EE6302 - ELECTROMAGNETIC THEORY
TWO MARK QUESTIONS WITH ANSWERS
UNIT 1 – ELECTROSTATICS 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

$$\int H.dl = \int\int (\Delta x H) ds$$

Where, H=Magnetic field intensity

2. State the condition for the vector F to be solenoidal.

$$\Delta.F = 0$$

Where, F=A i + B i + C i

3. State the condition for the vector F to be irrotational.

$$\Delta x F = 0$$

Where, F=A i + B i + C i

4. Give the relationship between potential gradiant and electric field.

$$E = -\Delta V$$

Where, E=Electric Field Intensity
V=Electric Potential

5. 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.

6. 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 magneto statics.

7. State Divergence Theorem.

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

$$\iint \Delta.F\, ds = \iiint F\, dv$$

Where, F=A i + B i + C i

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 enclosed by the surface around the point shrinks to zero.

9. State coulombs law.

Coulombs law states that the force (F) between any two point charges (Q1 and Q2) 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.

$$F = (Q1Q2) / (4\Pi\varepsilon r^2)\ dr$$

10. 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.

11. Define electric flux.

The lines of electric force is known as electric flux.

12. Define electric flux density.

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

Electric flux density=ϕ/A

13.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

14. Name few applications of Gauss law in electrostatics.

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

PART B

1. The electric field in a spherical co-ordinate is given by E=rρr/5ε. Show that closed ∫E.dS=∫(▼.E)Dv.
2. State and proof divergence theorem and strokes theorem.
3. Check validity of the divergence theorem considering the field D=2xy ax +x2ay c/m2 and the rectangular parallelepiped formed by the planes x=0,x=1,y=0,y=2 & z=0,z=3.
4. A vector field D=[5r2/4]Ir is given in spherical co-ordinates. Evaluate both sides of divergence theorem for the volume enclosed between r=1&r=2.
5. Given A= 2r cosΦ+Riφ in cylindrical co-ordinates for the contour x=0to1 y=0to1 , verify stoke's theorem.
6. Explain three co-ordinate system.
7. State and proof gauss law .and explain applications of gauss law.

UNIT 2 – ELECTROSTATICS - II

1. 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.

2. 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.

3. 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.

4. 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.

5. 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 at infinity.

6.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.

7.What is a point charge?

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

8.Define linear charge density(ρ1).

It is defined as the charge (Q) per unit length (L).

$$\rho 1 = Q/L$$

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.

$$V = Q / 4\Pi\varepsilon r^2$$

Where, V=Electric Potential
Q=Charge
ε= Relative permittivity
r=Distance between charge

11. Give the relation between electric field intensity (E) and electric flux density (D).

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

12. Write the expression for energy density in electrostatic field.

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

Where, V=Electric Potential
W=Energy Density

13. 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) $D_{n1}=D_{n2}$

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

$$C=\varepsilon A / d$$

Where, C=Capacitance
A=Area
d= Distance between charge

15.State amperes circuital law.

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

$$H.dl=I$$

Where, H=Magnetic field intensity
I= Current

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

$$dB=\mu_0 \, Idl \sin\theta / 4\Pi\varepsilon r^2$$

Where, B=Magnetic field density
I= Current
r= Distance between charge
ε= Relative permittivity

17. 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.

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

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

Where, E=Electric field indensity
r= Distance between charge
ε= Relative permittivity

19. Give the expression for potential between two spherical shells

$$V= 1/ 4\Pi \, (Q1/a – Q2/b)$$

20. Define electric dipole.

Electric dipole is nothing but two equal and opposite point charges separated by a finite distance.

21. How is electric energy stored in a capacitor?

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

PART B QUESTIONS

1. Given that potential $V=10\sin\theta\cos\Phi/r2$ find the electric flux density D at $(2,\pi/2,0)$
2. 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 $+\lambda$ c/m at a point P which lies along the perpendicular bisector of wire.
3. Explain poissons and lapace's equations.
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 (2,3,15)m.
5. Obtain the expression for the energy stored in a capacitor.
6. Drive an expression for energy stored and energy density in an electrostatic field.
7. Derive an expression for the capacitance of two wire transmission line.

8 Derive an expression for capacitance of concentric spheres.

9. Derive an expression for capacitance of co-axial cable.

10 .Explain and derive the polarization of a dielectric materials.

11. List out the properties of dielectric materials.

12. Derive an expression for series and parallel plate capacitor.

UNIT 3 - MAGNETOSTATICS

1. Define current density.

Current density is defined as the current per unit area.

$$J= I/A \text{ Amp/m2}$$

2. What is meant by displacement current?

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

3.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.

$$J=\sigma E$$

4. Define surface charge density.

It is defined as the charge per surface area.

$$\rho S=Q/S$$

5.Define magnetic vector potential.

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

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

$$H = I/2A.$$

Where, H=Magnetic Field Intensity

I=Current
A=Area

7.Give the relation between magnetic flux density and magnetic field intensity.

$$B = \mu H$$

Where, H=Magnetic Field Intensity
B=Magnetic Field Density

8.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.

9. Give the force(F) on a current element (dl).

$$dF = BIdl\sin\theta$$

Where, B=Magnetic Field Density
I=Current

10.Define magnetic moment.

Magnetic moment(m) is defined as the maximum torque (T) per magnetic induction of flux density (B).

$$m=T/B$$

11. State Gauss law for magnetic field.

The total magnetic flux passing through any closed surface is equal to zero.

$$B.ds = 0$$

Where, B=Magnetic Field Density

12. Define magnetic field strength.

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

$$H=B/\mu$$

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

$$F=\mu I1.I2 / 2\Pi R$$

Where, F=Force I=Current
R=Distance between charge

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

$$T = IAB\sin\theta$$

Where, T=Torque
I=Current
A=Area
B=Magnetic Field Density

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.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.

$$\int E.dl = 0$$

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

$$H=NI / 2\Pi R$$

Where,

H= Magnetic Field Intensity
N=Number of Turns
I=Current
R=Distance between charges

18. What are equipotential surfaces?

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

19. Define loss tangent.

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

20. Define reflection coefficients.

Reflection coefficient is defined as the ratio of the magnitude of the reflected field to that of the incident field.

21. Define transmission coefficients.

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

22. What will happen when the wave is incident obliquely over dielectric – dielectric boundary?

When a plane wave is incident obliquely on the surface of a perfect dielectric part of the energy is transmitted and part of it is reflected .But in this case the transmitted wave will be refracted, that is the direction of propagation is altered.

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

$$W = \frac{1}{2} LI2$$

24. What is energy density in magnetic field?

$$W = \frac{1}{2} \mu H2$$

25. Distinguish between solenoid and toroid.

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

PART B QUESTIONS

1. Derive the expressions for magnetic field intensity due to finite and infinite line.
2. Derive the expressions for magnetic flux intensity due to solenoid of the coil.
3. Derive the expressions for magnetic field intensity due to toroidal coil and circular coil.
4. Derive an expression for energy stored and energy density in magnetic field.
5. Derive an expression for self inductance of two wire transmission line.
6. Derive an expression for force between two current carrying conductors.
7. Derive an expression for co-efficient of coupling.
8. Explain Magnetic materials and scalar and vector magnetic potentials.
9. Derive the expressions for boundary conditions in magnetic fields.
10. Derive the expression for torque developed in a rectangular closed circuit carrying current I a uniform field.

UNIT 4 - ELECTRODYNAMIC FIELDS

1. State Maxwells fourth equation.

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

2. State Maxwells Third equation

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

3. 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.

4. Define ohms law at a point

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

5. Define self inductance.

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

6. 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.

7. State Lenz law.

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

8. 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.

9. State electric displacement.

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

10. What is displacement flux density?

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

11. 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.

12. Distinguish between conduction and displacement currents.

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

13. Define inductance.

The inductance of a conductor is defined as the ratio of the linking magnetic flux to the current producing the flux.

$$L = N\Phi / I$$

14. What is main cause of eddy current?

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

15. 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.

16.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.

PART B QUESTIONS

1. Explain the relation between field theory and circuit theory.
2. Derive an expression for displacement, conduction current densities. Also obtain an expression for continuity current relations
3. Derive all the maxwells equations. i)Maxwells equation from electric Gauss law.
   ii) Maxwells equation from magnetic Gauss law. iii)Maxwells equation from Amperes law.
   iv) Maxwells equation from Faradays law.

4. State and explain Faradays and Lenzs law of induction and derive maxwells equation.

UNIT 5 - ELECTROMAGNETIC WAVE EQUATIONS

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. Define Poynting vector.

The pointing vector is defined as rate of flow of energy of a wave as it propagates.

$$P = E \times H$$

7. State Poynting Theorem.

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

8. Give significant physical difference between poisons and laplace's equations.

When the region contains charges poisons equation is used and when there is no charges laplaces equation is applied.

9. Give the difficulties in FDM.

FDM is difficult to apply for problems involving irregular boundaries and non homogenious material properties.

10. Explain the steps in finite element method.

i) Discretisation of the solution region into elements. ii) Generation of equations for fields at each element iii) Assembly of all elements

iv) Solution of the resulting system

11. 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.

12. Write short notes on imperfect dielectrics.

A material is classified as an imperfect dielectrics for ó <<ùå, that is conduction current density is small in magnitude compared to the displacement current density.

13.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.

14.What is the major drawback of finite difference method?

The major drawback of finite difference method is its inability to handle curved boundaries accurately.

h and bound algorithm?

PART B QUESTIONS

1. A uniform plane wave of 200 MHz, traveling in free space Impinges normally on a large block of material having $\varepsilon_r = 4$, $\mu_r = 9$ and $\sigma = 0$. Calculate transmission and reflection co efficient of interface.

2.What are the different ways of EMF generation? Explain with the governing equations and suitable practical examples.

3. With necessary explanation, derive the maxwell's equation in differential and integral forms

4. Write short notes on faradays law of electromagnetic induction.

5. What do you mean by displacement current? write down the expression for the total current density

6.In a material for which $\sigma = 5$ s/m and $\varepsilon_r = 1$ and E=250 sin 1010t (V/m). find the conduction and displacement current densities.

7.Find the total current in a circular conductor of radius 4mm if the current density Varies according to J=104/R A/m2 .

8. The magnetic field intensity in free space is given as H=H0sinθ ay t A/m. where $\theta = \omega t - \beta z$ and β is a constant quantity. Determine the displacement current density.

9. Show that the ratio of the amplitudes of the conduction current density and displacement current density is $\sigma/\omega\varepsilon$,for the applied field amplitude ratio if the applied field is E=Em e-t/λ where λ is real.

10. Calculate the attenuation constant and phase constant for the uniform plane wave with the frequency of 10GHz in a medium for which $\mu = \mu_0$, $\varepsilon_r = 2.3$ and σ=2.54x10^-4Ω/m

11. Derive the expression for the attenuation constant ,phase constant and intrinsic impedance for a uniform plane wave in a good conductor.

12. Derive the one dimensional general wave equation and find the solution for wave equation.

13. Discuss about the plane waves in lossy dielectrics.

14. Discuss about the plane waves in lossless dielectrics.

15. Briefly explain about the wave incident
(i) Normally on perfect conductor
(ii) Obliquely to the surface of perfect conductor.
16. Briefly explain about the wave incident
(i) Normally on perfect dielectrics
(ii) Obliquely to the surface of perfect dielectrics.
17. Assume that Eland H waves, traveeling in free space, are normally Incident on the interface with a perfect dielectric with $\varepsilon r=3$ .calculate the magnitudes of incident, reflected and transmitted E and H waves at the interface.