Chettinad College of Engineering & Technology
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Academic Year 2024 - 2025

Question Bank

Year/Semester:II/ III	Department : EEE Subject Code/Title: EE3301 / Electromagnetic Field Faculty Name :Mrs.A.Bhuvaneswari	Unit : I/II/III/IV/V Section : Part A/B

UNIT I ELECTROSTATICS – I

Part-A

1. Obtain in the Cylindrical Co-ordinate System the Gradient of the function: f(r, ,z)=5r^{4}z$^{3\sin\theta}$.(AU M/J 2012)

$$\nabla.F = \frac{1}{r}\frac{\partial(5r^4z^3\sin\theta)}{+\partial r}\overline{a_r}\quad \frac{\partial(5r^4z^3\sin\theta)}{a_\phi + \partial\phi}\quad \frac{\partial(5r^4z^3\sin\theta)}{\partial z}\overline{a_z}$$

$$= 20z^3r^2\sin\theta\overline{a_r} + 5z^3r^4\sin\theta\overline{a_y} + 15z^2r^4\sin\theta\overline{a_z}$$

2 . State stokes theorem. (AU M/J 2012,&2014,NOV/DEC 2013)

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

$$\oint H.dl = \oiint_s \nabla X H\, ds$$

3.Mention the sources of electromagnetic field? (AU-M/J 2013)

The sources of EMF are electrical lighting and appliances, computer monitors, microwave ovens, radios, TV, Cellular phones, broadcast stations, overhead lines and communication satellites.

4.State the physical significance of curl of a vector field? (AU-M/J 2013)

(∇XH) = 0. The physical significance of the curl of a vector field is the curl provides the

maximum value of the circulation of the field per unit area indicates the direction along which this maximum value occurs. The curl of a vector field A at a point P may be regarded as a measure of the circulation or how much the field curls around P.

5.How is the unit vectors defined in cylindrical coordinate systems? (AU N/D 2013)

i. A unit vector is a dimensionless quantity of unit magnitude.

ii. The coordinates are r, ϕ and z are the units vector

$$= \begin{bmatrix} a_\rho \\ a_\Phi \\ a_z \end{bmatrix} \begin{bmatrix} \cos\Phi & \sin\Phi & 0 \\ -\sin\Phi & \cos\Phi & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} a_x \\ a_y \\ a_z \end{bmatrix}$$

6.State the condition for the vector A to be (a) solenoidal (b) irrotational. (AU N/D 2012)

(a) $\nabla \bullet A = 0$ (b) $\nabla \times A = 0$

7. 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.

8.Define divergence

The divergence of a vector F at any point is defined as the limit of its surface integral per unit volume as the volume round the point shrinks to zero

$$\nabla . A = \underset{V \to 0}{Lt} \oint A . \vec{n} \, ds \frac{1}{v}$$

9.What are a scalar field and a vector field?

If at every point in a region, a scalar function has a defined value, the region is called a scalar field. Example: Temperature distribution in a rod.

If at every point in a region, a vector function has a defined value, the region is called vector field. Example: velocity field of a flowing fluid.

10.Define Scalar and Vector and give examples.

A scalar is a quantity that is completely characterized by its magnitude and algebraic sign. Eg. Mass, Work, etc. A Vector is a quantity that is completely characterized by its magnitude and direction. Eg. Force, Displacement, etc.

11.Give the types of vectors with examples.

There are two types of Vectors: Localized vectors and free vectors. Localized vectors are those for which the point at which the vector acts should also be specified whereas a free vector doesn't have such restriction. Eg. Force (Localized), Couple (Free).

12.Define a unit vector and its value in Cartesian coordinate axis.

Unit vector is having magnitude and directed along the coordinates axis.

For Cartesian coordinates $A=A_xa_x+A_ya_y+A_za_z$ where a_x, a_y and a_z are unit vectors in the direction of x,y and z respectively.

13.What are the different types of coordinate systems?

a. Rectangular or Cartesian Coordinate Systems

b. Cylindrical Coordinate Systems

c. Spherical Coordinate Systems

14.State Coulomb's law.

Coulombs' law states that the force between two point charges is directly proportional to the product of magnitudes of the charges and inversely proportional to the square of the distances between the charges. The force is also dependent upon the medium in which the charge is placed. Q_1, Q_2 are point charges.

r – is the distance between two charges.

K – is a constant of proportionality and it depends on permittivity of the medium and is given by,

$\varepsilon_0 = 8.854 \times 10^{-12}$ F/m

$k = 9 \times 10^9$ m/F

15.State Gauss's law and give expression.

The Gauss's law states that the surface integral of the Electric field vector E over any closed surface in free space is given by Q/ε_0, where Q is the total charge enclosed by the surface.

16.Name few applications of Gauss law in electrostatics (AU NOV/DEC 2013)

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.

17.Write the expression for differential length in cylindrical and spherical co-ordinates.

For cylindrical coordinates $dl = [(d\rho)^2 + (\rho d\phi)^2 + (dz)^2]^{1/2}$

For spherical coordinates $dl = [(dr)^2 + (rd\theta)^2 + (r\sin\theta\, d\phi)^2]^{1/2}$

18.Give the prosperities of vectors.

Vectors can exist at any point in space. Vectors have both magnitude and direction.

Any two vectors that have the same direction and magnitude are equal no matter where they are located in space, this is called vector equality.

19.What is Unit Vector? What is function while representing vector?

a. A Vector which has magnitude unity and defining the same direction as given vector.
   i. Vector addition obeys commutative law A +B = B +A
   ii. Vector addition obeys associative law A + (B +C) = (A + B) + C
b. - A is also a vector. It has same magnitude; its direction is 180º away from direction of A. A –B = A + (- B)

20. **Show that the vector $H = 3y^4z^2\, a_x + 4x^3z^2 a_y + 3x^2y^2 a_z$ is solenoid**

$$\nabla . H = 0$$

$$y^4z^2) + \quad (4x^3z^2) + \quad (3x^2y^2) = 0$$

21. Points P and Q are located at (0,2,4) and (-3,1,5). Calculate the distance vector from P to Q. (AU-N/D2014)

$$r_Q - r_P = (-3 - 0)\bar{a}_x + (1 - 2)\bar{a}_y + (5 - 4)\bar{a}_z = -3\bar{a}_x - \bar{a}_y + \bar{a}_z$$

22. **Determine the electric flux density at a distance of 20 cm due to an infinite sheet of uniform charge 20μC/m2 lying on the z=0 plane. (AU-N/D2014)**

$$E = \frac{\rho_s}{2\varepsilon}(1 - cos\alpha)$$

$$= \frac{20X10^{-6}}{2X8.854X10^{-12}}(1 - \cos 90)$$

$$= 1.29X10^6\ V/m$$

23. Given $A = 4a_x + 6a_y - 2a_z \; and \; B = -2a_x + 4a_y + 8a_z$ **. Show that the vectors are orthogonal.**

$$\bar{A}.\bar{B}\ should\ be\ equal\ to\ zero$$

$$\bar{A}.\bar{B} = -8 + 24 - 16 = 0$$

Hence the vectors A & B are orthogonal

24. Express in matrix form the unit vector transformation from the rectangular to cylindrical co-ordinate system.

$$= \quad \begin{bmatrix} a_\rho \\ a_\Phi \\ a_z \end{bmatrix} \begin{bmatrix} cos\Phi & sin\Phi & 0 \\ -sin\Phi & cos\Phi & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} a_x \\ a_y \\ a_z \end{bmatrix}$$

PART-B

1. Points P and Q are located at (0,2,4) and (-3,1,5). Determine the distance vector from P to Q.
2. Derive the expression for electric field intensity due to an uniformly charged infinitely long straight line with constant charge density in C/m.
3. State the conditions for a vector A to be (a) solenoidal (b) irrotational.
4. Mention the criteria for choosing an appropriate coordinate system for solving a field problem easily. Explain with an example.
5. Find E' due to infinite sheet of charge placed in xy plane and having uniform surface charge density of ρs C/m^2
6. Derive the expression for electric flux density due to an uniformly charged circular ring with constant charge density in C/m.

UNIT II ELECTROSTATICS – II

PART-A

1.What is Electric potential? (AU NOV/DEC 2013)

The Electric potential is a scalar quantity and is found to be equal to the work done per unit charge in moving a test charge against the field from a reference point, say from infinity to its final position.

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

$D_{n1} = D_{n2}$

$E_{t1} = E_{t2}$

3.Define potential difference. (AU NOV/DEC 2013)

Potential difference is defined as the work done in moving a unit positive charge from one point to another point in an electric field.

4.State Poisson's and Laplace's Equation. (AU MAY/JUNE 2014)

Poisson 's eqn: $\nabla^2 V = -\rho_v / \varepsilon$

Laplace' s eqn: $\nabla^2 V = 0$

5.State the properties of electric flux lines (AU-A/M 2013, N/D2014)

It is independent of the medium

Its magnitude depends only upon the charge from which it is originated

If a point charge in enclosed in an imaginary sphere of radius R, the electric flux must pass perpendicularly and uniformly through the surface of the sphere.

6.A dielectric slab of flat surface with relative permittivity 4 is disposed with its surface normal to a uniform field with flux density 1.5 C/m2. Th slab is uniformly polarized. Determine polarization in the slab. (AU-A/M 2013)

Polarization $P = \Psi\varepsilon_o E$, $D = \varepsilon_o\varepsilon_r E$, $\Psi = \varepsilon_r - 1$

$P = \frac{\varepsilon r - 1}{\varepsilon r} = \frac{4-1}{4} \times 1.5 = 1.125$ C/ m^2

7.Show that $\nabla . E = 0$ in case of apoint charge.(AU- M/J 2012)

r for point charge, then $\nabla . E = 0$

8.At the boundary between copper and aluminum the electric field lines maked as an angle of 45o with the normal to the interface. Find the angle of emergence. The conductivity of copper and aluminum are 5.8 x 105 S/cm and 3.5 X 105 S/cm, receptively (AU- M/J 2012)

$\frac{\tan\theta_1}{\tan\theta_2} = \frac{\varepsilon_1}{\varepsilon_2}$ **$\theta 2 = 31.10o$**

9.Give the expression for Electrostatic energy.

Let W_E be the energy stored in static electric field of charge distribution. If the field has 'n' point charges, then

$$W_E = \frac{1}{2}\sum_{m=1}^{m=n} Q_m V_m \quad \text{Joules}$$

where Q_m is the charge of m^{th} point charge and V_m is the potential at point 'm'.

10.What is a parallel plate capacitor?

A parallel plate capacitor is a capacitor with two parallel conducting plates separated by a distance 'd'. The region between the plates contains a dielectric. When a potential V is applied the positive charges get stored in the upper plate and negative charges get stored in the lower plates.

11.What is Capacitance? Give expression.

The ratio of the absolute value of the charge to the absolute value of the voltage difference is defined as the capacitance of the system.

12.State Gauss law for magnetic field.

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

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.

$V=Q / 4 \pi\varepsilon r$

13.Write poisson's and laplace 's equations.

Poisson 's eqn: $\nabla^2 V = -\rho_v / \varepsilon$

Laplace' s eqn: $\nabla^2 V = 0$

14.What are the significant physical differences between Poisson 's and laplace 's equations? (AU-N/D2014)

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 in a known distribution ρ_v poissons equation can be used to find the potential. When the region is free from charge (ρ=0) laplace equation is used to find the potential.

15.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. E.dl = 0

16.Define Dipole

The equal and opposite charges are separated by a small distance is called Dipole.

Define Dipole Moment

The product of charge and spacing between the poles is called dipole moment M= Q.d

17.Define Polarization

Polarization is defined as the dipole moment per unit volume. P = Ql/V
Define dielectric strength of material.
The dielectric strength of a material is defined as the maximum value of electric field that can be applied to the dielectric without its electric breakdown.

18.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.

19.Show that $\nabla . E = 0$ in case of apoint charge.(AU- M/J 2012)

E = r $\frac{Q}{4\pi\varepsilon r^2}\vec{a}$

for point charge, then $\nabla . E = 0$

20.At the boundary between copper and aluminum the electric field lines maked as an angle of 45o with the normal to the interface. Find the angle of emergence. The conductivity of copper and aluminum are 5.8 x 105 S/cm and 3.5 X 105 S/cm, receptively (AU- M/J 2012) $\frac{\tan\theta_1}{\tan\theta_2}$ $\frac{\varepsilon_1}{\varepsilon_2}$

= θ_2 = 31.10°

21.Give the Poisson's equation in Cartesian, Cylindrical and Spherical co-ordinate systems.

Poisson Equation in Cartesian co-ordinates

$$\nabla^2 V = \frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2} = -\frac{\rho}{\varepsilon}$$

Poisson Equation in Cylindrical co-ordinates

$$\nabla^2 V = \frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial V}{\partial r}\right) + \frac{1}{r^2}\frac{\partial^2 V}{\partial \phi^2} + \frac{\partial^2 V}{\partial z^2} = -\frac{\rho}{\varepsilon}$$

Poisson Equation in Spherical co-ordinates

$$\nabla^2 V = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial V}{\partial r}\right) + \frac{1}{r^2\sin\theta}\frac{\partial}{\partial \theta}\left(\sin\theta\frac{\partial V}{\partial \theta}\right) + \frac{1}{r^2\sin^2\theta}\frac{\partial^2 V}{\partial \phi^2} = -\frac{\rho}{\varepsilon}$$

PART-B

1. **1.** Deduce an expression for the capacitance of parallel plate capacitor having two identical media.
2. **2.** (i)State and derive electric boundary condition for a dielectric to dielectric medium and a conductor to dielectric medium.

   (ii)Derive the expression for energy density in electrostatic field.
3. **3.** Find the potential at any point along the axis of a uniformly charged disc.
4. **4.** Obtain an expression for the capacitance of a parallel plate capacitor with two dielectrics of relative permittivity and respectively interposed between the plates.
5. **5.** Explain electric dipole. Derive the expression for the electric field intensity and potential due to an electric dipole at any point P.
6. **6.** A Parallel plate capacitor has a plate separation t. The capacitance with air only between the plates is C. When a slab of thickness t' and relative permittivity ε' is placed on one of the plates.

Unit III- MAGNETOSTATICS

1.What is Lorentz law of force?(AU NOV/DEC 2013)

The Lorentz force equation gives the force on a charge Q moving in a region where both the electric field E and magnetic field B are present.

$F = Q\ E + v \times B$ N

Where v is the velocity with which the charge moves in the field.

2. State Ampere's Circuital law (AU MAY/JUNE 2014) (AU-M/J 2012)

The Ampere's law states that the line integral of H around a single closed path is equal to the current enclosed. It can also be stated as the line integral of B around a single closed path is equal to the permeability of the medium times the current enclosed.

3. Write down the magnetic boundary condition. (AU NOV/DEC 2013)

The normal component of flux density B is continuous across the boundary. The tangential component of field intensity H is continuous across the boundary .

4. Write the expression for inductance per unit length of a long solenoid of N turns and having a length 'l' mtr carrying a current of I amperes (AU-M/J 2014)

Inductance $L = \frac{\mu_o\ N^2 A}{l}$ where N- no of turns, A- area of cross section of the solenoid in m2 , llength of a solenoid in meter.

5. Write the expression for the magnetic force between an electromagnet and an attracted armature relay. (AU-M/J 2013)

$F = \frac{B^2 A}{2\mu_0}$ K gm f, where B- magnetic flux density in tesla

6. What is the torque on a current carrying loop?

The torque, or moment, of a force is a vector whose magnitude is the product of the magnitudes of the vector force, the vector lever arm, and the sine of the angle between these two vectors. The direction of the vector torque is normal to both the force and lever arm.

7. Define magnetic field strength.

The magnetic field strength (H) is a vector having the same direction as magnetic flux density.

H=B/μ 12.

8. Define inductance.

The inductance of a conductor is defined as the ratio of the linking magnetic flux to the current producing the flux. L = Nφ / I

9. Define magnetic vector potential.

It is defined as that quantity whose curl gives the magnetic flux density.

B=▼ x A=μ / 4πJ/r dv web/m^2

10. What is the practical significance of Lorentz's force? (AU-A/M2015)

Lorentz's force equation relates mechanical force to the electrical force. If the mass of the charge is m, then

$$F = m\bar{a} = m\frac{dv}{dt} = Q(\bar{E} + \bar{V}X\bar{B})Newton$$

11. Define Mutual inductance and Self inductance.

Mutual Inductance: It is defined as the ratio of induced magnetic flux linkage in one coil to the current through the other coil.

$$M = N_1\frac{\Phi_{21}}{I_2} \qquad M = N_2\frac{\Phi_{12}}{I_1}$$

Self inductance: It is the property of a circuit by which change in current induces emf in the circuit to oppose the change in current.

$$L = \frac{N\Phi}{I}\ H$$

12. Write down magnetic boundary conditions.(May/June 2016)

The normal components of flux density vector B is continuous across the boundary but the normal components of field intensity vector H is discontinuous at the boundary

$$\frac{H_{N1}}{H_{N2}} = \frac{\mu_2}{\mu_1} = \frac{\mu_{r2}}{\mu_{r1}}$$

b. The tangential component of field intensity vector H is continuous across the boundary but the tangential components of flux density vector B are discontinuous at the boundary.

$$\frac{B_{t1}}{B_{t2}} = \frac{\mu_1}{\mu_2} = \frac{\mu_{r1}}{\mu_{r2}}$$

13. **Define the terms: Magnetic Moment and Magnetic Permeability. (May 2010)**

The magnetic moment of a current loop is defined as the product of current through the loop (I) and area of the loop (S), directed normal to the current loop.

14.What are major classifications of magnetic materials?

On the basis of the magnetic behavior, the magnetic materials is classified as diamagnetic, paramagnetic, anti-ferromagnetic, ferro magnetic and super magnetic.

15. **Find the maximum torque on an 100 turn rectangular coil,0.2m by 0.3m,carrying a current of 2A in the field of flux density 5W/m^2 (April/May2015)**

Given:

N= 100

A=0.2×0.3=0.06m^2

I=2A

B=5W/m^2

T_{max} = NIAB

=100×2×0.06×5

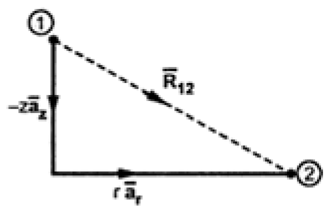
=60N-m

PART-B

1. **Obtain the flux density produced by an infinitely long straight wire carrying a current I at any point at a distant „r" normal to the wire.**
Derive the expression for magnetic field intensity due to infinitely long straight conductor carrying a current of I amps along Z- axis.(Nov/Dec 2016)

Consider an infinitely long straight conductor along z axis. The current passing through the conductor is a direct current I Amp. The field intensity at a point P is to be calculated which is at a distance „r" from z axis.

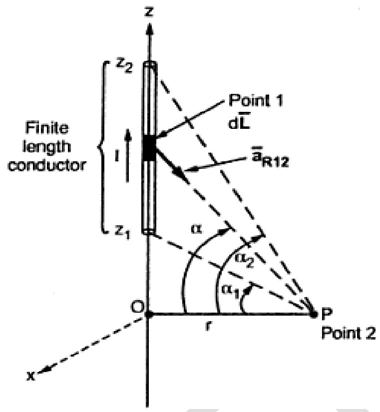
Considering a differential element at point 1, given as



The distance vector joining point 1 and point 2

2.Find the magnetic field intensity at a point P due to a finite straight conductor, carrying a current I using Biot-savarts law.(Dec 2010)
(April/May 2017)

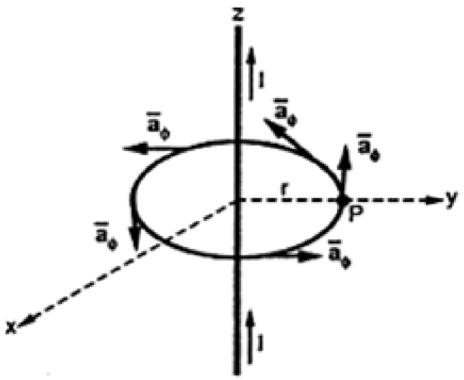
Obtain an expression for magnetic flux density and magnetic field intensity at any point due to a finitelength conductor.(May 2016)



Consider the conductor of finite length placed along z axis. It carries a direct current I. The perpendicular distance of point P from z- axis is „h" as shown in figure.Consider a differential element dLalong z axis, at a distance „z" from the origin, which is given as

3. State and explain Ampere"s circuital law using mathematical expression for finding magnetic flux density due to current I.(May 2010,)(April/May 2017)

Ampere"s circuital law:



It states that the lines integral of magnetic field intensity around a closed path is exactly equal to the direct current enclosed by the path.

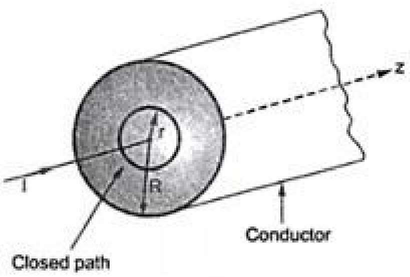
$\oint$

Proof of Ampere"s circuital law:
Consider a long straight conductor carrying direct current I placed along z axis as show in figure. Consider a closed circular path of radius „r" which encloses the straight conductor carrying direct current I. The point P is at perpendicular distance „r" from the conductor. Consider differential element d at point P which is in direction tangential to circular path at point P.

4. Obtain the expression for in the regions of a cylindrical conductor carries a direct current I and its radius is „R" m. Plot the variation of against the distance R from the center of the conductor. (Jun 2007, May 2013) (Nov / Dec 2014) (Nov / Dec 2016)

Let the cylindrical conductor of radius R, carries a uniform direct current of „I" A. It is placed along z axis and has infinite length. is to be obtained considering two regions.

Region 1: Within the conductor r <R



- Consider the closed path of radius r within the conductor.
- As current I flows uniformly, it flows across the cross sectional area of .
- But the closed path encloses only part of the current which passes across the cross sectional area of
- Hence current enclosed by the path,
- H has only component and it is the function of r only hence,

5. Derive the expression for energy stored in magnetic field and energy density in the magnetic field.(May 2013,Dec 2012)

6. Derive the boundary conditions at an interface between two magnetic media. (May‟10) or Consider the boundarybetween two media. Show that the angles between the normal to the boundary and the magnetic flux densities oneither side of the boundary satisfy the relation

Where μ_1 and μ_2 are the permeability‟s of the respective media and θ_1 and θ_2 are the angles(May / June 2014) (Nov/Dec 2017) OR State and prove magnetic boundary conditions (May/June 2015)(April/May 2017)

7. Write short notes on classification of magnetic material. (Apl/May 2018) (May 2011)
Describe the classification of magnetic material and draw atypical magnetization (B-H) curve. (Nov/Dec 2017) (Nov / Dec 2014,2015)

UNIT IV- ELECTRODYNAMIC FIELDS

1.What is Displacement current (AU-N/D 2013)

Displacement current ID is flowing through a capacitor when ac voltage is applied across the capacitor.

2. Distinguish between transformer emf and motional emf (AU-N/D 2013, A/M2015)

The emf induced in a stationary conductor due to the change in flux linked with it, is called transformer emf or static induced emf.

Emf $= -\iint \frac{\partial B}{\partial t}.ds$, eg : transformer

The emf induced due to the movement of conductor in a magnetic field is called motional emf or dynamic induced emf

Emf = $\oint_c v \times B.dl$, eg: generator

3. State Faraday's law.

Faraday's law states that, the total emf induced in a closed circuit is equal to the time rate of decrease of the total magnetic flux linking the circuit.

4. State Lenz's law.

The Lenz's law states that, the induced current in the loop is always in such a direction as to produce flux opposing the change in flux density.

5. Explain briefly the different types of emf's produced in a conductor placed in a magnetic field.

There are two ways in which we can induce emf in a conductor. If a moving conductor is placed in a static magnetic field then the emf produced in the conductor is called dynamically induced emf. If the stationary conductor is placed in a time varying magnetic field, then the emf produced is called statically induced emf.

6.Give the Maxwell’s equation – I in both integral form and point form.

Maxwell’s equation – I is derived from the Ampere’s circuital law which states that the line integral of magnetic field intensity H on any closed path is equal to the current enclosed by that path.

Maxwell’s equation – I in integral form is

$$\oint H.dl = \int_s \left(\sigma E + \varepsilon \frac{\partial E}{\partial t} \right) ds$$

Maxwell’s equation – I in point form is

$$\nabla \times H = \sigma E + \varepsilon \frac{\partial E}{\partial t}$$

The magneto motive force around a closed path is equal to the sum of the conduction current and displacement current enclosed by the path.

7. Give the Maxwell’s equation – II in both integral form and point form.

Maxwell’s equation – II is derived from Faraday’s law which states that the emf induced in a circuit is equal to the rate of decrease of the magnetic flux linkage in the circuit. Maxwell’s equation - II in integral form is

$$\oint E.dl = -\mu \int \frac{\partial H}{\partial t} ds$$

Maxwell’s equation – II in point form is $\times E = -\frac{B}{t}$ The electro motive force around a closed path is equal to the magnetic displacement (flux density) through that closed path.

8. Distinguish between the conduction current and displacement current.

Conduction current Ic is flowing through a conductor having resistance R, when potential V is applied across the conductor. Displacement current ID is flowing through a capacitor when ac voltage is applied across the capacitor.

9. Write the point form of continuity equation .

▼•J= - ρv / ε

10.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.J= σE

11.Write down the magnetic boundary conditions.

The normal components of flux density B are continuous across the boundary. The tangential component of field intensity is continuous across the boundary.

12. State continuity equation (AU-M/J 2012).

$\nabla . J = -\frac{\partial \rho_v}{\partial t}$ Since the charge is conserved, the outside flux of J must therefore be equal to the rate of loss of charge within the volume.

PART-B

1. Derive the Maxwell's equations both in integral and point forms.
2. Derive the set of Maxwell's equations in integral form from fundamental laws for a good conductor.
3. Describe the relationship between field theory and circuit theory.
4. Derive Maxwell's equation in both point and integral form for conducting medium and free space
5. State and derive the Maxwell's equations for free space in integral form and point form for time varying field.
6. State Faraday's law. What are the different ways of emf generation? Explain with governing equation and suitable example for each.
7. Obtain the expression for energy stored in the magnetic field and develop the expression for magnetic energy density.

UNIT V - ELECTROMAGNETIC WAVES

PART-A

1. State Poyntings Theorem. (AU-M/J 2014) (AU-N/D 2013)

The net power flowing out of a given volume is equal to the time rate of decrease of the energy stored within the volume- conduction losses.

2. Define pointing vector.

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.

3. Mention any two properties of uniform plane wave. (AU-N/D 2013)

At every point in space, the electric field E and magnetic field H are perpendicular to each other. The fields vary harmonically with time and at the same frequency everywhere in space.

4. Define characteristic impedance or intrinsic impedance.

Characteristic impedance is defined as the ratio of square root of permeability to the dielectric constant of the medium. It is also defined as the ratio of electric field intensity to the magnetic field intensity.

5.Give the wave equation in terms of electric field and magnetic field.

The electromagnetic wave equation in terms of electric field is,

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

The electromagnetic wave equation in terms of magnetic field is,

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

6. Give the wave equation in free space.

The wave equation in free space in terms of electric field is,

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

The wave equation in free space in terms of magnetic field is,

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

7. List out the properties of a uniform plane wave.

If the plane of wave is the same for all points on a plane surface, it is called plane wave. If the amplitude is also constant in a plane wave, it is called uniform plane wave.

The properties of uniform plane waves are:

a) At every point in space, E and H are perpendicular to each other and to the direction of travel.

b) The fields vary with time at the same frequency, everywhere in space.

c) Each field has the same direction, magnitudes and phase at every point in any plane perpendicular to the direction of wave travel

8. Define intrinsic impedance or characteristic impedance.

It is the ratio of electric field to magnetic field.or It is the ratio of square root of permeability to permittivity of medium.

9. What is the effect of permittivity on the force between two charges?

Increase in permittivity of the medium tends to decrease the force between two charges and decrease in permittivity of the medium tends to increase the force between two charges.

10. Define loss tangent.

Loss tangent is the ratio of the magnitude of conduction current density to displacement current density of the medium.

11. 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.

12. Define intrinsic impedance or characteristic impedance.

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14. Define loss tangent.

Loss tangent is the ratio of the magnitude of conduction current density to displacement current density of the medium.

15. 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.

16. **What is the wavelength and frequency of a wave propagation in free space when β =2? . (AU-A/M2015)**

$$\beta = \frac{2\pi}{\lambda}, \qquad \lambda = \frac{2\pi}{\beta} = 3.14m$$

$$f = \frac{v_o}{\lambda}$$

$$f = \frac{3X10^8}{3.14} = 95.5MHz$$

PART-B

1. Deduce the equation of the propagation of the plane electromagnetic waves in free space.
2. State and prove Poynting theorem.
3. Describe the concept of electromagnetic wave propagation in a linear, isotropic, homogeneous, lossy dielectric medium.
4. Obtain an expression for electromagnetic wave propagation in lossy dielectrics.
5. (i)Deduce the wave equations for conducting medium.

   (ii) Discuss group velocity, phase velocity and propagation constant of electromagnetic waves.
6. Write the short notes on the following:

   i)Plane waves in lossless dielectrics

   ii) Plane waves in free space.

   iii) Plane waves in good conductors.