K.S.R. COLLEGE OF ENGINEERING: TIRUCHENGODE–637 215.

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE / LESSON PLAN SCHEDULE

NAME: C.KARTHIK

CLASS: II-ECE **SUBJECT: 18EC315- Electromagnetic theory**

A). TEXT BOOK:

1. W H.Hayt& J A Buck, "Engineering Electromagnetics" TATA McGraw-Hill, 7th edition 2011.
2. E.C. Jordan & K.G. Balmain, "Electromagnetic Waves and Radiating Systems" Pearson Education/PHI, 4th edition 2006.

B). REFERENCES:.

1 Matthew N.O.Sadiku, "Elements of Engineering Electromagnetics" Oxford University Press, 4th edition, 2007.
2 NarayanaRao, N "Elements of Engineering Electromagnetics", Pearson Education, New Delhi,6th edition 2006.
3 Ramo, Whinnery and Van Duzer, "Fields and Waves in Communications Electronics" John Wiley & Sons, 3rd edition 2003.
4 David K.Cheng, "Field and Wave Electromagnetics", Pearson Edition, 2nd edition, 2004.
5 G.S.N. Raju, "Electromagnetic Field Theory &Transmission Lines", Pearson Education, 1st edition, 2013.

.

C). LEGEND:

L1 -Lecture 1 BB- Black Board T1- Tutorial1
OHP- Over Head Projector Tx1-Text1 pp- Pages Rx1-Reference1

S.No.	Lecture Hour	Topics to be covered	Teaching Aid Required	Book No./Page No.
UNIT-I STATIC ELECTRIC FIELD				
1	L1	Rectangular,Cylindrical and Spherical Co- ordinate System	BB	Tx1/pp 1.1-1.38 Rx3/pp-13,Rx5/pp-1.11-1.114, Rx 1/pp-9-24, Rx2/pp-14,Rx 4/pp-30-52
2	L2	line, Surface and Volume Integrals &Curl, Divergence and Gradient ,Strokes theorem and Divergence theorem	BB	Tx1/pp 1.5-1.79 Rx3/pp-14-19,Rx 1/pp-119-122,Rx 2/pp-6 Rx3/pp-82,Rx5/pp-1.17-1.20, Rx 1/pp-190 201,Rx2/pp-810-17,43,84 Rx 1/pp-22-24
3	L3	Coulomb's Law , Electric Field Intensity &Principle of Superposition	BB	Tx1/pp 2.2-2.35 Rx3/pp-27, 30,Rx5/pp-2.4-2.7, Rx 1/pp-54-55,Rx 2/pp-29, 30
4	L4	Electric Field due to discrete charges, continuous charges	BB	Tx1/pp 2.5-2.17 Rx3/pp-34, Rx5/pp-2.5,Rx 2/pp-96, Rx1/pp-57-58
5	L5	Electric Field due to charges distributed uniformly on an finite and infinite line	BB	Tx1/pp 2.17-2.21 Rx5/pp-2.10-2.14,Rx3/pp-37
6	L6	Electric Field on the axis of a uniformly charged circular disc	BB	Tx1/pp 2.27-2.32 Rx3/pp-43Rx5/pp-2.14-2.15Rx 1/pp-62-65
7	L7	Electric Scalar Potential – Relationship between potential and electric field	BB	Tx1/pp 2.71-2.86 Rx5/pp-2.7-2.9,Rx 1/pp-203,Rx 2/pp-467
8	L8	Potential due to infinite uniformly	BB	Tx1/pp 2.82-2.89

		charged line and electric dipole		Rx3/pp-101Rx5/pp-2.22-2.23Rx 1/pp-209-210
9	L9	Electric Flux Density, Proof of Gauss Law	BB	Tx1/pp 2.35-2.38 Rx3/pp-51, 55, 59,Rx5/pp-2.2-2.3 Rx 1/pp-146-150,Rx 2/pp-31,33
10	T1,T2, T3	Problems	BB	Tx1/pp2.110-2.113
UNIT-II STATIC MAGNETIC FIELD				
11	L10	The Biot-Savart Law	BB	Tx1/pp 4.11-4.12 Rx3/pp-210,Rx5/pp-3.4-3.5, Rx 2/pp-87, 89 Rx 4/pp-250-254
12	L11	Magnetic Field intensity due to a finite and infinite wire	BB	Tx1/pp 4.13-4.17 Rx3/pp-216, 229,Rx5/pp-3.5-3.8, Rx 1/pp-70-71
13	L12	Magnetic field intensity on the axis of a circular	BB	Tx1/pp 4.19-4.21 Rx3/pp-218, Rx5/pp-3.9-3.10
14	L13	Magnetic field intensity on the axis of a rectangular loop	BB	Tx1/pp 4.27-4.29 Rx3/pp-219,Rx5 /pp-3.11-3.13, Rx 1/pp-72-74
15	L14	Ampere's circuital law and its applications	BB	Tx1/pp 4.30-4.37 Rx3/pp-218 -225,Rx5/pp-3.5,Rx1/pp-139-141,Rx 2/pp-80,
16	L15	Magnetic flux density, The Lorentz force Equation for a moving charge and its applications	BB	Tx1/pp 4.38-4.50,4.77 Rx3/pp-237,Rx5/pp3.1-3.2Rx 1/pp-67-68,76-81Rx2/pp-24, 79,
17	L16	Force on a current carrying wire placed in a magnetic field	BB	Tx1/pp 4.80-4.82 Rx3/pp-260,Rx5/pp-3.3, Rx 1/pp-68-70,Rx 2/pp-705, 718
18	L17	Torque on a loop carrying a current	BB	Tx1/pp 4.83-4.89 Rx3/pp-267 Rx5/pp-3.16-3.17
19	L18	Magnetic moment, Magnetic Vector Potential.	BB	Tx1/pp 4.88-4.91 Rx3/pp-268,269,Rx5/pp-3.19-3.22,Rx 1/pp-203-204,Rx 2/pp-96,90
20	T4,T5, T6	Problems	BB	Tx1/pp 4.16-4.167 Rx3/pp-218-225
UNIT-III ELECTRIC AND MAGNETIC FIELDS IN MATERIALS				
21	L19	Poisson's and Laplace's equation	BB	Tx1/pp 3.53-3.56 Rx3/pp-173-175,Rx 5/pp-2.24-2.25. Rx 1/pp-233-238,Rx 2/pp-45,Rx 4/pp-168-172
22	L20	Nature of dielectric materials	BB	Tx1/pp 3.21-3.25 Rx3/pp-137-149,Rx5/pp-3.23,Rx 1/pp-91-92 Rx 2/pp-130
23	L21	Definition of Capacitance, Capacitance of various geometries using Laplace's equation	BB	Tx1/pp 3.59-3.86 Rx3/pp-152-160,Rx5/pp-2.25-2.37,Rx2/pp-24, 51-52,Rx 4/pp-142-148
24	L22	Electrostatic energy and energy density	BB	Tx1/pp 2.96-2.109 Rx3/pp-152-160,Rx5/pp-2.79-.96, Rx1/pp-216-220,
25	L23	Boundary conditions for electric fields	BB	Tx1/pp 3.35-3.43 Rx3/pp-106,Rx5/pp-2.37-2.39,2.51Rx 1/pp-161-163,Rx 2/pp-57Rx 4/pp-132-136

26	L24	Electric current, Current density ,Point form of ohm's law, continuity equation for Current	BB	Tx1/pp 3.2-3.10 Rx3/pp-114,Rx 2/pp-210, 24,153 Rx3/pp-121, 116-118,Rx5/pp-2.45-2.46, Rx 1/pp-85-86,Rx 2/pp-77, 120
27	L25	Definition of Inductance,Inductance of loops and solenoids	BB	Tx1/pp 4.111-4.130 Rx3/pp-296-297,Rx5/pp-4.2-4.4,4.10-4.11, Rx 2/pp-24, 209,210
28	L26	Energy density in magnetic fields	BB	Tx1/pp 4.131-4.141 Rx3/pp-292-298,Tx 2/pp-4.17-4.18,Rx 1/pp-216-220, Rx 2/pp-61, 164,
29	L27	Nature of magnetic materials, Magnetization and permeability, Magnetic boundary conditions	BB	Tx1/pp 4.148-4.153 Rx3/pp-273-276,Rx5/pp-3.21-3.3.25, Rx 1/pp-98-99,102-104,137-139,Rx 2/pp-303-305 Rx3/pp-28 Rx5/pp-3.26-3.27,Rx 2/pp-105
30	T7, T8, T9	Problems	BB	Rx3/pp-116-118
UNIT-IV TIME VARYING ELECTRIC AND MAGNETIC FIELDS				
31	L28	Ampere's circuital law -	BB	Tx1/pp 5.3-5.5 Rx3/pp-306,Rx5/pp-4.1-4.2, Rx3/pp-319, Rx5/pp-5.4-5.5Rx 1 /pp-129-135 Rx 2/pp-589
32	L29	Maxwell's first equation from Ampere's circuital law ,Equation expressed in point form	BB	Tx1/pp 6.1-6.9 Rx3/pp-317,Rx 1/pp-175-182,Rx 2/pp-100
33	L30	Faraday's law	BB	Tx1/pp 4.30-4.35 Rx3/pp-313,218-225 Rx5/pp-5.1-5.4 Rx 2/pp-210
34	L31	Maxwell's Second Equation from Faraday's Law , Equation expressed in point form	BB	Rx3/pp-232,248-249 Rx5/pp-5.1-5.4 Rx 1/pp-139-142
35	L32, L33	Maxwell's four equations in integral form and differential form	BB	Tx1/pp 5.1-5.41 Rx3/pp-70-71,317-320Tx2/pp-5.6-5.12,Rx1/pp-175-190, Rx2/pp-100,723,123,
36	L34	Poynting vector and Poynting theorem	BB	Tx1/pp 6.29-6.35 Rx3/pp-413Rx5/pp-6.45-6.48,Rx 2/pp-162, 165
37	L35	Power flow in a Co-axial cable	BB	Rx 2/pp-165-167
38	L36	Instantaneous Average and Complex PoyntingVector	BB	Tx1/pp 6.29-6.35 Rx3/pp-414, 453,471,533-535,Rx5/pp-6.48-6.50Rx1/pp-338-339
39	T10, T11, T12	Problems	BB	Rx5/pp-5.13,Rx 4/pp-177,181,183,188-189 Rx3/pp-319-320,317-318 Rx5/pp-6.45-6.48
UNIT-V ELECTROMAGNETIC WAVES				
40	L37	Wave Equation, Uniform Plane Waves	BB	Tx1/pp 6.1-6.9 Rx3/pp-503-506,Rx 1/pp-296-299,Rx5/pp-6.1-6.3,6.6-6.13,Rx 2/pp-114, 124
41	L38	Wave equation in Phasor form, Plane waves in free space	BB	Rx3/pp-401,Rx 2/pp-123Rx5/pp-6.3-6.6,Rx 2/pp-124,

42	L39	Wave equation for a conducting medium	BB	Tx1/pp 6.9-6.15 Rx5/pp-6.14-6.15,Rx 1/pp-321-322, Rx 2/pp-119
43	L40	Plane waves in lossy dielectrics	BB	Tx1/pp 6.16-6.24 Rx 1/pp-329-332,Rx 2/pp-20,Rx 4/pp-383-384
44	L41	Propagation in good conductors, Skin effect	BB	Tx1/pp 6.25-6.29 Rx3/pp-416-423, 426 Rx5/pp-6.16-6.22 Rx 2/pp-214,731
45	L42	Linear, Elliptical and circular polarization	BB	Tx1/pp 6.35-6.43 Rx 1/pp-311-312
46	L43	Reflection of Plane Wave from a conductor, normal incidence	BB	Tx1/pp 7.1-7.7 Rx3/pp-456-457,434 Rx 1/pp-341-344 Rx 2/pp-136
47	L44	Reflection of Plane Wave by a perfect dielectric, normal incidence	BB	Tx1/pp 7.7-7.16 Rx3/pp-453, 464 Rx5/pp-6.28-6.29,Rx 2/pp-634Rx 4/pp-422-433
48	L45	Brewster's angle	BB	Tx1/pp 7.41-7.43 Rx5/pp-6.41-6.42,6.51-6.7
49	T13, T14, T15	Problems	BB	Rx3/pp-503-506

UNIT-I STATIC ELECTRIC FIELD (CO1)

1. **Define gradient.(R)**
   The gradient of any scalar function is the maximum space rate of change of that function. If scalar V represents electric potential, ∇V represents potential gradient.
   $$\nabla V = \frac{\partial V}{\partial x}\overline{ax} + \frac{\partial V}{\partial x}\overline{ay} + \frac{\partial z}{\partial x}\overline{az}.$$ This operation is called gradient.
2. **Define divergence.(R)**
   The divergence of a vector 'A' at any point is defined as the limit of its surface integrated per unit volume as the volume enclosed by the surface shrinks to zero.
   $\nabla.V = \lim_{v\to 0}\frac{1}{v}\iint_S A.\bar{n}ds$ $\nabla .A = \frac{\partial Ax}{\partial x} + \frac{\partial Ay}{\partial x} + \frac{\partial Az}{\partial x}$
3. **Define curl.(R)(Jan 2017)**
   The curl of a vector 'A' at any point is defined as the limit of its surface integral of its cross product with normal over a closed surface per unit volume shrinks to zero.
   $|\text{curl } A| = \lim_{v\to 0}\frac{1}{v}\iint_S \bar{n}\, X A ds$
4. **Define divergence theorem.(R)(June 2013,May 2011,June 2015)**
   The volume integral of the divergence of a vector field over a volume is equal to the surface integral of the normal component of this vector over the surface bounding the volume.
   $\iiint_v \nabla Del .A\, dv = \iint_S A.ds$
5. **State stokes theorem.(U)(May2010, Dec2013,Jan 2016)**
   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.
   $\int H.dl dl = (\nabla x H)\, ds$
6. **State coulombs law.(U) (Dec 2011,June 2010,Jan 2018)**
   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. $F=Q_1Q_2 / 4\pi\varepsilon r^2\overline{ar}$

7. **State Gauss law. Under what condition in Gauss's law especially useful in determining the Electric field intensity of a charge distribution.(U) (June 2010,Jan 2016)**
   The total electric flux passing through any closed surface is equal to the total charge enclosed by that surface.
   Charge distribution is symmetrical the Gauss's law is useful in determining the Electric field intensity of a charge distribution.
8. **Define electric flux and electric flux density and also give the relation between E &D .(R) (June 2015)**
   The lines of electric force are electric flux.Electric flux density is defined as electric flux per unit area. the relation between E & D is $D = \varepsilon E$ C/m^2
9. **Define electric field intensity.(R)(June 2013,May2011)**
   Electric field intensity is defined as the electric force per unit positive charge.$E = F/Q = Q/4\pi\varepsilon r^2$ V/m
10. **Name few applications of Gauss law in electrostatics.(Ana) (May2011)**
    Gauss law is applied to find the electric field intensity from a closed surface.
    e.g) Electric field can be determined for shell, two concentric shell or cylinders etc.
18. **Define potential difference.(R)**
    Potential difference is defined as the work done in moving a unit positive charge from one point to another point in an electric field.
19. **Define electric scalar potential.(R)(June 2013,May2011,May2010)**
    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. $V=Q / 4\pi\varepsilon r$ Volts
20. **Give the relationship between potential gradient and electric field. (U)(Jan 2016)**
    $E= - \nabla V$
21. **What is the physical significance of div D ?(R)**
    $\nabla \bullet D=-\rho_v$ 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.
22. **Define dipole and dipole moment. Write down the potential due to an electric dipole.(U)(June 2012,Dec 10)**
    Dipole or electric dipole is nothing but two equal and opposite point charges are separated by a very small distance.
    The product of electric charge and distance n know as dipole moment. It is denoted by m where Q is the charge l is the length. $m=Q.l$
23. **A vector field is given by the expression $F = (1/R)u_R$ in spherical co-ordinates. Determine F in Cartesian form at a point, x =1, y =1 and z =1 unit.(Ana)(June 2009)**
    In general, spherical system, $F = F_R u_R + F_\theta u_\theta + F_\varphi u_\varphi$
    $F_R = 1/R$ $R = \sqrt{1+1+1+1} = \sqrt{3}$ $F_R = 1/\sqrt{3}$
    $F_x = F_R (y/R) = 1/\sqrt{3} \times 1/\sqrt{3} = 1/3$ $F_z = F_R (z/R) = 1/\sqrt{3} \times 1/\sqrt{3} = 1/3$
    Hence at (1,1,1) = $F = 1/3(u_x + u_y + u_z)$
24. **Give the transformations of scalar co-ordinates from the spherical co-ordinates to rectangular co ordinate.(Ana) (Dec 2008)**

$$F_x = \frac{F_R\, x}{\sqrt{x^2+y^2+z^2}} + \frac{F_\theta\, xz}{\sqrt{(x^2+y^2)(x^2+y^2+z^2)}} - \frac{F_\varphi\, y}{\sqrt{(x^2+y^2)}}$$

$$F_y = \frac{F_R\, y}{\sqrt{x^2+y^2+z^2}} + \frac{F_\theta\, yz}{\sqrt{(x^2+y^2)(x^2+y^2+z^2)}} + \frac{F_\varphi\, x}{\sqrt{(x^2+y^2)}}$$

$$F_x = \frac{F_R\, z}{\sqrt{x^2+y^2+z^2}} - \frac{F_\theta \sqrt{x^2+y^2}}{\sqrt{(x^2+y^2)(x^2+y^2+z^2)}}$$

25. **State the principle of superposition with respect to Electric field.(U)**
The principle of superposition of fields states that the electric field at a point due to n number of charges is the algebraic sum of the individual field intensities produced by the various charges at that point.In vector –superposition, the resultant field at P is given by, E $=\frac{1}{4\pi\varepsilon}\sum_{k=1}^{N}\frac{q_k}{r_{kp}^2}u_{kp}$

Where q_k =k^{th} charge, r_{kp} = distance of kth charge.U_{kp} = unit vector directed from kth charge to P.

26. **Find the gradient of scalar system t= x^2 y + e^z at point P(1, 5, -2). (A)**
$\nabla\tau = (\frac{\partial}{\partial x}i + \frac{\partial}{\partial y}j + \frac{\partial}{\partial z}k)\ (x^2\ y + e^z)$ $=2xyi + x^2j + e^zk = 10i + j + e^{-2}k$

27. **Define volume charge density.(U)**
Volume charge density is defined as, the charge per unit volume.
$P_e = \frac{Total\ charge\ in\ columb}{Total\ volume\ in\ cubic\ metres}\ (\frac{C}{m^3})$

28. **State the nature of conservative field. (U)**
Any field where the closed line integral of the field is zero said to be conservative field.

29. **Transform the vector A = ya_x –x a_y +z a_z in to cylindrical co–ordinates.(Ana)(June 2010)**
$r = \sqrt{y2 + x2}$ $\varphi = \tan^{-1}(-x/y)$ z = z B = [ycos φ -xsin φ] a_r + [-ysin φ-xcos φ]a φ +za_z

30. **Determine the potential difference between the points a and b which are at a distance of 0.5m and 0.1m respectively from a negative charge 2x10^{-10} C (E)(Dec 2010,Jan 2018)**
x_2=a=0.5m x_1=b=0.1m Q=-2x10^{-10} C $V_{ba}=\frac{Q}{4\pi\varepsilon o}(\frac{1}{a}-\frac{1}{b})$

V_{ba}=potential rise from b to a = - (9*10^9) x2x $10^{-10}(\frac{1}{0.5}-\frac{1}{0.1})$=1.8x8=14.4 volts

31. **Find the force of interaction between two charges spaced 10cm apart in a vacuum. The charges are 4x10^{-8} and 6x10^{-5} C respectively. If the same charges are separated by the same distance in kerosene (=2) what is the corresponding force of interaction. (R)(Dec 2010,Jan 2016)**
q_1 =4x10^{-8} C q_2 =6x10^{-5} C r_{12}=10cm=0.1m ε_o=1/(36πx10^9)
F=$q_1q_2/4\pi\varepsilon_o r^2$ F=2.16 N For kerosene ε_r=22.16/2= 1.08N

32. **Determine the Gradient of Scalar Field F = 5r2+rsinθ? (E)(June 2012)**

33. **A point charge +2nC is located at the origin. What is the value of potential at P(1,0,0)m (C)(Dec 11)**

34. **Convert the given rectangular coordinate A(2,3,1)m into the cylindrical coordinate.(A)(Dec 10)**

35. **What is the significance of electric flux density (A)(June 2012)**

16 MARK QUESTIONS:

1. State and explain (i)Divergence Theorem (ii) Stoke's theorem(iii) The electric flux density is given as D =r/4 1_rnc/m^2 in free space. Calculate: 1) the electric field intensity at r = 0.25 m 2) the total charge within a sphere of r = 0.25 m and the total flux leaving the space of r = 0.35 m.(U)(Jan 2017)
2. (i) Define Divergence, Gradient, Curl and Laplacian in cylindrical and spherical Coordinate system with mathematical expressions.(R) (June 2010,June 2016)
(ii) Given a vector field D = ($5r^2$ /4))a_r is given in spherical co –ordinates. Evaluate both sides of the divergence theorem for the volume enclosed between r =1 and r =2. (E) (June 2010, 2012)
3. State the principle of superposition as applied to electric potential and derive a general expression for the resultant potential due to point, line, surface and volume charges composing the systems.(U) (May/June 2010)
4. (i) Derive an expression for the electric field due to a straight uniformly charged wire of length 'L' metres and with a charge density of +λ c/m at the point P which lies along the perpendicular bisector of wire(R)(June 2015)(April 2019)
ii) Given A = (Ycosa_x) $\overrightarrow{a_x}$ + (Y +e^x)$\overrightarrow{a_z}$. Find V X A at the origin.(A) (June 2013)

5. (i) A circular disc of radius 'a'm is charged uniformly with a charge density of σ c/m^2. Find the electric field intensity at a point 'h' m from the disc along its axis.(R)
   (June2009, May 2010, Dec 2010,June 2016)
   (ii) If V = $\frac{60\ sin\theta}{r^2}$ volts, Find V and E atP(3,60^0,25^0) where V = electric potential and E = electric field (R) (May 2010,June 2016,Jan 2017)
6. (i) State and prove Gauss's law. (R) (Dec 2010,June 2009, Jan 2014,Jan 2016)(Jan 2017)
   (ii)Describe any two applications of Gauss's law.(R) (Dec 2010,June 2015)
7. (i) Determine the variation of filed from point to point due to (1) A single spherical shell of charge with radius R_1 (2) Two concentric spherical shells of charge of radii R_1 (inner) and R_2 (outer). (R)
   (ii) Derive the expression for electric field intensity due to an array of point charges. (R)
8. Verify Stoke's theorem for a vector field, $\vec{F}$ =r^{2}cosφ$\overrightarrow{a_r}$ +z sinφ $\overrightarrow{a_z}$ around the path L defined by 0<= r<= 3, 0<=φ<=45^0 and z =0.(Ana) (June 2009)
9. (i)If V = (2x^{2}y +20z - $\frac{4}{x^2+y^2}$) volts, find $\vec{E}$ and $\vec{D}$ at P (6, -2.5, 3). (Ana) (May 2009,2010)
   (ii) Given that potential V=10sinθcosφ/r2 find the D at (2,π/2,0) (Ana) (June 2013)
10. (i) Determine the electric field intensity of an infinitely long, straight, line charge of a uniform density ρ_λ in air. (E) (June 2013,May2011,Jan 2014)
    (ii) Determine Electric field intensity at P (1,2,5) due to a point charge of 10nc at Q(1,-2,3).(E)
11. (i) Explain potential due to charged disc.(E)
    (ii) Three charged cylindrical sheets are present in three spaces with σ = 5C/m^2 at R = 2m σ = -2C/m^2 at R = 4m & σ = -3C/m^2 at R = 5m. Find flux density at R = 1, 3, 4, 5 and 6 m. (A)
12. (i) Explain the electric field due to 'n' number of charges. (Jan 2017) (U)
    (ii) A uniform line charge of 1nC is situated along x-axis between the points (-500, 0) and (500, 0) mm. Find the electric scalar potential at (0,1000) mm. (R)
13. (i) State super position theorem in relevance to field theory and derive the equation for total electric field intensity.(R)
    (ii) Consider two point charges Q_1 =8πε_0 coulombs and $Q_{2=}$ -4 πε_0 coulombs situated at (-1, 0, 0) m respectively. Find the electric field intensity at the point (0, 0, 1).(R) (June 2010)
14. (i) Let, $\vec{A}$=5$\overrightarrow{a_x}$, and $\vec{B}$= 4 $\overrightarrow{a_x}$+B_y $\overrightarrow{a_y}$, Find by such that, angle between , $\vec{A}$ and , $\vec{B}$ is 45^0. If, $\vec{B}$ also has a term $B_z\overrightarrow{a_z}$, what relationship must exist between by B_y and B_z. (R)
    (ii) A uniform line charge ρ_L = 25nC/m lies on the line, x= -3m and y= 4m, in free space. Find the electric field intensity at a point (2, 3, 15) m. (R) (June 2013, June 2006)
15. (i) If two vectors are expressed in cylindrical coordinates as A = 2a_x +π a_y +a_z
    B = -a_x+3π/2 a_y -2a_zCompute a unit vector perpendicular to the plane containing A and B.(A)
    (ii) A regular tetrahedron has vertices at P_1 (2, 0, 0) .P_2(-1, √3, 0), P_3(-1, -√3, 0) , P_4(0, 0, 2√2). Charges of 1mC are located at each of the four vertices. If the configuration is located in free space, find the magnitude of force on each charge. (R)(June 2007, Jan 2016, June 2016)
16. Derive the expression for the potential due to electric dipole at a point on the broad side position with a neat sketch (U) (Dec 2010,May2011)
17. Given the two points A(x=2,y=3,z=-1) and B(r=4,θ=25°,Ø=120°).find the spherical co-ordinates of A and Cartesian co-ordinates of B. (R) (May2010)
18. Find curl H ,if H=(2ρ cosØ aρ-4ρ sinØ a$_Ø$+3a$_z$) (R)(May2010)
19. Determine the divergence and curl of the given field F=30ax+2xyay+5xz2az at (1,1,-0.2)and hence state the nature of the field (E) (Dec 2010)
20. Two point charges 1.5nC at (0,0,0.1) and -1.5nC at(0,0,-0.1)are in free space treat the two charges as a dipole at the origin and find potential atP(0.3,0,0.4) (R)(Dec 2010,June 2012)
21. Find the total E at the orign due to 10^{-8}Ccharge located at P(0,4,4)m and a -0.5x10^{-8} C charge at P(4,0,2)m (R)(May2011)
22. Derive the expression for the electric field intensity at any point due to a uniformly charged sheet with density ρs C/m^2 (U)(May2011)

23. Given field E= $-6y/x^2\ a_x+6/x\ a_y + 5a_z$ V/m find the potential difference V_{AB} between A(-7,2,1) and B(4,1,2)(R)(May2011)
24. 1)Consider an infinite uniform line charge of 5 nC/m parallel to z axis at x=4,y=6.find the E at the point P(0,0,5) in free space 2)the D within the cylindrical volume bounded by r=2m z=0 and z=5 m is given by d=30e-r-2zaz C/m2.what is the total outward flux crossing the surface of the cylinder(R) (Dec 2011,Jan 2016)
25. A point charges Q_1=300μC located at (1,-1,-3)m experiences a force F_1=8ax-8ay+az N due to point charge Q_2 at (3,-3,-2)m, find the charge Q_2 (R)(June 2012)
26. Two dielectric small diameter balls of 10gms slide freely on a vertical channel a negative charge of 1μC.find the separation between the balls if the lower ball is restricted from moving.(Ana)(Dec 2013)
27. Prove that if the path selected is such that it is always perpendicular to E the work done is zero (E) (Jan 2014)
28. A total charge of 40/3 nC is uniformly distributed over a circular ring of radius 2m placed in z=0 plane, with center as origin .Find the electric potential at a A(0,0,5). (A) (Jan 2014)

UNIT-II STATIC MAGNETIC FIELD (CO2)

1. **State Biot –Savart's law. (R) (May 10,2011,Jun 2013,Dec 2014,Jan 2016)**
   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 lengths and inversely proportional to the square of the distance between them
   Biot –Savarts law in vector form = $dB=\mu_0 Idl \sin\theta / 4\pi r^2$
2. **State amperes circuital law. (U) (May2011,Dec 2010,Jan 2016,June2016,Jan 2017)**
   The line integral of magnetic field intensity around a closed path is equal to the direct current enclosed by the path. $\int H.dl = I$
3. **Define magnetic scalar potential.(Jan 2018)(R)**
   It is defined as dead quantity whose negative gradient gives the magnetic intensity if there is no current source present. $H = -\nabla V_m$,Where V_m is the magnetic vector potential.
4. **Define magnetic vector potential.(June 2013, Jan 2018)(R)**
   It is defined as that quantity whose curl gives the magnetic flux density.
   $$B=\nabla \times A \quad =\mu / 4\pi \iiint_v \frac{J}{r} dr \text{ web/m}^2$$
5. **Define magnetic field strength and magnetic flux density.(May 2012,Dec2010,Jan 2016)(R)**
   The magnetic field strength (H) is a vector having the same direction as magnetic flux density. H=B/μMagnetic flux density (B) = $\frac{Magnetic\ flux}{area} = \frac{\Phi}{A}$ webers /m^2(Tesla)
6. **State Gauss law for magnetic field.(U)**
   The total magnetic flux passing through any closed surface is equal to zero.B.ds =0
7. **Write down the equation for general, integral and point form of Ampere's law.(Dec2008)(A)**
   General form: $\oint H.dl = I$Integral form: $\oint H.dl = \iint_s J.dl$Point form :$\nabla \times H = J$ φ
8. **Give the relation between magnetic flux density and magnetic field intensity.(U) (June 2010)**
   B =μ H
9. **State Lorentz force equation. (May2010,May2011,Dec 2010,Jan 2018)(U)**
   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.F = (I x B) l =BIlsinθ
10. **Define magnetic moment and sketch the field due to magnetic dipole. (May2011,Jan 2014,Jan 2017)(R)**
    Magnetic moment is defined as the maximum torque on the loop per unit magnetic Induction of flux density. m=IA
11. **A long conductor with current 5A is in coincident with positive 'z' direction. If $\vec{B}$ =4i +4j. Find the force per unit length. (June 2009)(U)**

F = BI l sinθ => F/ l = IBsinθ $= \vec{I} \times \vec{B} = 5\vec{k} * (4\vec{i} + 4\vec{j}) = 20\vec{j} - 25\vec{i}$ N/m

12. **A steady current of 'I' flows in a conductor bent in the form of a square loop of side 'a' meteres. Find the magnetic field intensity at the centre of the loop. (June 2016) (U)**
$\vec{H} = \frac{I}{4\pi d}(\cos\alpha - \cos\beta) = \frac{I}{4\pi a/2}(\cos 45 - \cos 135) = \frac{I}{2\pi a}\left(\frac{1}{\sqrt{2}} + \frac{1}{\sqrt{2}}\right) = \frac{1}{\sqrt{2}}\frac{1}{\pi a}$
13. **Define magnetic dipole.(R)**
A small bar magnet with pole strength Q_m and length l may be treated as magnetic dipole whose magnetic moment is Q_m l.
14. **Define magnetization.(Dec 2011,May2010,Jan 2018)(R)**
Magnetization is defined as the ratio of magnetic dipole moment to unit volume.
M = Magnetic dipole / volume = Q_m / A a/m
15. **Define magnetic susceptibility.(U)**
Magnetic susceptibility is defined as the ratio of magnetization to the magnetic field intensity. It is dimensionless quantity. χ_m =M /H
16. **A very long and thin wire located along the z axis carries a current I in the Z direction. Determine the magnetic field intensity using Ampere's law.(June 2010)(E)**
H = (I / 2πr)a_φ A/m
17. **Write the expression for the torque experienced by a current carrying loop placed in the magnetic field. (June 2012,June 2016)(Ana)**
T = BIA sinθT = Torque on a current carrying loop.
I = current B = Magnetic flux density A = Area of the loop
θ = the angle of a current carrying loop
18. **What is the significance of ▼.B=0?(Dec 2010)(R)**
▼.B=0 the divergence of magnetic flux density is always is zero. This is called gauss's law in differential form for magnetic fields.
19. **Write the expression for the magnetic field at a point due to a straight current carrying filamentary conductor of finite length** $H = \frac{I}{4\pi d}(\cos\theta_1 + \cos\theta_2)$**(May2011)(U)**

16 MARK QUESTIONS

1. (i) State and prove Ampere's law.(ii) Find the magnetic field intensity at the centre 'O' of a square of sides and carrying I amperes of current.(/May 09,2010)(June 2013)(Dec 2011)(R)
2. (i) find the magnetic field intensity due to a finite wire carrying a current I.
(May 2010),(June 2009) (Dec 2011,Jan 2016)(U)
(ii) At a point P(x, y, z) the components of magnetic vector potential $\vec{A}$ are given as
A_x=(4x +3y +2z); A_y = (5x +6y +3z); A_z = (2x +3y +5z); Determine $\vec{B}$ at point P.(June 2009)(E)
3. (i) State Biot -Savart's law in vector form.(E)
(ii)Obtain the expression for magnetic field intensity due to a circular loop of wire carrying a current I, placed with its centre at origin. (Dec 2010)(May 2011)(E)
4. (i) Derive an expression for Magnetic Gauss law in point form and integral form.(Ana)
(ii) Explain the magnetic field intensity due to a straight wire. (May 2008)(U)
5. Find the magnetic flux density around infinitely long straight conductor using Bio-Savart law. (June 2010,2013,June 2016,Jan 2017)(U)
6. (i) Find the force exerted between current carrying conductors kept in '1' meter distance and carries the current in the same direction.(June2013)(E)
(ii) Find the magnetic field intensity at the origin due to a current element IdL = 3π (u_x + 2u_y +3u_z) μA. m, at the point P (3, 4, 5) in free space.(June 2007)(E)
7. (i) Consider a conductor of rectangular loop 'abcd' situated in a uniform magnetic field of 'B' wb/m^2. Derive the expression for torque and magnetic moment. (June 2016) (C)
(ii) A single –phase circuit comprises two parallel conductors A and B, 1cm diameter and spaced 1 metre apart. The conductors carry currents of +100 and -100 amps respectively. Determine the field

intensity at the surface of each conductor and also in the space exactly midway between A and B. (Dec 2006)(U)

8. (i) Consider a solenoid in a uniform magnetic field of flux density 'B' wb/m^2. Obtain the expression for the torque on the solenoid.(C)
   (ii) A conductor located at x =0.4 m; y =0 and 0< z<2.0 m carries a current of 5.0 A in the a_z direction. Along the length of conductor B = 2.5a_z T. Find the torque about Z axis. (June 2009)(E)
9. (i) Obtain the expression for magnetic field intensity at the centre of a circular wire.(E)
   (ii) If the vector magnetic potential is given by A = $\frac{10}{x^2+y^2+z^2} u_x$, obtain the magnetic flux density in vector form.(June 2007)(R)
10. (i) A rectangular loop (8 x 4) m, carrying 10A in placed on z =0 plane. Find the field intensity at (4, 2, 0) m.(ii) Find the magnetic flux density around infinitely long straight conductor by magnetic vector potential.(Dec 2005)(U)
11. (i) Explain the constructional features of solenoid.(ii) Derive expressions for a magnetic flux density (B) at any point along the axis of the solenoid.(iii) Draw the variations of flux density (B) along the axis. (May 2005,June 2016)(U)
12. (i)Define a magnetic circuit with a sketch and hence obtain the expression for its reluctance.
    (ii) A magnetic circuit employs an air core toroid with 500 turns, cross sectional area 6cm^2 mean radius 15cm and coil current 4A. Determine the reluctance of the circuit, flux density and magnetic field intensity. (E)
13. A rectangular loop in the loop in the xy plane with sides b_1 and b_2 carrying a current I lies in a uniform magnetic field B = $a_xB_x + a_y B_y + a_zB_z$. Determine the force and torque on the loop.(June 2016)(E)
14. The magnetic vector potential is A wb/m. calculate the total magnetic flux crossing the surface (Dec 2010)(E)
15. Determine the force per unit length between two infinitely long parallel conductors carrying current l in the opposite direction, this conductors being separated by a distance d(Dec 2010)(U)
16. a.Explain about magnetic vector potential b.Explain the different applications of ampere's law (May2010,Jan 2017)(A)
17. 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=6.5 T(May 2010)(E)
18. A –ve point charge Q=-40nC is moving with a velocity of 6x106 m/s in a direction specified by the unit vector av=-0.4ax-0.6ay+0.64az.find the magnitude of the vector exerted on the moving particle by the field B=2a_x-3a_y+5a_z(Dec 2011)(E)
19. A loop with magnetic dipole moment 8x10$^{-3}a_z$ A.m^2.Lies in a uniform magnetic field B=0.2a_x+0.4a_z wb/m^2.calculate the torque(May 2011)(E)
    20. find the magnetic field intensity at a point (0.01,0,0)m, if the current through a co-axial able 6A, which is along the z axis and (a=3,b=9,c=11)mm.(Nov/Dec 2010, Jan 2014)(E)
21. An iron ring with a cross sectional area of 3cm square and mean circumference of 15cm is wound with 250 turns wire carrying a current of 0.3A.the relative permeability of ring is 1500.calculate the flux established in the ring. (June 2013)(C)
22. Explain the different applications of ampere's law (June 2012,Dec 2011,May 2011)(U)
23. Obtain the expressions for scalar and vector magnetic potential (May 2010,June 09,2012,Jan 2014)(U)
24. The vector magnetic potential A=(3y-3)ax+2xyay Wb/m in the a certain region of free space. 1)show that ∇.A=0 2)find the magnetic flux density B and H at P(2,-1,3) (June 2012) (E)
25. A circular loop located on x^2+y^2=4,z=0 carries a direct current of 7A along aø. find the magnetic field intensity at (0,0,-5) (Dec 2011)(E)
26. 1) A differential current element Idza_z is located at the origin in free space. obtain the expression for the vector magnetic potential due to the current element and hence the magnetic field intensity at the

point(ρ,ø,z) 2) Find the force on a wire carrying a current of 2mA placed in the xy plane bounded by x=1,x=3 and y=0,y=2.the magnetic fields is due to a long conductor, located in y axis, carrying a current of 15A(Dec 2011)(E)

27. Derive an expression for a torque on a closed rectangular loop carrying current(May 2011)(C)
28. In cylindrical co-ordinates ,$A=50\rho^2 a_z$wb/m is a vector magnetic potential in a certain region of free space. Find the H,B and J(May 2011)(C)
29. Find the magnetic flux density at the center of the square loop with width w carrying a direct current of I. (Jan 2014,2016) (E)
30. Given the magnetic flux density $B=2.5(\sin \pi c/2)a_z wb/m^2$ find the total magnetic flux crossing the strip defined by z=0, y>0,0<x<2m(June 2012)(E)

UNIT-III ELECTRIC AND MAGNETIC FIELDS IN MATERIALS (CO3)

1. **Write poisson's and laplace 's equations.(June 2009,Dec 2010,June 2010,June 2016,Jan 2017)(U)**
   Poisson 's equation: $\nabla^2 V = -\rho_v / \varepsilon$ Laplace' s equation: $\nabla^2 V = 0$
2. **Define current density.(May2011)(U)**
   Current density is defined as the current per unit area. J= I/A Amp/m^2
3. **What is the expression for energy stored in a an inductor?** $W = ½ LI^2$**(June 2012,June 2016)(R)**
4. **What is energy density in magnetic field?(R)** $W = ½ \mu H^2$
5. **Write the point form of continuity equation and explain its significance.(U)**
   $\nabla \bullet J = -\delta\rho_v / \delta t$
6. **Write the expression for energy density in electrostatic field. W=1/2 CV^2 (U)**
7. **Write the boundary conditions at the interface between two perfect dielectrics.(U) (June 2010)**
   i)The tangential component of electric field is continuous i.e) Et1=Et2
   ii)The normal component of electric flux density is continuous i.e) Dn1=Dn2
8. **State point form of ohms law. (Dec 2010,June 2013,Jan 2017))(U)**
   Point form of ohms law states that the field strength within a conductor is proportional to the current density. $J=\sigma E$
9. **What is polarization?(May2011)(R)**
   The product of electric charge and distance n know as dipole moment. It is denoted by m where Q is the charge l is the length. m=Q.l Dipole moment per unit volume is called Polarization. P = Q/A
10. **What are equipotential surfaces?(Dec 2010)(R)**
    An equipotential surface is a surface in which the potential energy at every point is of the same value.
11. **Distinguish between solenoid and toroid.(A) (Dec 2008)**
    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.
12. **What are the significant physical differences between Poisson's and Laplace's equations. (Dec 2010, June 2016)(R)**
    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 poisson's equation can be used to find the potential.When the region is free from charge Laplace equation is used to find the potential.
13. **What are dielectrics? (June 2016)(R)**
    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.

14. **Define dielectric strength.(May2010)(R)**
    The dielectric strength of a dielectric is defined as the maximum value of electric field that can be applied to the dielectric without its electric breakdown.
15. **What is meant by dielectric breakdown?(R)**
    As the electric field applied to dielectric increases sufficiently, due to the force exerted on the molecules, the electrons in the dielectric become free. Under such large electric field, the dielectric becomes conducting due to presence of large number of free electrons. This condition is called dielectric breakdown.
16. **Define inductance.(R) (Dec 2008)**
    The inductance of a conductor is defined as the ratio of the linking magnetic flux to the current producing the flux. $L = N\Phi / I$
17. **Define self-inductance.(May2011,Dec 2010)(R)**
    Self inductance is defined as the rate of total magnetic flux linkage to the current through the coil. $L = \Phi / i$ where, Φ = magnetic flux. i =current.
18. **Define mutual inductance. (June 2009,June 2016)(R)**
    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. $M = N_2\, \Phi_{12} / i_1$ Where, N_2 = no of turns in coil 2
19. **Distinguish between diamagnetic, paramagnetic and ferromagnetic materials or classify the magnetic materials (Jan 2014)(Ana)**
    Diamagnetic: In diamagnetic materials magnetization is opposed to the applied field. It has weak magnetic field.
    Paramagnetic: In paramagnetic materials magnetization is in the same direction as the applied field. It has weak magnetic field.
    Ferromagnetic: In ferromagnetic materials magnetization is in the same direction as the applied field. It has strong magnetic field.
20. **A ferrite material has μ_R = 50, operate with sufficiently low flux densities and B = 0.05T and H.**
    The magnetic field intensity $\vec{H} = \vec{B} / \mu_0\, \mu_R$ = 796 amperes/m **(U)**
21. **Determine whether the potential field V = $x^2 - y^2 + z^2$ satisfy Laplace equation.(June 2016)(E)**
    $V = x^2 - y^2 + z^2$, $\frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2} = \nabla^2 V$ $\frac{\partial^2 V}{\partial x^2} = 2 \frac{\partial^2 V}{\partial y^2} = -2 \frac{\partial^2 V}{\partial z^2} = 2$

    $\nabla^2 V = 2-2+2 = 2 \neq 0$, Hence potential field V does not satisfy Laplace equation.
22. **Express Laplace equation in spherical co-ordinates(June 2012,Dec 2011,Jan 2016)(C)**
23. **What do you understand from the current continuity equation?(May 2011)(R)**
    Continuity equation indicates that the current diverging from a small volume per unit volume is equal to the time rate of decrease of charge per unit volume at every point

<u>16 MARK QUESTIONS</u>

1. (i) Derive the expressions for energy stored in magnetic field of a coil possessing an inductance L when the current in the coil is 1 amp.(June 2010)(U)
   (ii) Obtain the boundary conditions of normal and tangential components of magnetic field at the interface of two media with different dielectrics. (U) (June 2010, Jan 2016,June 2016,Jan 2017)
2. (i) Derive an expression for the capacitance of a spherical capacitor with conducting shells of radius 'a' and 'b'.(June 2009,Jan 2016)(U)
   (ii) Obtain the expressions for the energy stored and energy density in a capacitor. (Dec10,June 09, Jan 2016, June 2016)(A)
3. (i) Derive the boundary conditions between two magnetic media.(June 2009,May 2010)(R)
   (ii) A solenoid has an inductance of 20mH. 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.(June 2009)(E)
4. (i) An air core toroid has a mean radius of 40mm and is wound with 4000 turns of wire. The circular cross section of the toroid has a radius of 4mm. A current of 10A is passed in the wire. Find the

inductance and the energy stored. (ii) Calculate the inductance of a 10m long co-axial cable filled with a material for which μ_r= 80 and radii of inner and outer conductors are 1mm and 4mm respectively.(C)

5. (i) Derive the boundary relations at the boundary between a conductor and a dielectric.ii) Parallel plate capacitor is of area 1m2 and has a separation of 1mm. The space between the plates is filled with dielectric of Σn =25. If 1000V is applied, find the force squeezing the plates together.(U)
6. (i) Three point charges 1, 2, 3 coulombs are situated in free space at the corners of an equilateral triangle of side 1m. Find the energy stored in the system.(Ana)(Jan 2017)
   (ii) Show that the inductance of the cable L= $\frac{\mu l}{2\pi}\ln\frac{b}{a}H$. (Ana)(/May 2011)
   iii) Derive an expression for the capacitance of a parallel plate capacitor with two dielectric media.
   (iv) A parallel plate capacitor with a separation of 1cm has 29kV applied, when air was the dielectric used. Assume that the dielectric strength of air as 39kV/cm. A thin piece of glass with ε_r =6.5 with a dielectric strength of 290kV/cm with thickness 0.2 cm is inserted. Find whether glass or air will break.(Ana)
7. (i) Derive an expression for inductance of a solenoid with N turns and l meters length carrying a current of I amperes.(Dec 2010)
   (ii) Calculate the inductance of solenoid of 200 turns wound tightly on a cylindrical tube of 6cm diameter.The length of the tube is 60cm and the solenoid is in air.(E)
8. (i)A parallel plate capacitor has a plate separation t. The capacitance with air only between the plates is C. When a slap of thickness'' and relative permittivity ε_r is placed on one of the plates, the capacitance is C'. Show that C'/C = $\varepsilon_r t/(t' + \varepsilon_r(t-t'))$. (E)
   (ii) Obtain the expression for the inductance of a toroid and solenoid. (Ana)(May 2010, Dec2010, Jan 2014)
9. (i) A dielectric slab of flat surface with relative permittivity 4 is disposed with its surface normal to a uniform field with flux density 1.5C/m^2. The slab occupies a volume of 0.08m^3 and is normally polarized. Determine (1) The polarization in the slab and (2) The total dipole moment of the slab.(U)
   (ii) Capacitance of coaxial cable with two dielectrics ε_1 and ε_2. (R)
10. (i) Discuss briefly about nature of dielectric materials.(A)
    (ii) Given the potential field, V = $\frac{50\sin\theta}{r^2}V$, in free space, determine whether V satisfies Laplace's equation.(Ana)
11. (i) Explain and derive the polarization of a dielectric material. (A)
    (ii) Draw and explain the magnetization curve and hysteresis loop of a toroid with ferromagnetic core. List out any five ferro magnetic material.(Ana)
12. A solenoid 25cm long, 1cm mean diameter of the coil turns uniformly distributed windings of 2000 turns. The solenoid is placed in uniform field of 2 tesla flux density. A current of 5A is passed through the winding. Determine the (1) maximum force on the solenoid (2) maximum torque on the solenoid and (3) compute the magnetic moment on the solenoid.(E)
13. Evaluate the capacitance of (i) a spherical satellite 1.5m diameter in free space. (ii) a co-axial cable 1.5m long filled with polyethylene (ε_r =2.26) with inner conductor of radius 0.6 mm and inner radius of outer conductor 3.5 mm.(iii) An infinitely long conductor with 1.5 mm radius and suspended horizontally at a height of 15 m above a conducting plane and parallel to it in air. (E)
14. Calculate the inductance of a ring shaped coil having a mean diameter of 20 cm. Wound on a wooden core of 2 cm diameter. The winding is uniformly distributed and contains 200turns.(E)
15. Derive Poisson's and Laplace's equation. state their significance in electrostatic problems(May 10,2011)(U)
16. A parallel plate capacitor has an area of 0.8 m^2,separated by 0.1mm with a dielectric ε_r=1000 and field=106 v/m, find C &V. (May 2010,Jan 2016)(A)
17. With neat diagram explain the B-H curve for classifying magnetic materials**.**(Nov/Dec 10),(May 2011)(R)
18. Find the μof the material whose magnetic susceptibility is 49. (May 2011) (E)

19. Determine whether or not the following potentials fields satisfy the Laplace equation 1)$V=x^2-y^2+z^2$ 2)V=rcosø+z 3)V=rcosθ+ø (/May 2011)(E)
20. Solve the Laplace equation for the potential field in the homogenous region between the two concentric conducting spheres with radius a and b where b>a v=0 at r=b and V=Vo at r=a. Find the capacitance between the two concentric spheres. (May 2011) (C)
21. Two parallel conducting plates are separated by distance d apart and filled with dielectric medium having ε_r as relative permittivity. Using Laplace equation derive an expression for capacitance per unit length. (May 2011)(Ana)
22. A solenoid is 50cm long, 2 cm in diameter and contains 1500 turns. The cylindrical core has a diameter of 2 cm and a relative μ of 75.this coil is co-axial with a second, also 50cm long, but 3cm diameter and 1200 turns. Calculate L for the inner solenoid; and L for the outer solenoid. (Dec 2010)(E)
23. Determine the capacitance of the parallel plate capacitor composed of tin foil sheets,25cm square for plates separated through a glass dielectric 0.5cm thick with relative permittivity of 6.(May 2013)(C)
24. Calculate the internal and external inductance per unit length of a transmission line consisting of two long parallel conducting wire of radius a that carry in opposite directions. The axis of the wires are separated by a distance d much larger than a.(Jan 2014)(E)
25. The capacitance of the conductor formed by the two parallel metals sheets, each $100cm^2$in area separated by a dielectric 2mm thick is 2x10-10 micro farad. A potential of 20kv is applied to it find electric flux, potential gradient, μ_r,electric flux density.(June 2013)(C)
26. Derive the expression for continuity equation of current in differential form .(E)
27. A metallic sphere of radius 10cm has a surface charge density of $10nc/m^2$.calculate the energy stored in the system.(A)

UNIT-IV TIME VARYING ELECTRIC AND MAGNETIC FIELDS (CO4)

1. **Define Poynting vector?(May2011,May2010,Jan 2016)(R)**
   The cross product of electric field and magnetic intensity vector is defined as pointing vector
   $P = E \times H$ (or)
   Poynting vector gives the magnitude as well as the direction in which power flows in time varying electromagnetic fields.
2. **Determine emf developed about the path r = 0.5, z = 0 and t = 0. If B = 0.01 sin 377 t.(E)**
   $e = - d\phi / dt = - d / dt (B.A) = -A\, d / dt (0.01 \sin 377 t)$ $e_{t=0} = -2.96V$
3. **Write down any two Maxwell's equation derived from Faraday's law? (Dec 10,2011,Jan 2018)(C)**
   $\int E.\, dl = -\int\int (\partial B / \partial t)\, ds$ ---- Integral form $\nabla x E = - \partial B / \partial t$ --- Differential form
4. **What is displacement current and conduction current?(June 2013,Jan 2014)(R)**
   The current through a capacitor is called displacement current. It is denoted as I_D.
   $I_D = dQ / dt$
   The current through a conductor is called conduction current. It is denoted as I_C.
   $I_C = V / R$
5. **Brief about the ampere's circuital law for a in integral form.(June 2010,2012,Jan 2017)(U)**
   Ampere's law states that the line integral of magnetic field intensity H on any closed path is equal to the current enclosed by the path $\int H.\, dl = I$
   $\int H.\, dl = \int\int \{J + \partial D / \partial t\}\, ds$
6. **State Faraday's law for a moving charge in a constant magnetic field.(R)**
   (June 2009, June 2010, Jan 2014)
   Faraday's law states that the electromagnetic force (mmf) induced in a circuit is equal to the rate of decrease of the magnetic flux linkage the circuit. $v = - d\phi / dt$

7. **Write down Maxwell's equation in integral form? (June 2010,June 2016)(R)**
   (i) $\int H.\,dl = \int\int \{J + \partial D / \partial t\}\, ds$ ii) $\int E.\,dl = -\int\int (\partial B / \partial t)\, ds$
   (ii) $\iint D.\,ds = \iiint \rho.\,dv$ iii) $\iint B.\,ds = 0$
8. **Write down Maxwell's equation in point form? (Jan 2016,Jun 2016)(R)**
   $\nabla \times H = J + \partial D / \partial t$ $\nabla . D = \rho$
   $\nabla \times E = -\partial B / \partial t$ $\nabla . B = 0$
9. **State Poynting Theorem?(U)(Jan 2017)**
   Poynting Theorem states that the net power flowing out of a volume v is equal to the time rate of decrease in the energy stored within a volume v minus the conduction losses.
   $\int (E \times H).ds = - \partial / \partial t \int (½\, \varepsilon E^2 + ½\, \mu H^2)\, dv - \int \sigma E^2\, dv$.
10. **Mention significance of displacement current density and conduction current density?(R)**
    Displacement current density = $J_D = \partial D / \partial t = \varepsilon \partial E / \partial t$**(May2011)**
    Conduction current density = $J_c = \sigma E$
11. **Discuss the condition under which conduction current is equal to displacement current?(C)**
    In a conductor conductivity σ goes to zero means it act as a dielectric and corresponding current is displacement current.
12. **Brief about complex Poynting vector?(June 2010,2013,Jan 2016,June 2016)(Ana)**
    The complex Poynting vector is given by, P = ½ (E x H)
    The product of E and H is vector product. The mutually perpendicular components E and H, contribute to the power flow. This power flow is directed along the normal to the plane containing E and H.
13. **In a material for which σ = 5.0 s/m and ε_r =1 and E = 250 sin 10 ^{10}t (V/m). Find the conduction and displacement current densities. (June 2010)(E)**
    Conduction current density = $J_c = \sigma E$ = 1250250 sin 10 ^{10}t (V/m)
    Displacement current density = $J_D = \partial D/\partial t = \varepsilon\, \partial E/\partial t = \varepsilon_0 \varepsilon_r\, \partial E/\partial t$ = 22.1 cos10^{10}t V/m.
14. **A poor conductor is characterized by a conductivity σ =100s/m and permittivity $\varepsilon=4\varepsilon_o$.at what angular frequency ω is the amplitude of the conduction current density J equal to the amplitude of displacement current density J_d.(Dec 2010)(E)**
15. **What is displacement current density?(May2010)(R)**
    The current through a capacitor is called as displacement current .the displacement current to the area is called as displacement current density and it is denoted by J_D
16. **Write down instantaneous and average pointing vector .(Dec 2010,June 2012, 2013,June2016) (R)**
    The poynting vector is given by P=E XH .This equation represents the instantaneous power flow per unit area. Hence it is also called instantaneous pointing vector using the complex poynting vector we can obtain the average and reactive parts of the power flow per unit area. The average part of the power flow per unit area is given by Pavg=1/2 Re[E X H*].
17. **What is the power flow in the co-axial cable? (Dec 2011)(R)**
    Consider a coaxial cable with inner and outer conductors concentric to each other. Suppose power is transferred along a co-axial cable to the load resistance R. the total power flow along a cable is given by W=V I
18. **Give the situation when the rate of change of flux results in a non-zero value(Nov/Dec 2011)(U)**
    The following situation rate of change of flux results in a non-zero value
    - there exists a relative motion between conductor and flux
    - plane of flux and motion of conductor should not be parallel
    - an altering flux linking with coils N turns
19. **Write down Maxwell's equation in phasor form?(Dec 2010)(U)**
20. **An EM wave has Ex and Hy has components of electric and magnetic fields respectively. Find the direction of the power flow (June 2012)(Ana)**

16 MARK QUESTIONS

1. Obtain the expressions for the four Maxwell's equation in the point form and integral form. (Dec 2010,June 2010, 2013, Jan 2016, June 2016,Jan 2017)(U)
2. Derive the Maxwell's curl equation from ampere's law and faraday's law. Explain the equations in phasor form for time harmonic fields. (/May 2010,June 2012,Jan 2014)(U)
3. A circular loop of N turns of conducting wire lies in the x-y plane with its center at the origin of a magnetic field specified by $B = a_z B_0 \cos(\pi r/2b)\sin\omega t$, where b is the radius of the loop and ω is the angular frequency. Find the emf induced in the loop.(Ana)
4. Define poyntingvector and deduce the poynting theorem neatly. (A)
5. (i) Derive the expressions for displacement current and conduction current densities.
   (ii) State and prove Poynting theorem. (June 2010,11,Dec 2010, 2011,Jan 2017)(C)
6. Prove that $\nabla \times E = -\delta B/\delta t$.(U)
7. Discuss about Poynting vector and power flow. (Ana)
8. Obtain the expression for total power flow in co-axial cable. (June 2011)(E)
9. Define poynting vector and prove that the electromagnetic power flow is the product of electric and magnetic field intensities.(June 2015,Jan 2016) (U)
10. If $D = 20x\, a_X - 15y\, a_y + kza_Z$ $\mu C/m^2$, $D = 10x\, a_X + 5y\, a_y + kz^2 a_Z$ $\mu C/m^2$find the value of k to satisfy the Maxwell's equation for region $\sigma = 0$ and $\rho_v = 0$.(E)
11. A conductor 1 cm in length is parallel to z axis and rotates at radius of 25 cm at 1200 rpm. Find induced voltage, if the radial field is given by $B = 0.5a_r T$.(Jan 2014) (A)
12. If the magnetic field $H = (3x \cos\beta + 6y \sin\alpha)a_z$, find current density J if the fields are invariant with time.(E)
13. A conducting cylinder of radius 5 cms, height 20cm , rotates at 600 rps in a radial field B =0.5 tesla. The sliding contacts at the top and bottom are connected to a voltmeter. What is the reading of voltmeter?(E)
14. The conduction current flowing through a wire with conductivity $\sigma = 3 \times 10^7$ s/m and relative permittivity $\varepsilon_r = 1$ is given by $I_c = 3 \sin\omega t$ (mA). If $\omega = 10^8$ rad/s, Find the displacement current? (June 2013)(U)
15. A material for which $\sigma = 5$ mho/m and $\varepsilon_r = 1$, electric field intensity is $E = 250 \sin 10^{10} t\, u_x$ V/m. Determine the conduction and displacement current densities and the frequency at which they equal magnitude.(June 2012)(U)
16. Explain about displacement current and displacement current density. Also find displacement current density for the field $E = 300 \sin 10^9 t$ V/m.(E)
17. Find the frequency at which conduction current density and displacement current density are equal in (1) distilled water, for which $\varepsilon_r = 81$ and $\sigma = 2.0 \times 10^{-4}$ mho/m.(2) sea water, for which $\varepsilon_r = 1$ and $\sigma = 4.0$ mho/m. (C)
18. Given the conduction current density in a lossy dielectric as $J_c = (0.02 \sin 10^9 t)$ A/m^2. Find the displacement current density if $\sigma = 10^3$ mho/m and $\varepsilon_r = 6.5$ (C)
19. Derive the expression for displacement and conduction current densities.(June 2010,Dec 11)(A)
20. Find the amplitude of displacement current density inside a capacitor where $\varepsilon_r = 600$ and $D = 3\times10^{-6}\sin(6\times10^6 t - 0.3464x)a_z$ c/m^2. (May 2010)(A)
21. In free space,$H = 0.2 \cos(\omega t - \beta x)a_z$ A/m. find the total power passing through a circular disc of radius 5cm.(/May 2010,June 2012)(R)
22. An electric field in a medium which is source free is given by $E 1.5\cos(10^8 t - \beta z)ax$ V/m. find B,H and D. assume $\varepsilon_r = 1, \mu_r = 1, \sigma = 0$ (U)(June 2013)

23. Explain the following :poynting, average power and instantaneous power.(June 2012)(U)
24. A rectangular loop of length a=1m,width b=80cm is placed in a uniform magnetic field. find the maximum value of induced EMF if the B=0.1 Wb/m^2 is constant and the loop rotates with a frequency of 50hz.(Dec 11)(E)
25. Give the physical interpretation of Maxwell's first and second equation.(Dec 11)(A)
26. In free space E= 50cos ($\omega t-\beta z$) ax v/m. find the average power crossing a circular area of radius 2.5m in the plane z=0.assume $E_m=H_m\eta_o$ and $\eta_o=120\pi\ \Omega$.(Dec 11,Jan 2016)(A)
27. If electric field intensity in free space is given by $E=50/\rho\cos(108t-10z)a_\rho$V/m.find the magnetic field intensity H.(May 2011)(E)
28. Do the fields E=Emsinxsint a_y and H=Hmcosxcosta_z satisfy the Maxwell equations.(U)
29. Find the amplitude of J_D in the antenna where the field strength of TM signal $E=80\cos(6.277\times10^8t-2.092y)a_z$ v/m.(E)
30. Generalize amperes law for time varying fields.(June 2016)(Ana)

UNIT-V ELECTROMAGNETIC WAVES (CO5)

1. **Define a wave?(R)**
   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. **Find the velocity of a plane wave in a lossless medium having a relative permittivity of 5 and relative permeability of 2.** (E) v $=1/\sqrt{\mu\varepsilon} = 1/\sqrt{(\mu_0\mu_r\ \varepsilon_0\varepsilon_r)}$ =
3. **Define the term intrinsic impedance of free space with its value?(June 2010)(U)**
   It is the ratio of electric field to magnetic field or It is the ratio of square root of permeability to permittivity of the medium. $\eta = E/H = \sqrt{(\mu_0/\omega_0)}$ =377 ohms
4. **What is homogeneous material?(R)**
   The medium is called homogeneous when the physical characteristics of the medium do not vary from point to point but remain same everywhere throughout the medium.
5. **Mention properties of uniform plane wave?(June 2015)(U)**
   1. 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.
   2. The fields are varying harmonically with time and at the same frequency, everywhere in space.
   3. Each field has the same direction, magnitude and phase at every point in any plane perpendicular to the direction of wave travel.
6. **What is meant by skin depth or depth of penetration? (Jan 2016,Jan2017)(U)**
   Skin depth is defined as that of depth in which the wave has been attenuated to 1/e or 37% of its original value. $\delta = 1/\alpha = \sqrt{2/(j\omega\sigma)}$ = for good conductor.
7. **Define Polarization?(May 2011)(R)**
   Polarization is defined as the Polarization of a uniform plane wave refers to the time varying nature of the electric field vector at some fixed point in space.
8. **What is meant by linear polarization?(R)**
   If x and y component of electric field E_x and E_y are present and are in phase, the resultant field has a direction at an angle of $\tan^{-1}(E_y/E_x)$ and if the phase angle is constant with time, the wave is to be linearly polarized.
9. **What is meant by circular polarization? (June 2016)(U)**
   If x and y component of electric field E_x and E_y have different amplitude and 90° phase difference, the locus of the resultant electric field E is a circle and wave is to be circularly polarized.

10. **What is meant by elliptical polarization? (June 2016)(U)**
    If x and y component of electric field E_x and E_y have different amplitude and 90° phase difference, the locus of the resultant electric field E is a ellipse and wave is to be elliptically polarized.
11. **What is Brewster Angle?(June 2010,2012,2013,June 2016,Jan 2018))(U)**
    Brewster Angle is an incident angle at which there is no reflected wave for parallely polarized wave.$\theta = \tan^{-1}\sqrt{\varepsilon_2/\varepsilon_1}$where, ε_1= dielectric constant of medium 1, ε_2 = dielectric constant of medium 2
12. **Write down the wave equation for E and H in free space.(Ana)**
    $\nabla^2 H - \mu\varepsilon\frac{\partial 2H}{\partial t2} = 0$ $\nabla^2 E - \mu\varepsilon\frac{\partial 2E}{\partial t2} = 0$
13. **Write down the wave equations for E and H in a conducting medium. (June 2010)(Ana)**
    $\nabla^2 H - \mu\varepsilon\frac{\partial 2H}{\partial t2} - \mu\sigma\frac{\partial H}{\partial t} = 0$ $\nabla^2 E - \mu\varepsilon\frac{\partial 2E}{\partial t2} - \mu\sigma\frac{\partial E}{\partial t} = 0$
14. **Define propagation constant.(U)**
    Propagation constant is a complex number $\gamma = \alpha + j\beta\gamma = \sqrt{j\omega\mu(\sigma + j\omega\varepsilon)}$
    Where α is attenuation constantβ is phase constant
15. **Define loss tangent. (May2011)(U)**
    Loss tangent is the ratio of the magnitude of conduction current density to displacement current density of the medium.
16. **Define reflection coefficients** and **transmission coefficients(U)**
    Reflection coefficient is defined as the ratio of the magnitude of the reflected field to that of the incident field.
    Transmission coefficient is defined as the ratio of the magnitude of the transmitted field to that of incident field.
17. **What are uniform plane waves?(June 2010)(R)**
    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.
18. **State Snell's law.(U)**
    When a wave is travelling from one medium to another medium, the angle of incidence is related to angle of reflection as follows. $\frac{\sin\theta i}{\sin\theta t} = \sqrt{\frac{\eta 1}{\eta 2}} = \sqrt{\frac{\varepsilon 2}{\varepsilon 1}}$
    Where, θ_i is angle of incidence, θt is angle refraction
19. **A plane TEM wave has a power density of 1.2 W/m^2 in a medium with ε_r=3,μ_r=1 . find E&H (Dec 2010)(E)**
20. **The electric field E in free space is given as E=$E_m$cos (ωt-βz) ux. Determine magnetic flux density. (Dec 2010)(E)**
21. **Define skin effect. mention its significance (Dec 2010,2011,Jan 2014)(U)**
    For a good conductor all the fields and currents are confined to a very thin layer near the surface of the conductor .this thin layer is skin of the conductor hence this effect is called skin effect.
22. **The dielectric constant of pure water is 80.determine the Brewster angle for parallel polarization.**
    For pure water ε_{r1}=80; ε_{r2}=1 Tan $\theta_1 = \sqrt{\frac{\varepsilon r1}{\varepsilon r2}} = (80/1)^{1/2} = 8.944$ $\theta_1 = 83.62°$**(Dec 2010)**
23. **Define perpendicular and parallel polarization.(Dec 2010,Jan 2017)(U)**
    The electric vector is Perpendicular to the boundary surface or parallel to the Plane of incidence is termed as vertical polarization or parallel Polarization.
    The electric vector is parallel to the boundary surface or perpendicular to the plane of incidence is termed as horizontal polarization or Perpendicular polarization.
24. **Write the equation for the attenuation constant, phase constant, intrinsic impedance of a perfect conductor. (Dec 2010)(C)**

Attenuation constant $\alpha = \pi f\mu\sigma$ Np/m Phase constant: $\alpha = \pi f\mu\sigma$ rad/m

Intrinsic impedance: $j\omega\mu/\sigma+j\omega\varepsilon$

25. **Write general wave equation (Nov/Dec 2011). (Ana)**
26. **Determine the skin depth of copper at 60 Hz with σ=5.8x107S/m. given μr=1.(June 2012) (E)**
27. **What are the types of polarization (Dec 2011) (U)**

    There are different types of polarization of a uniform plane wave as given below
    - Linear polarization
    - Elliptical polarization
    - Circular polarization
28. **Find the skin depth at a frequency of 3MHZ is Al where σ =38.2 Ms/m and μr=1(June 2013)(U)**
29. **State the conditions to be satisfied for a linearly polarized uniform plane waves(Jan 2014)(A)**

16 MARK QUESTIONS

1. (i) Derive the general wave equation. (ii)Discuss about the plane waves in lossy dielectrics.(Jan 2016, June 2016,Jan 2017) (R)
2. Briefly explain about the wave incident (i) normally on a perfect conductor (ii)obliquely to the surface of perfect conductor.(June 2016)(R)
3. Explain in detail the wave incident normally on perfect dielectric.(June 2010)(U)
4. (i)Explain about the propagation of EM waves in good conductor. (E)
   (ii) A uniform plane wave is travelling at a velocity of 2.5×10^5 m/s having wavelength $\lambda = 0.25$mm in a good conductor. Calculate the frequency of wave and the conductivity of the medium.(E)
5. Derive the wave equations for plane waves in(E)
   (i) free space (ii) homogeneous materials (iii)conducting medium.(E)
6. (i) Calculate the attenuation constant and phase constant for a uniform plane wave with frequency of 10GHz in a medium for which $\mu = \mu_0$,ε_r=2.3andσ =2.56×10^{-4}mho/m(E)
7. (i) Calculate the attenuation constant and phase constant for a uniform plane wave with frequency of 100GHz in a medium for which μr =1andσ =58×10^{6}mho/m (May 2011)(U)
   (ii) Derive the expressions for the attenuation constant, phase constant and intrinsic impedance for a uniform plane in a good conductor.(May 2010,June 2009)(E)
8. (i) Assume that E and H waves, travelling in free space, are normally incident on the interface with a perfect dielectric with ε_r =3. Calculate the magnitudes of incident, reflected and transmitted E and H waves at the interface.(ii) A uniform plane wave of 200MHz, travelling in a free space impinges normally on a large block of material having $\varepsilon_r = 4$, $\mu_r = 9$, $\sigma = 0$. Calculate transmission and reflection coefficients at the interface. (June 2006)(E)
9. Derive the expression for total field when a horizontally polarized and vertically polarized EM wave is incident obliquely on a perfect conductor.(June 2016)(E)
10. Determine the reflection and transmission coefficient of oblique incidence on a dielectric- interface for perpendicular and parallel polarization.(Dec 2010,Jan 2017)(E)
11. A lossy dielectric is characterized by εr = 2.5, $\mu_r = 4$ and $\sigma = 10^{-3}$ mho/m at 10MHz. Let $E = 10e^{-Vz}\, a_x$ V/m. Find (i) α (ii) β (iii) λ (iv) V_p (v) η ?(A)
12. Given two dielectric media, medium 1 is free space and medium 2 has $\varepsilon_2 = 4\,\varepsilon_0$ and $\mu_2 = \mu_0$. Determine reflection coefficient for oblique incidence $\theta_1 = 30^o$ for a) perpendicular polarization and b) parallel polarization.(Ana)
13. (i)Find the depth of penetration of plane wave in copper at a power frequency of 60Hz and at microwave frequency 10^{10} Hz. Given $\sigma = 5.8 \times 10^7$ mho/m.(ii)Explain reflection of uniform plane waves with normal incidence at a plane dielectric boundary.(E)
14. (i)Explain the types of polarization of uniform plane wave. (Jan 2016,Jan 2017)
    (ii)Define skin effect. Obtain the expression for it. (May/June 2010)(E)
15. (i)Derive wave equation for E and H in conducting medium.(May 2010)(U)

(ii)Write briefly on total internal reflection.(R)

16. 1. Explain the reflection of plane waves by perfect dielectric.2. Discuss the wave motion in good conductor. (May2010)(U)
17. Derive vector wave equation for a lossy dielectric medium.(May 2011)(U)
18. Derive the transmission and reflection coefficient for the electromagnetic waves when incident normally on perfect dielectric.(June 2010,June 2016)(Ana)
19. An EM wave has electric component given by $E=E_o \sin (t-z)(a_x+a_y)$v/comment on the polarization of the wave (Dec 2011)(Ana)
20. E and H wave travelling in free space are normally incident on the interface with perfect dielectric with εr=3.compute the magnitude of the incident reflected and transmitted E and H wave at the surface(Dec 2010,May 2011)(E)
21. The electric fields associated with the plane travelling in a perfect dielectric medium is given by Ex(z,t)=10cos[2πx107t-0.1πx]V/m.find the velocity of propagation and η.Assume μ=μo(Dec 10)(E)
22. A uniform plane in free space is normally incident on a dielectric having relative permittivity 4 and μr=1.the electric field of incident wave is given by $E=E_oe^{-z}$ ax to z<0,where E_o is constant find1)frequency and λ of incident and transmitted wave 2)H of incident wave 3)transmission coefficient and the expression for the electric field of the transmitted wave 4)expression for the magnetic field of the transmitted wave.(Nov/Dec 2011,JAN 2016,JUN 2016)(A)
23. Determine α,β,γ,λ,v,ή for damp soil at a frequency of 1MHZ given ε_r=12,μ_r=1and σ=20mv(Jan 2014)(A)
24. Determine the critical angle for the EM wave passing through glass to air if ε_r for glass is 9.(Jan 2014)(A)
25. Derive the wave equation starting from Maxwell's equation for free space (Jan 2014)(E)
26. A plane of sinusoidal electromagnetic waves travelling in space has Emax=150μV/m. Find i) the H max, ii) propagation is in X direction and H is oriented in Y direction, iii) compute the average power transmitted (June 2013).(E)
27. A uniform plane wave in a medium having σ=10-3 S/m,ε=80εo and μ=μo is having a frequency of 10Khz find i) verify whether the medium is good conductor ii) α iii) β iv) γ v) η vi)λ vii)v
    (June 2012, JAN 2016)(E)