities, a static magnetic field is produced. The intensity of the produced field s calculated using H

11. A Current of 3A flowing through an inductor of 100mH. What is the energy stored in inductor? **(May 2010)**

12. What is the relation between relative permeability and susceptibility? **(May 2012)**

Xm is a dimensionless quantity called magnetic susceptibility of the medium. It is more or less how susceptible the material is to a magnetic field.

$$\mu_r = 1 + x_m = \frac{\mu}{\mu_0}$$

13. Can a magnetic field exist in a good conductor if it is static or time varying? Explain.

An electrostatic field is produced by static or stationary charges and if the charges are moving with constant velocity, a static magnetic field is produced.
Hence a magnetic field doesn't exist in a good conductor if it is static.

14. Write down the equation for general integral and point form of Ampere's law?

Integral Form $\oint \overline{H}.d\overline{l} = I_{enc}$

Pint Form $\nabla \times \overline{H} = J$

15. Give the similarities between electrostatic and magnetic field?

Electrostatic field	Magnetic field
Electric field intensity E volts/m Magnetic flux density $D = \varepsilon E$ C/m2 Energy stored $\frac{1}{2}CV^2$	Magnetic field intensity H A/m Magnetic flux density $B = \mu H$ wem/m2 Energy stored is $\frac{1}{2}LI^2$

PART- B (16 Marks)

1. Derive the expression for magnetic field intensity and magnetic flux density due to finite and infinite line. (16) **(May 2010) (Nov 2010) (May 2012)**
2. Derive the expressions for magnetic field intensity and magnetic flux density due to circular coil. (16)**(Nov2010) (Nov 2009)**
3. State Ampere's circuital law and explain any two applications of Ampere's Circuital law. (8) **(May 2010)**
4. Derive the magnetic field intensity developed in a triangular closed circuit carrying current I in a uniform field. (8) b. State Ampere's circuital law and explain any two applications of Ampere's Circuital law. (8) **(Nov 2014)**
5. 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 (16) **(April 2011)**
6. 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. (16) **(Nov 2011)**
7. Derive the expression for curl H=J? (Nov 2008) **(May 2014)**

8. 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 **(May 2010) (Nov 2008) (May 2012) (Apr 2011)**
9. State and explain ampere circuital law **(May 2009) (May 2014)**
10. Obtain an expression for magnetic vector potential **(May 2009) (Nov 2012) (May 2010) (Dec 2010)**
11. 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 (16) **(Dec 2010)**
12. An iron ring with a cross sectioned of 3 cm2 and a mean circumference of 15 cm is wound with 250 turns wire carrying a current of 0.3A. The relative permeability of the ring is 1500. Calculate the flux established in the ring?
13. Find the magnetic field at the centre of a square loop which carries a steady current I. let R is the distance from centre to side. Find the field at the centre of the n-sided polygon carrying a steady current I. Again, let R be the distance from the centre to any side. Find the formula in the limit n tends to infinity. Find the magnetic field a distance h above the center of a circular loop of radius R, Which carries a steady current I. (16) **(May 2014) (Nov 2012)**
14. 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. (r, pi, z) **(Nov 2011)**
15. Obtain the expression for scalar and vector magnetic potential.(8) (Apr/May 2010). (April/ May 2008)

UNIT- IV
MAGNETIC FORCES AND MATERIALS
PART-A (2 Marks)

1. Define magnetic moment **(May 2009) (May 2007) (Nov 2014)**
   Magnetic moment is defined as the maximum torque per magnetic induction
   m=T/A or m=IA
2. What is solenoid? **(Nov 2008)**
   Solenoid is a coil wounded core of N number of turns carrying the current I. If B is the flux density and 'A' is the area of cross section of the solenoid. Then the inductance of the solenoid is given as $L = \frac{\mu N^2 I}{l}$
3. Give the torque experienced by a current carrying loop placed in a magnetic field? **(May 2010)**
   The torque T on the loop is the vector product of the force **F** and the moment arm **r.**
   $$T = r \times F$$
   $$T = BIS \sin\alpha$$
4. What is field due to toroid and solenoid?
   Toroid $B = \frac{\mu_0 NI}{l}$ & Solenoid $B = \frac{\mu_0 NI}{l}$ both are same.
5. Define self inductance **(Nov 2008)**
   The self inductance of a coil is defined as the ratio of total magnetic flux linkage with the circuit to the current through the coil.
   $$L = \frac{\phi}{I}$$
6. Define Mutual Inductance.
   The mutual inductance between two coils is defined as the ratio of induced magnetic flux linkage in one coil to the current through the other coil.
   $$M = \frac{N_2 \phi_{12}}{I_1}$$
7. Define Polarization in dielectrics. **(Nov 2010) (May 2012)**
   A dipole results from the displacement of the charges and the dielectric is said to be polarized
   Polarization $P = \frac{\lim}{\Delta v \to 0} \frac{\sum_{K=1}^{N} Q_k d_k}{\Delta v}$
8. Give the expression for inductance per unit length of a coaxial transmission line
   $$L = \frac{\mu_0}{2\pi} \ln\left(\frac{b}{a}\right)$$
   Where a is the radius of inner conductor
   b is the radius of outer conductor
9. Distinguish between diamagnetic, paramagnetic and ferromagnetic materials.
   In diamagnetic materials, magnetization is opposed to the applied field.
   In paramagnetic materials, magnetization is in the same direction as the field.
   In Ferromagnetic materials, magnetization is in the same direction as the field.
10. Define magnetic dipole.
    A bar magnet or a small filamentary current loop is usually referred to as magnetic dipole
    The B lines due to a magnetic dipole are similar to the E lines due to an electric dipole.
11. Define relative permeability.
    The dimension less quantity μ_r is the ratio of the permeability of a given material to that of free space and is known as the relative permeability of the material.

12. State the boundary conditions of magnetic field.
    The tangential component of H is continuous while that f B is discontinuous at the boundary
13. Define magnetostatic energy density.
    The magnetstatic energy density w_m is defined as

$$w_m = \frac{1}{2} B.H$$

14. Define magneto motive force (mmf).
    We define magneto motive force as $f = NI = \oint H.dL$
    The source of mmf in magnetic circuits is usually a coil carrying current.
15. Define Reluctance and Permeance.
    Reluctance defined as ampere turns per weber as

$$R = \frac{l}{\mu S}$$

    Where l and s are, respectively, the mean length and the cross sectional area of the magnetic core. The reciprocal of reluctance is permeance.

16. What is the mutual inductance of two inductively tightly coupled coils with self inductance of 25mH and 100 mH ?

PART-B (16 Marks)

1. A plane wave propagating through a medium with εr=8, μr=2 has E=0.5 sin (108t-βz) az v/m. Determine β The loss tangent, Wave impedance Wave velocity of Magnetic field (16) **(Nov 2008)**
2. Derive a wave equation for non dissipative medium making use of Maxwell equations and field Vectors E and H. (16) **(May 2014) (Nov 2012)**
3. A plane sinusoidal electromagnetic wave traveling in space has Emax=150μV/m.
   (i)Find the accompanying Hmax
   (ii)Propagation is in X direction and H is oriented in Y direction. What is the direction of E. And Compute the average power transmitted. (16) **(April 2010)**
4. Derive an expression for force between two current carrying conductors. (8) **(May/ June 2013)**
5. An iron ring with cross sectional area of 3cm square and mean circumference of 15cm is wound with 250 turns wire carrying a current of 0.3 A. the relative permeability of ring is 1500. Calculate the flux established in the ring. (8) **(May/ June 2013)**
6. Derive the expression for coefficient of coupling in terms of mutual and self inductances
7. Derive an expression for force between two current carrying conductors (8) **(May/ June 2011)**
8. Derive the expression for torque developed in a rectangular closed circuit carrying current I in a uniform field. (8)
9. (i) Derive an expression for torque on a closed rectangular loop carrying current. (8) **(April/ May 2008)**
   (ii) Using ampere's circuital law. Derive the magnetic field intensity due to a coaxial cable carrying a steady current I. (8) **(April/ May 2011**)
10. Find the force exerted between current carrying conductors kept in '1' meter distance and carries the current in same direction. (8) **(April/ May 2008)**

11. Derive the expression for energy stored and energy density in the magnetic field.(8) **(April/ May 2008)**

12. (i)Derive the expression for inductance of a toroidal coil carrying current.(8)

    (ii)A Solenoid is 50cm long, 2cm in diameter and contains 1500 turns. The cylindrical core has the diameter of 2cm and relative permeability of 75.This coil is co-axial with the second solenoid, also 50cm long, but 3cm diameter and 1200 turns. Calculate L for the inner solenoid; and L for the outer solenoid.(8). **(Nov/Dec 2010).**

13. i) Derive an expression for the inductance of solenoid. (8) **(Nov/Dec 2011)**
    ii) Derive the boundary conditions at an interface between two magnetic medias. (8**) (April/ May 2010) (Apr/May 2010)(April/ May 2008)**

14. Find the permeability of the material whose magnetic susceptibility is 49 also find, if the inner and outer conductors of a co axial cable are having radii a and b respectively If the inner conductor is carrying current I and outer conductor is carrying the return current I in the opposite direction. Derive the expressions for the internal and external inductance (16) **(April 2011)**

15. Derive the expression for the inductance of a toroidal coil (solenoid) with N turns, carrying current I and the radius of the toroid R. Also considering a toroidal coil derive an expression for energy density. (16) **(Nov 2012) (May 2012) (April 2009) (Nov 2010)**

16. A solenoid has an inductance of 20 mH If the length of the solenoid is increased by two times and the radius is decreased to half of its original value, find the new inductance **(May 2009)**

17. Derive the boundary conditions of the normal and tangential components of magnetic field at the inter face of two media with different dielectrics. (16) **(Nov 2014)**

18. a. Derive the expression for co-efficient of coupling. (8)
    b.Also using the concept of magnetic vector potential, derive Biot Savart's law and amperes law? **(May 2010)(May 2012)**

19. A small loop wire lays a distance z above the center of a large loop. The planes of the two loops are parallel, and perpendicular to the common axis. Suppose current I flows in the big loop. Find the flux through the little loop. Find the mutual inductance. (16) **(May 2014)**

20. A positive charge Qv c/m^3 occupies the volume of a sphere. At a point in the interior at a distance of r from the centre, a small probe of charge of +q is inserted. What is the force acting on the probe charge?

UNIT- V
TIME VARYING FIELDS AND MAXWELL'S EQUATIONS
PART-A (2 Marks)

1. State Faraday's law of induction. **(May 2009) (Nov 2012) (May 2012)**
   Faraday's law States that the induced emf, Vemf, in any closed circuit is equal to the time rate of change of the magnetic flux linkage by the circuit

$$V_{emf} = -\frac{d\lambda}{dt}$$

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

$$V_{emf} = -\frac{d\phi}{dt}$$

3. What is motional electric field?
   When a conducting loop is moving in a static **B** field, an emf induced in the loop, the motional emf

$$E_m = u \times B$$

4. Write Maxwell's equation in point and integral form. **(Nov 2010) (Nov 2009) (Nov 2011)**

$$\nabla \times E = -\frac{\partial B}{\partial t}; \oint E.dl = -\frac{\partial}{\partial t}\int B.ds$$

$$\nabla \times H = J + \frac{\partial D}{\partial t}; \oint H.dl = \int J + \frac{\partial D}{\partial t}.ds$$

$$\nabla \cdot D = \rho_v; \oint D.dS = \oint \rho_v.dv$$

$$\nabla \cdot B = 0; \oint B.dS = 0$$

5. What is motional emf?
   An emf is called motional emf or flux cutting emf because it is due to motional action that is a conducting loop moving with uniform velocity **u** as consisting of a large number of free electrons.

6. What is Brewster angle? **(May 2010) (Nov 2008)(Nov 2014) (Nov 2012) (Nov 2009) (May 2008)**
   The Brewster angle is also known as the polarization angle because an arbitrarily polarized incident wave will be reflected with only the component of E perpendicular to the plane of incidence.

7. Define skin depth/effect? **(May 2010) (May 2014) (May 2011) (Nov 2011)**
   The skin depth is a measure of the depth to which an EM wave can penetrate the medium.

$$\delta = \frac{1}{\sqrt{\pi f \mu \sigma}}$$

8. State Pointing Theorem. **(May 2010) (Nov 2008) (May 2009) (May 2008)(Nov 2014) (May 2011)**
   Poynting's theorem states that the net power flowing out of a given volume v is equal to the time rate of decrease in the energy stored within v minus the ohmic losses.

9. What is time varying harmonic field?
   A time harmonic field is one that varies periodically or sinusoidal with time.

10. State the flux rule for a nonrectangular loop moving through a non uniform magnetic field. **(May 2014)**
    Whenever a conductor moving in a uniform magnetic field an emf induced in that conductor due to the flux linkage change while moving.
    An induced emf is directly proportional to the flux linkage.

11. Give the situations when the rate of change of flux results in a non-zero value. **(May 2011)**
    The rate of change of flux results in non zero when

a. A stationary loop in a time varying field
b. A time varying loop in a static field
c. A time varying loop in a time varying field.

d.

12. Write Maxwell's equation of time varying fields. **(Nov 2010)**

$$\nabla \times E_s = -j\omega B_s ; \oint E_s.dl = -j\omega \int B_s.ds$$

$$\nabla \times H_s = J_s + j\omega D_s ; \oint H_s.dl = \int J_s + j\omega D_s.ds$$

$$\nabla \cdot D_s = \rho_v ; \oint D_s.dS = \oint \rho_v.dv$$

$$\nabla \cdot B_s = 0; \oint B_s.dS = 0$$

13. What is the electric field and power flow in the co axial cable? **(Nov 2011)**

$$\text{Electric field } E = \frac{V}{r \ln\left(\frac{b}{a}\right)} \qquad \text{Power flow } \overline{P} = \overline{E} \times \overline{H}$$

14. For a loss dielectric material having μr=1, ε r=48, σ=20s/m. calculate the propagation constant at a
Frequency of 16 GHz

15. Mention the properties of uniform plane wave.**(Nov 2010)**

a. At every point in space, the electric field E and magnetic field H are perpendicular to each other and to the direction of the travel
b. The fields vary harmonically with time and at the same frequency, everywhere in space.
c. Each field has the same direction, magnitude and phase at every point in any plane perpendicular to the direction of the wave.

16. Define intrinsic impedance or characteristic impedance? **(May 2012)**

It is defined as the ratio of the electric field to the magnetic field.

$$\eta = \frac{E}{H} = \sqrt{\frac{\mu}{\varepsilon}}$$

17. Write down the expression for instantaneous power flow in electromagnetic field and instantaneous Pointing vector? **(Nov 2012)**

Instantaneous power $w = |V||I|\cos(\omega t + \theta_v) + \cos(\omega t + \theta_i)$

Instantaneous Pointing vector $\overline{P}_{av} = \frac{1}{2} I_m |\overline{E} \times \overline{H}^*|$

18. Write the two dimensional wave equations for a wave travelling in z direction **(May 2012)**

$$\nabla^2 E - \mu\varepsilon \frac{\partial^2 E}{\partial t^2} - \mu\sigma \frac{\partial E}{\partial t} = 0$$

$$\nabla^2 H - \mu\varepsilon \frac{\partial^2 H}{\partial t^2} - \mu\sigma \frac{\partial H}{\partial t} = 0$$

19. Determine the voltage reflection coefficient at the load end of a transmission **(Dec 2012)**

The voltage reflection coefficient at any point on the line is the ratio of the reflected voltage wave to that of the incident wave. $\Gamma(z) = \frac{V_0^-}{V_0^+} e^{2\gamma z}$

PART-B (16 Marks)

1. Derive the Maxwell's equation in differential and integral forms (16) **(May 2010) (Nov 2008) (May 2014)(Nov 2014) (May 2009)**

2. Derive Maxwell's four equations in point form and in differential form (16) **(Dec 2009)**

3. A. What is the physical significance of the pointing vector? And explain it in detail? Derive the expression for total power flow in coaxial cable? (16) **(Nov 2012) (Nov 2014)**

4. Derive general field relations for time varying electric and magnetic fields using Maxwell's equation? **(May 2010)**
5. Explain briefly about the motional emf and derive an expression for it?
6. Discuss the pointing vector and pointing theorem?**(Nov 2008) (May 2014) (Nov 2012)(May 2011)**
7. 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. **(May 2010)(May 2014) (May 2012)**
8. Define Brewster angle and derive its expression?
9. Derive the relationship between electric and magnetic fields?
10. Explain complex, average and instantaneous poynting vector. (16) **(May 2012) (Dec 2009)**
11. Explain the following terms: Motional emf and transformer emf, also find the amplitude of displacement current density in the air near car antenna where the field strength of FM signal is $E = 80 \cos (6.227 \times 10^8 t - 2.092y) a_z$ **(May 2009)**
12. Generate Ampere's law for time varying fields. Also list the Maxwell's equations in integral and point form for free space conditions **(Nov 2010)**
13. Derive an expression for displacement current density J_d, and also give the physical interpretation of Maxwell's equation. **(Nov 2011)**