## UNIT I

**1. 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

$$H.dl = (\nabla xH) ds$$

**2. 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 enclosed by the surface around the point shrinks to zero.

**3. State Divergence Theorem.**

The integral of the divergence of a vector over a volume v is equal to the surface integral o f the normal component of the vector over the surface bounded by the volume.

**4. What is the physical significance of div D?**

$\nabla \cdot D= \rho v$

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.

**5. State the condition for the vector F to be solenoidal.**

$\nabla \cdot F =0$

**6. State the condition for the vector F to be irrotational.**

$\nabla x F =0$

**7. 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.

**8. State coulombs law.**

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.

$F=Q_1Q_2/ 4 \pi \varepsilon r_2$

**9. 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.

**10. 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.

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

**11. State the principle of superposition of fields.**

The total electric field at a point is the algebraic sum of the individual electric field at that point.

**12. What is a point charge?**

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

**13. Define linear charge density.**

It is the charge per unit length.

**14. Define surface charge density.**

It is the charge per surface area.

**15. Define Biot –Savart Law?**

The magnetic flux density produced by a current element at any point in a magnetic field is proportional to the current element and inversely proportional to the square of the distance between them.

**16. What is a Scalar quantity?**

A Quantity which has magnitude only is called Scalar quantity. It is represented by length. EG: Temperature, Mass, Volume and Energy.

**17. What is a Vector quantity?**

A Quantity which has both magnitude and direction is called Vector quantity. It is graphically represented by a line with an arrow to show magnitude and direction.
EG: Force, Velocity, and Acceleration

**18. Define Unit Vector?**

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

**19. 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)

**20. Define Scalar or Dot Product.**

A.B = ABcos Φ 0≤ Φ ≤ Π 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.

**21. 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.

**UNIT II**

**1. State Gauss law for electric fields**

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

**2. Define electric flux.**

The lines of electric force is electric flux.

**3. Define electric flux density.**

Electric flux density is defined as electric flux per unit area.

**4. Define electric field intensity.**

Electric field intensity is defined as the electric force per unit positive charge.

$E = F/Q = Q/4\pi\varepsilon r^2$ V/m

**5. Name few applications of Gauss law in electrostatics.**

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

**6. State Gauss law for magnetic field.**

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

**7. Give the expression for electric field intensity due to a single shell of charge**

$$E = Q / 4\pi\varepsilon r^2$$

**8. Give the expression for potential between two spherical shells.**

$$V = 1/4\pi\varepsilon(Q1/a - Q2/b)$$

**9. Give the relationship between potential gradiant and electric field.**

$$E = -\nabla V$$

**10. What is electrostatic force?**

The force between any two particles due to existing charges is known as electrostatic force, repulsive for like and attractive for unlike.

**11. 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 electrons in atoms of a dielectric are tightly bound to their nucleus.

**12. What is a capacitor?**

A capacitor is an electrical device composed of two conductors which are separated through a dielectric medium and which can store equal and opposite charges ,independent of whether other conductors in the system are charged or not.

**13. Define dielectric strength.**

The dielectric strength of a dielectric is defined as the maximum value of electric field that can b applied to the dielectric without its electric breakdown.

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

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

**15. Why water has much greater dielectric constant than mica.?**

Water has a much greater dielectric constant than mica, because water has a permanent dipole moment, while mica does not have.

**16. Write down the expression for capacitance between two parallel plates.**

$C=\varepsilon A / d$

**17. What is meant by displacement current?**

Displacement current is nothing but the current flowing through capacitor. $J= D / t$

**18. 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)$D_{n1}=D_{n2}$

**19. 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.

$$E.dl = 0$$

**20. What are equipotential surfaces?**

An equipotential surface is a surface in which the potential energy at every point is of the same value.

## UNIT III

**1. Write poisson's and laplace 's equations.**

Poisson 's eqn:

$$\nabla^2 V = -\rho v / \varepsilon$$

Laplace' s eqn:

$$\nabla^2 V = 0$$

**2. 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 poissons equation can be used to find the potential. When the region is free from charge laplace equation is used to find the potential.

**3. Define magnetic field strength.**

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

**4. Write down the expression for magnetic field at the centre of the circular coil.**

$H = I/2a$.

**5. Write he expression for field intensity due to a toroid carrying a filamentary current I**

H=NI / 2ïR

**6. Give the relation between magnetic flux density and magnetic field intensity.**

$B = \mu H$

**7. Define inductance.**

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

**8. Give the formula to find the force between two parallel current carrying conductors.**

$$F = \mu I_1 I_2 / 2\pi R$$

**9. Give the expression for torque experienced by a current carrying loop situated in a magnetic field.**

$$T = I A B \sin\theta$$

**10. What is torque on a solenoid?**

$$T = N I AB \sin\theta$$

**11. Write the expression for energy density in electrostatic field.**

$$W = 1/2\, \varepsilon E^2$$

**12. What is the expression for energy stored in a magnetic field?**

$$W = ½ LI^2$$

**13. What is energy density in magnetic field?**

$W = ½ \mu H2$

**14. 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 thereby closed on itself it becomes a toroid.

**15. What is lorentz force?**

Lorentz force is the force experienced by the test charge .It is maximum if the direction of movement of charge is perpendicular to the orientation of field lines.

**16. State Biot –Savarts law.**

It states that the magnetic flux density at any point due to current element is proportional to the current element and sine of the angle between the elemental length and inversely proportional to the square of the distance between them

$$dB = \mu\, Idl \sin\theta / 4\pi r2$$

**17. State amperes circuital law.**

Magnetic field intensity around a closed path is equal to the current enclosed by the path.

$$H \bullet dl = I$$

**18. Give the force on a current element.** $dF = B\,I\,dl\,\sin\theta$

**19. Define magnetic vector potential.**

It is defined as that quantity whose curl gives the magnetic flux density. $B = \nabla \times A = \mu / 4\pi J/r \, dv$ web/m2

**20. Define magnetic moment.**

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

**21. Give the relation between electric field intensity and electric flux density.**

$$D = E\varepsilon \text{ C/m2}$$

**22. Define current density.**

Current density is defined as the current per unit area.

$$J = I/A \text{ Amp/m}^2$$

**23. Define self inductance.**

Self inductance is defined as the rate of total magnetic flux linkage to the current through the coil.

**24. Define magnetic moment.**

Magnetic moment is defined as the maximum torque on the loop per unit magnetic induction.

**25. Write the point form of continuity equation and explain its significance.**

$$\nabla \cdot J = - \rho v / \varepsilon$$

**26. 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.

$$J = \sigma E$$

**27. 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.

## UNIT IV

**1. State Maxwell's fourth equation.**

The net magnetic flux emerging through any closed surface is zero. 2. **State Maxwell's Third equation**

The total electric displacement through the surface enclosing a volume is equal to the total charge within the volume.

**3. Define ohms law at a point**

Ohms law at appoint states that the field strength within a conductor is proportional to current density.

**4. State electric displacement.**

The electric flux or electric displacement through a closed surface is equal to the charge enclosed by the surface.

**5. What is displacement flux density?**

The electric displacement per unit area is known as electric displacement density or electric flux density.

**6. What is the significance of displacement current?**

The concept of displacement current was introduced to justify the production of magnetic field in empty space. It signifies that a changing electric field induces a magnetic field .In empty space the conduction current is zero and the magnetic fields are entirely due to displacement current.

**7. State Poyntings Theorem.**

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.

**8. Define poynting 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. P =E X H

**9. What is an emf?**

An electro-motive force is a voltage that arises from conductors moving in a magnetic field or from changing magnetic fields.

**10. 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.

$$e = -\frac{d\phi}{dt} \quad \text{V}$$

**11. 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.

**12. 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.

**13. 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.

$$\oint H.dl = I$$

Maxwell's equation – I in integral form is

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

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.

**14. 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.

$$e = -\frac{d\phi}{dt}$$

Maxwell's equation - II in integral form is

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

Maxwell's equation – II in point form is

$$\nabla \times E = -\frac{\partial B}{\partial t}$$

The electro motive force around a closed path is equal to the magnetic displacement (flux density) through that closed path.

**15. Give the Maxwell's equation – III in both integral form and point form.**

The Maxwell's equation – III is derived from electric Gauss's law which states that the electric flux through any closed surface is equal to the charge enclosed by the surface.

$$\psi = Q$$

Maxwell's equation – III in integral form is

$$\iint_s D.ds = \iiint_v \rho dv$$

Maxwell's equation – III in point form is

$$\nabla \cdot D = \rho$$

The total electric displacement through the surface enclosing a volume is equal to the total charge within the volume.

**16. Give the Maxwell's equation – IV in integral form.**

Maxwell's equation – IV is derived from magnetic Gauss's law which states that, the total magnetic flux through any closed surface is equal to zero.

$$\phi = 0$$

Maxwell's equation – IV in integral form is

$$\iint_s B.ds = 0$$

**17. Give the Maxwell's equation – IV in point form.**

Maxwell's equation – IV in point form is

$$\nabla \cdot B = 0$$

The net magnetic flux emerging through any closed surface is zero.

**18. Distinguish between the conduction current and displacement current.**

Conduction current $I_c$ is flowing through a conductor having resistance R, when potential V is applied across the conductor.

$$I_c = \frac{V}{R} \quad \text{A}$$

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

$dt$

$$I_c = \frac{V}{R} \quad \text{A}$$

**19. What is Eddy current and Eddy current loss?**

In electrical machines, the alternating magnetic fields induce emf in the cores also apart from the coil. This small amount of emf induced in the core circulates current in the core. This current is called eddy current and the power loss, which appears in the form of heat, due to these eddy currents is called eddy current loss.

**20. What is main cause of eddy current?**

The main cause of eddy current is that it produces ohmic power loss and causes local heating

## UNIT V

**1. 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.

**2. Mention the properties of uniform plane wave.**

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 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.

**4. Give the characteristic impedance of free space.**

377ohms

**5. Define skin depth**

It is defined as that depth in which the wave has been attenuated to 1/e or approximately 37% of its original value.

**6. 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.

**7. Define loss tangent.**

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

**8. 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.

**9. Define transmission coefficients.**

Transmission coefficient is defined as the ratio of the magnitude of the transmitted field to that of incident field.

**10. How can the eddy current losses be eliminated?**

The eddy current losses can be eliminated by providing laminations. It can be proved that the total eddy current power loss decreases as the number of laminations increases.

**11. 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 terminates on charges, whereas magnetic flux tubes are continuous.

**12. What are uniform plane waves?**

Electromagnetic waves which consist of electric and magnetic fields that are perpendicular to each other and to the direction of propagation and are uniform in plane perpendicular to the direction of propagation are known as uniform plane waves.

**13. Write short notes on imperfect dielectrics.**

A material is classified as an imperfect dielectrics when conduction current density is small in magnitude compared to the displacement current density.

**14. 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.

**15. 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,

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

**16. 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,

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

**17. 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.

**18. Give the expression for the characteristic impedance of the wave.**

The characteristic impedance or intrinsic impedance is the ratio of the electric field intensity to the magnetic field intensity.

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

**19. What is Vector Helmholtz equation.**

The wave equation in lossless medium in phasor form is called the vector Helmholtz equation.

$$\nabla^2 E + \mu\varepsilon\omega^2 E = 0$$

**20. Give the wave equation for a conducting medium.**

The wave equation for a conducting medium in phasor form is given as,

$$\nabla^2 E - j(\omega\mu\sigma + j\mu\varepsilon\omega^2)E = 0$$

**21. What is skin effect and skin depth?**

In a good conductor the wave is attenuated as it progresses. At higher frequencies the rate of attenuation is very large, and the wave may penetrate only a very short distance before being reduced to a small value. This effect is called skin effect.

The skin depth is defined as that depth in which the wave has been attenuated to 1/e or approximately 37% of its original value. It is also known as depth of penetration.

$$\delta = \frac{1}{\alpha}$$

where is the attenuation constant,

$$\delta = \frac{1}{\alpha}$$

$$\alpha = \omega\sqrt{\frac{\mu\varepsilon}{2}\left(\sqrt{1+\frac{\sigma^2}{\omega^2\varepsilon^2}}-1\right)}$$

**22. Give the expression for attenuation constant and phase shift constant for a wave propagating in a conducting medium.**

The attenuation constant for a wave propagating in a conducting medium is,

$$\alpha = \omega\sqrt{\frac{\mu\varepsilon}{2}\left(\sqrt{1+\frac{\sigma^2}{\omega^2\varepsilon^2}}-1\right)}$$

The phase shift constant for a wave propagating in a conducting medium is,

$$\beta = \omega\sqrt{\frac{\mu\varepsilon}{2}\left(\sqrt{1+\frac{\sigma^2}{\omega^2\varepsilon^2}}+1\right)}$$

**23. Give the expression for the velocity of propagation of a wave in any medium.**

The velocity of propagation of a wave in any medium is,

$$v = \frac{\omega}{\beta} = \frac{1}{\sqrt{\mu\varepsilon}}$$