Subject: Field Theory (2140909)

B.E. – Second year [Fourth Semester]

Branch – Electrical Engineering

Term: 16/2 (Jan-17 to May-17)

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Contents:

Instructions For Assignment/Tutorial:

[1] This set of Assignment-Tutorial consist the collection of questions of past GTU Question papers.
[2] Attend those questions which are bold marked and/or frequently asked in GTU exam.
[3] Students should make a separate Chapter wise Files[write on File Pages] to solve these Questions.
[4] Students must solve these given set of Assignments by themselves only.
[5] Assessment of given assignment should be done regularly after completion of each chapter by Students from the respective faculty members.

[1] Course Outcomes:

1. Vector Algebra and Different Co-ordinate System
2. Laws governing to Electric Field Intensity and their application
3. Laws governing to Electric Flux density and their application
4. Potential and Energy of the charge in an Electrostatic Fields
5. Nature and Boundary Condition of Dielectric Materials
6. Poisson's and Laplace's Equations' Application
7. Laws governing to Steady Magnetic Fields and their application
8. Types of Inductance, Nature of Magnetic materials and Magnetic Forces on Current Elements
9. Lossless Propagation of Transmission Line and its Equation Solution
10. Electromagnetic Interference and Compatibility

[2] Course Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	**Vector Analysis** Scalars and Vectors, Vector Algebra, The rectangular coordinate system, Vector components and unit vectors, The vector field, The dot product, The cross product, Circular cylindrical co-ordinates, Spherical co-ordinate system.	3	9
2	**Coulomb's law and Electric Field Intensity** The experimental law of Coulomb, Electric field intensity, Field due to a continuous volume charge distribution, Field of a line charge, Field of a sheet charge.	4	9
3	**Electric Flux Density, Gauss' law and Divergence** Electric flux density, Gauss' law, Application of Gauss' law: some symmetrical charge distributions, Application of Gauss' law to differential volume element, Divergence, Maxwell's first equation, The divergence theorem.	4	9
4	**Energy and Potential** Energy expended in moving a point charge in electric field, The line integral, Definition of potential and potential difference, The potential field of a point charge, The potential field of a system of charges, Potential gradient, The dipole, Energy density in the electrostatic field.	4	9
5	**Current and Conductors** Current and current density, Continuity of current, Metallic conductors, Conductor properties and boundary conditions, Semiconductors.	3	7
6	**Dielectrics and capacitance** The nature of dielectric materials, Boundary conditions for perfect dielectric materials, Capacitance, Several capacitance examples, Capacitance of a two wire line.	3	7
7	**Poisson's and Laplace's Equation** Derivation of Poisson's and Lapalce's equations, Uniqueness theorem, Example of the solution of Laplace's equation Example of solution of Poisson's equation.	3	8
8	**The Steady Magnetic Field** BiotSavart law, Ampere's circuital law, Curl, Stoke's theorem, Magnetic flux and magnetic flux density, The scalar and vector magnetic potentials, Derivation of steady magnetic field laws.	4	10

9	**Magnetic Forces, Materials and Inductance** Force on a moving charge, Force on a differential current element, Force between differential current elements, Force and torque on a closed circuit, The nature of magnetic materials, Magnetization and permeability, Magnetic boundary conditions, The magnetic circuit, Potential energy and forces on magnetic materials, Inductance and mutual inductance.	4	9
10	**Time Varying Fields and Maxwell's equation** Faraday's Law, Displacement current, Maxwell's equation in point form, Maxwell's equation in integral form.	3	7
11	**Transmission Lines** Physical description of transmission line propagation, The transmission line equation, Lossless propagation, Lossless propagation of sinusoidal voltages, Complex analysis of sinusoidal voltages, Transmission line equations and their solutions in phasor form.	4	8
12	**Effects of Electromagnetic Fields** Electromagnetic Interference and Compatibility (EMI/EMC), EMI Sources, Effects of EMI, Methods to eliminate EMI, EMC Standards, Advantages of EMC standards, Biological effects of EMI/EMR (Electromagnetic Interference, Electromagnetic radiation).	3	8

[3] Text Books:

1. **William Hart Hayt and John A. Buck. Engineering Electromagnetics, McGraw-Hill Education, 2006.**
2. **Field Theory by Uday A. Bakshi and Ajay V.Bakshi, Technical Publications.**
3. Matthew N. O. Sadiku, Principles of Electromagnetics, fourth edition, Oxford university press, 2007.
4. Fundamentals of Engineering Electromagnetics by Sunil Bhooshan, Oxford University Press.
5. Nathan Ida, "Engineering Electromagnetics" Second edition, Springer, Indian Edition, 2005.

Reference Book:

1. **Problems & Solutions of Engineering Electromagnetics by CBS Problems & Solutions Series.**
2. Electromagnetic Field Theory and Transmission Lines by G.S.N. Raju, Pearson Education.
3. Fundamentals of Electromagnetics by A.V. Mahatme, University Science Press.
4. Elements of Electromagnetics by Matthew N.O. Sadiku, Oxford University Press.
5. Electromagnetics with Applications by Kraus and Fleisch, Tata McGraw Hill Publications.

[4] List of Experiments:

SR. NO.	LIST OF PRACTICALS
1.	INTRODUCTION TO THE MATLAB 2010 SOFTWARE.
2.	EXECUTE A PROGRAM TO COMPUTES SCALER , VECTORS,CO-ORDINATE SYSTEMS AND FIELDS
3.	WRITE A PROGRAM COMPUTES COORINATES FOR VARIOUS COORDINATE SYSTEMS: 1. CARTESIAN TO POLAR 2. CARTESIAN TO SPHERICAL 3. POLAR TO CARTESIAN 4. SPHERICAL TO CARTESIAN
4.	WRITE A PROGRAMME TO FIND FORCE BETWEEN TWO CHARGES IN ELECTRIC FIELD.
5.	EXECUTE A PROGRAM COMPUTES THE POTENTIAL DIFFERENCE BETWEEN TWO POINTS DUE TO A POINT CHARGE.
6.	EXECUTE A PROGRAM COMPUTES THE CAPACITANCE OF CO-AXIAL CABLE OF THE CONDUCTOR.
7.	EXECUTE A PROGRAM COMPUTES A MAGNETIC FIELD ON THE AXIS OF A ROTATING CHARGED DISC.
8.	TUTORIAL NO 1
9.	TUTORIAL NO 2
10.	TUTORIAL NO 3

[5] Major Equipments required for Experiments :

- Computers:
  - Intel core i5 CPU
  - 500 GB Hard disk
  - 4 GB DDR-3 RAM
  - 18.5" LCD Monitor
  - Keyboard, Mouse

[6]List of Open source software and learning websites required for experiments :

1. Numericals based on solving Engg. Electromagnetics problems using MATLAB for tutorials are available in CD accompanied with the book of "Fundamentals of Engineering Electromagnetics by Sunil Bhooshan"
2. Matlab Experiments manual for Electromagnetics by Dr. M.H. Bakr

[7] Learning Assignments / Tutorial :

Chapter No.	Topic	Teaching Hrs.	Module Weightage
1	**Vector Analysis** Scalars and Vectors, Vector Algebra, The rectangular coordinate system, Vector components and unit vectors, The vector field, The dot product, The cross product, Circular cylindrical co-ordinates, Spherical co-ordinate system.	3	9

❖ **ATTEMPT THREE THEORY AND SIX EXAMPLES:**

SR. NO.	QUESTIONS	YEAR	MARKS
1.	**Explain dot product and cross product of two vectors. Also explain unit vectors of Cartesian, cylindrical and spherical co-ordinate systems.**	**DEC-11 JAN-13**	**07**
2.	Explain cylindrical coordinate system, differential elements and transformation method from cylindrical to Cartesian coordinate system.	JUNE-13	07
3.	Explain the physical significance of the term: (i) Divergence of a vector field and (ii) curl of a vector field.	MAY-13	07
4.	Give the basic concepts of transformation of one coordinate system to another.	MAY-13	07
5.	Explain spherical coordinate system. Explain conversion from cylindrical to spherical system.	Dec-14	07
6.	**Explain cylindrical coordinate system in brief. Also write the equations of differential length, differential surfaces and Differential volume elements.**	**MAY-15**	**07**
7.	**Explain Cartesian co-ordinate system along with the equations of differential length, differential surfaces and differential volume elements.**	**DEC-15**	**07**
8.	Give the importance of unit vectors. And discuss the concepts of differential surface vector.	**JUN-16**	**03**
9.	Draw the figure for the orthogonal system which has its second coordinate is angle made by cone and z- axis. Transform the co-ordinates of this system in to Cartesian co-ordinate	**JUN-16**	**07**
10.	Explain spherical coordinate system in brief. Also write the equations of differential length, differential surfaces and differential volume elements.	**JUN-16**	**03**
11.	Write down equation for , and for spherical coordinate system.	**JUN-16**	**02**
12.	Cylindrical coordinate 'z' is related to the Cartesian coordinate as	**JUN-16**	**02**

	_____. a) tan−1(y/x) (b) z (c) xy/z (d) cot z		
13.	Curl of the gradient of scalar magnetic potential is (a) zero (b) 1 (c) -1 (d) undefined	**NOV-16**	**02**
14.	Write the equation for point form of Ohm's law	**NOV-16**	**02**
15.	In a spherical co-ordinate system θ = constant is a plane (True or False)	**NOV-16**	**02**
16.	Explain how dot product and cross product of vectors is carried out	**NOV-16**	**03**
17.	Explain cylindrical co-ordinate system of vectors in brief	**NOV-16**	**04**
	EXAMPLES		
1.	**Let each of the vectors A= 5ax –ay +3az, B= -2ax +2ay +4az and C= 3ay-4az extend outward from the origin of a Cartesian coordinate system to points A, B and C respectively. Find a unit vector directed from point A toward: (a) to the origin; (b) point B; (c) appoint equidistance from B and C on the line BC; (d)Find the length of the perimeter of the triangle ABC.**	**MAY-11**	**07**
2.	Given points A(x = 2, y = 3, z = -1) and B(ρ= 4, Φ = -50, z = 2), find a unit vector in cylindrical coordinates at point B directed towards point A.	MAY-11	07
3.	**Given the point A(x=2 ,y=3 ,z=-1) and B(r=4 , θ=250 ,Φ=1200) Find (a) The spherical co-ordinates of A (b) The Cartesian co-ordinates of B (c) The distance from A to B.**	**DEC-11**	**07**
4.	Obtain the spherical co-ordinates of 10 $\bar{a}_x$ at the point P(x= - 3, y = 2, z = 4).	MAY-12	07
5.	**Find $\bar{E}$ at the origin if the following charge distributions are present in free space: 1) point charge 12 nC at P (2,0,6), 2) uniform line charge density 3 nC/m at x = - 2, y = 3, 3) uniform surface charge density 0.2 nC/m2 at x = 2.**	**MAY-12**	**07**
6.	**Transform the vector *4ax−2ay−4az* into spherical coordinates at a point *P (x=−2, y=−3, z=4)*.**	**JUNE-13**	**07**
7.	Transform the following vectors to spherical coordinates at the points given: (a) 10ax at P (x = -3, y =2, z = 4); (b) 10ay at Q (rho= 5, Ø = 300, z =4); (c) 10az at R(r =4, _ = 1100, Ø = 1200).	DEC-13	07
8.	**The two vectors are F = 10 ax - 6 ay + 5 az and G = 0.1 ax + 0.2 ay + 0.3 az (i) Find the vector component of F that is parallel to G (ii) Find the vector component of F that is perpendicular to G (iii) Find the vector component of G that is perpendicular to F.**	**Dec-14**	**07**
9.	If **G = 5 r sin2 θ cos2 Φ ar**e valuate both sides of Divergence theorem for the region r ≤ 2.	DEC-14	07
10.	Find spherical coordinates of **10 ax**at the point **P (-3, 2, 4).**	DEC-14	07

11.	The given points are $A(x = -1, y = 2, z = 3)$, $B(\rho = 3, \Phi = 60°, z = 6)$ and $C(x = 2, y = 3, z = -1)$. Find (i) Cylindrical co-ordinates of A (ii) Cartesian co-ordinates of B and (iii) Spherical co-ordinates of C.	MAY-15	07
12.	**The given points are *A(x=2,y=3,z=-1)* and B *(r=4,θ=25°,ϕ=120°)*. Find (i) Spherical co-ordinates of *A* (ii) Cartesian co-ordinates of *B* and (iii) Distance from *A* to *B*.**	**DEC-15**	**07**
13.	Given points A (x = 2 , y = 3, z = -1) and B (=4, =-50,z=2). Find a unit vector in Cylindrical coordinate (a)At point B directed towards point A (b) At point A directed towards point B	**JUN-16**	**07**
14.	A triangle is defined by the three points A (2,-5, 1), B (-3, 2, 4), and C (0, 3, 1) Find: (a) X ; (b) The area of the triangle; (c) A unit vector perpendicular to the in which the triangle located.	**JUN-16**	**07**
15.	The cross product of the same vector to itself is _____. (a) 0 (b) 1 (c) ∞ (d) 100	**JUN-16**	**02**
16.	The divergence of is _____ (a) scalar (b) vector (c)curl of F(d) none of this	**JUN-16**	**02**
17.	Points A(r = 100, θ = 900, Φ = 0) and B = (r = 100, θ = 900, Φ = 50) are located on the surface of a 100m radius sphere (i) What is their separation using a path on the spherical surface? (ii) What is separation using a straight line path? Give the answer upto four decimal places after the decimal point.	**NOV-16**	**07**

Chapter No.	Topic	Teaching Hrs.	Module Weightage
2	**Coulomb's law and Electric Field Intensity** The experimental law of Coulomb, Electric field intensity, Field due to a continuous volume charge distribution, Field of a line charge, Field of a sheet charge.	4	9

❖ **ATTEMPT THREE THEORY AND FOUR EXAMPLES:**

SR NO.	QUESTION	YEAR	MARKS
1.	Define electric field intensity. Obtain an expression for the electric field intensity at a point which is at a distance of R from a point charge Q.	MAY-11 JAN-13	07
2.	Write short note: Electrostatic boundary conditions between perfect dielectrics.	MAY-11	07
3.	**Describe coulomb's law also explain concept of electric potential difference.**	**DEC-11**	**07**
4.	**Derive expression of electric field intensity due to a uniform line charge over z-axis having a charge density of *P* C/m. OR** **Define Electric field intensity. Derive the necessary equation for electric filed Intensity due to line charge.**	**JAN-13** **DEC-13** **Dec-14**	**07**
5.	Develop an Expression for electric field intensity at a general point P due to a semi –infinite straight line charge with charge density ρl C/m.	MAY-14	07
6.	**Derive the expression for total electric field intensity due to infinite surface charge distribution in free space.**	**JUNE-13**	**07**
7.	Derive the equation of total electric field intensity in vector form due to infinite uniform sheet charge distribution in free space.	MAY-15	07
8.	Derive the expressionof E (Electricfieldintensity) at any point *P* due to infinite uniform line charge distribution in free space.	DEC-15	07
9.	**State coulomb's law of electric for various type of charge distribution.**	**JUN-16** **NOV-16**	**04**
10.	Write down Streamlines equation of electric field intensity for (r, θ, Φ) and (ρ, Φ, z)	JUN-16	02
11.	1) The proportionality constant in Coulomb's law has a unit of (a) Farad (b) Farad/metre (c) Newton/metre (d) metre/Farad	NOV-16	02
12.	If a pair of (+)ve and (-ve) charges of 1C are separated by a distance of 1 μm, the magnitude of dipole moment is (a) 1C- μm (b) 1C/ μm (c) zero (d) 2C- μm	NOV-16	02
13.	Derive the expression for electric field intensity due to line charge	NOV-16	07
	EXAMPLES		
1.	Find the total charge inside a volume having volume charge density as 10z2e-0.1xsinπy c/m^3. The volume is defined between -2 < x < 2, 0 < y < 1and 3 < z < 4.	MAY-11	07
2.	An electric potential is given by, V = 60sinθ / r2 volt. Find V and **E** atP(3, 600, 250).	MAY-11	07
3.	**A charge of -0.3 μC is located at A(25,-30,15) (in cm), and a second charge**	**DEC-13**	**07**

	of 0.5 µC is at B(-10,8,12) cm. Find Electric field intensity E at (a) the origin; (b) P(15,20,50) cm.		
4.	Potential is given by V= $2(x+1)^2 (y+2)^2 (z+3)^2$ V in free space. At point P (2,-1,4) calculate : (i) The potential at point P, (ii) electric field intensity E at point P,(iii) volume charge density at P.	MAY-14	07
5.	**Find E at P(1,5,2) in free space if a point charge of 6 µC is located at Q(0,0,1),a uniform line charge of 180 nC/m lies along the *x axis* and a uniform sheet of charge equal to 25 nC/m2 lies in the plane *z* = - 1**	**DEC-14**	**07**
6.	An infinite uniform line charge having line charge density of $\rho_L = 30\ \mu C/m$ placed on the z-axis. Find the total electric field intensity at $(3,\ 4,\ 5)\ m$.	MAY-15	07
7.	A positively charged circular ring with $\rho_L = 10\ nC/m$ having radius of $5\ m$ lies on $z = 0$ plane with its centre at origin. Find $\bar{E}$ at point $(0,\ 0,\ 5)\ m$ and also find the value of a point charge Q which will produce the same $\bar{E}$ at a point $(0,\ 0,\ 5)\ m$.	MAY-15	07
8.	**An infinite uniform line charge having line charge density of ρL = 200 nC/m placed on the z-axis. Find the total electric field intensity at (6, 8, 3) m.**	**DEC-15**	**07**
9.	**A circular ring with radius of 5 m lies on z = 0 plane with its center at origin. If ρL= 10 nC/m, find value of a point charge Q placed at origin which will produce the same value of $\bar{E}$ (Electric field intensity) at point (0, 0, 5) m.**	**DEC-15**	**07**
10.	A point charge Q1 = 2µC is located at P1(3,7,-4) and Q2 = -5µC is at P2 (2,4,-1) At a point (12,15,18) find (i) E (ii) |E| (iii) aE	NOV-16	07
11.	What net flux crosses the closed surface which contains charge distribution in the form of a plane disc of radius 4m in z=0 plane with ρs = sin2Φ/2ρ	NOV-16	04
12.	If E = 2xax – 4yay V/m find the work done in moving a point charge of +2C from (2,0,0) to (0,0,0) to (0,2,0)	NOV-16	03

Chapter No.	Topic	Teaching Hrs.	Module Weightage
3	**Electric Flux Density, Gauss' law and Divergence** Electric flux density, Gauss' law, Application of Gauss' law:some symmetrical charge distributions, Application of Gauss' law todifferential volume element, Divergence, Maxwell's first equation,	4	9

❖ **ATTEMPT THREE THEORY AND ONE EXAMPLE:**

SR NO.	QUESTION	YEAR	MARKS
1.	State and prove the Gauss's law. Also state the conditions to be satisfied by the special Gaussian surfaces.	MAY-11	07
2.	**State and explain gauss's law. Obtain electric field intensity of line charge using gauss's law OR Explain the Gauss's law applied to infinite line charge and derive the expression for D due to infinite line charge.**	**DEC-11 MAY-12 JAN-13 JUNE-13 NOV-16**	**07**
3.	State and explain gauss's law. Obtain electric field intensity of line charge using gauss's law	MAY-15	07
4.	**Derive Maxwell's first equation as applied to the electrostatics, using Gauss's law. Also state the Divergence theorem.**	**JAN-13 MAY-14 MAY-11**	**07**
5.	State and Explain Gauss Law. Explain Divergence Theorem.	Dec-14	07
6.	Derive the Maxwell's first equation applied to Electrostatic by using equations of divergence and Gauss's law for electric flux density.	MAY-15	07
7.	**Define divergence and its physical significance.**	**DEC-15**	**07**
8.	Derive Maxwell's first equation applied to electrostatic using Gauss's law.	DEC-15	07
9.	State and explain the gauss's law	JUN-16	04
10.	Maxwell's equations shelter on _____ law(s). (a) Faraday's (b) Gauss's (c) Ampere's (d) All of these	JUN-16	02
11.	In the case of a linear material medium, _____ equation can be derived easily from Gauss' law. (a) Poisson (b) Laplace (c) Both (a) and (b) (d) None of these	JUN-16	02
12.	Another boundary condition using Maxwell's equations is given as _____. (a) Htan '1' + Htan '2' = 0 (b) Htan '1' – Htan '2' = 0 (c) Htan '1' + Htan '2' = Js (d) Htan '1'– Htan '2' = Js	JUN-16	02
13.	At the Brewster angle, polarization _____. (a) Cannot be reflected (b) Is reflected at 30° (c) Is reflected at 90° (d) None of these	JUN-16	02

14.	Point form of Gauss' law is (a) ∇·D = ρs (b) ∇·D = ρv (c) ∇·D = ρv/ϵ0 (d) ∇·D = Q	NOV-16	02
15.	Unit of electric flux is (a) Coulomb (b) Weber (c) Tesla (d) Weber/m	NOV-16	02
16.	Write Maxwell's equations in integral form and point form	NOV-16	04
	EXAMPLES		
1.	**The finite sheet 0 ≤ x≤ 1, 0≤y≤1 on the z = 0 plane has a charge density *ρs = xy (x² + y² + 25)*3/2 nC/m2. Find:** **1) The total charge on the sheet, 2) The electric field at (0, 0, 5)** **3) The force experienced by a – 1 mC charge located at (0, 0, 5).**	**MAY-12**	**07**
2.	State Gauss's Law. Find divergence D at the origin if $D = e^{-x}\sin yax - e^{-x}\cos yay + 2za_z$	DEC-13	07
3.	A co-axial conducting cylinder has charge density of ρs on the outer surface of the inner cylinder. Use Gauss' law to find 'D' in all the regions. Assume that inner cylinder has radius of 'a' metres and outer cylinder has radius of 'b' metres	NOV-16	07

Chapter No.	Topic	Teaching Hrs.	Module Weightage
4	**Energy and Potential** Energy expended in moving a point charge in electric field, The line integral, Definition of potential and potential difference, The potential field of a point charge, The potential field of a system of charges, Potential gradient, The dipole, Energy density in the electrostatic field.	4	9

❖ **ATTEMPT THREE THEORY AND FIVE EXAMPLES:**

SR NO.	QUESTION	YEAR	MARKS
1.	**Explain an electric dipole. Also derive expression of E due to an electric dipole.**	**MAY-11 JAN-13**	**07**
2.	Define divergence and its physical significance.	JUNE-13	07
3.	Explain potential and potential gradient. Derive relationship between potential and electric field intensity.	JUNE-13	07
4.	Derive necessary equation for potential gradient from the electric filed intensity by means of a line integral.	DEC-13	07
5.	**Explain concept of potential gradient and prove that E = - ∇V.**	**Dec-14**	**07**
6.	Definethepotentialgradient.Deriverelationshipbetweenpotentialandelectric fieldintensity.	MAY-15	07
7.	Derive equation of potential difference V_{AB} with in the electric field produced by a point charge Q.	MAY-15	07
8.	**Derive expression of electric field intensity due to an electric dipole.**	**DEC-15**	**07**
9.	Derive relationship between potential and electric field intensity.	DEC-15	07
10.	Express for electric field intensity at any point to a line charge with uniform charge density C/m on the infinitely long Z-axis.	JUN-16	07
11.	Define the potential gradient. Derive relationship between potential and electric field intensity	JUN-16	04
12.	Derive equation of energy stored in magnetic fields.	JUN-16	03
13.	Emf is closed _____ integral of non-conservational electric field that is generated by battery. (a) Line (b) Surface (c) volume (d) None of these	JUN-16	02
14.	$\oint B \cdot dS$ is (a) zero (b) Q (c) H (d) J	NOV-16	02
15.	Explain electric dipole. Derive the expression for E and V at any distant point from dipole	NOV-16	04
	EXAMPLES		
1.	Determine electric flux density at (4,0,3) if there is a point charge -5 π mc at (4,0,0) and a line charge 3 π mc/m along the y-axis.	DEC-11	07
2.	**Consider a cylindrical electron beam having length of 2 cm and radius 1 cm. The uniform charge density ρ_v within the cylinder is**	**JAN-13**	**07**

	$-5 \times 10^{-6} e^{(-10^3 \rho z)}$ **C/m^3. Calculate the total charge enclosed in this cylinder. Use volume integral for this calculation. ρ is the shortest distance of the point from the axis of cylinder (the z- axis). For the calculation consider the electron beam between cm z=2 and z=4 cm.**		
3.	(i) Consider a vector field **G= *y* a_x -2.5*x* a_y +3 a_z**and the point Q(4, 5, 2). Find (1) **G** at Q, (2) the scalar component of **G** at Q in the direction of $\mathbf{a}_N$ = 1/3 (), (3) the vector component of **G** at Q in the direction of $\mathbf{a}_N$ and (4) the angle Θ between **G**($\mathbf{r}_Q$) and $\mathbf{a}_N$ (ii) Describe vector fields.	JAN-13	07
4.	Given the potential field **V=2*x*^{2}*y*-5*z***, , and a point P(-4, 3, 6), find following at point P: (1) the potential V, (2) the electric field intensity **E,** (3) the direction of **E,** (4) the electric flux density **D,** and (5) the volume charge density.	JAN-13	07
5.	Let ***D***=*2y$_2$z$_2$* ***a_x*** *+ 3xy$_2$z$_2$* ***a_y*** *+ 2xyz* ***a_z***pC/m$_2$ in free space. Find (a) the total electrical flux passing through the surface x=2, 0≤y≤2, and 0≤z≤2 in a direction away from the origin, (b) the total charge contained in an incremental sphere of a radius 1 μm centered at *P(2,2,2)*.	JUNE-13	07
6.	**A 15-nC point charge is at the origin in free space. Calculate V_1 if point P_1 is located at P_1(-2,3,-1) and (a) V=0 at (6,5,4); (b) V=0 at infinity; (c) V = 5V at (2,0,4).**	**DEC-13**	**07**
7.	**An electric dipole located at the origin in free space has a moment p = 3a_x-2a_y+a_z nC.m (a) find V at P_A (2,3,4).**	**DEC-13**	**07**
8.	**In a field E= -50y a_x- 50x a_y+30 a_zV/m, calculate the differential amount of work done in moving 2 μC charge a distance 5 μm from A(1,2,3) to B(2,4,1).**	**MAY-14**	**07**
9.	**A point charge Q_1 = 10 μC, is located at P_1 (1, 2, 3) in free space, while Q_2 = -5 μCis at P_1 (1, 2, 10). Find (a) the vector force exerted on Q_2 by Q_1. (b) The coordinates of P_3 at which point charge Q_3 experience no force.**	**Dec-14**	**07**
10.	Three identical point charges of 4 PC each are located at the corners of an equilateral triangle 0.5 mm on a side in free space. How much work must be done to move one charge to a point equidistant from the other two and on the line joining them?	Dec-14	07
11.	A Point charge of 16 nC is located at Q (2, 3, 5) in free space, and a uniform line charge of 5 nC/m is at the intersection of the planes x = 2 and y = 4. If the potential at the origin is 100V, find V at Point P (4, 1, 3).	JUN-16	07
12.	If a current of 1A is flowing in an inductor with L = 2H, the energy stored in the inductor is (a) 2.0 J (b) 1.0 J (c) 4.0 J (d) 0.5 J	NOV-16	02

Chapter No.	Topic	Teaching Hrs.	Module Weightage
5	**Current and Conductors** Current and current density, Continuity of current, Metallic conductors, Conductor properties and boundary conditions, Semiconductors.	3	7

❖ **ATTEMPT TWO THEORY AND ONE EXAMPLE:**

SR NO.	QUESTION	YEAR	MARKS
1.	Define current and current density and derive convection current density.	-	07
2.	**Derive and discuss the equation of continuity of current.**	**-**	**07**
3.	Discuss the conductor properties and boundary conditions with neat sketch and required derivation.	-	07
4.	**Write a short note on continuity equation.**	**MAY-15**	**07**
5.	Derive and explain continuity equation for steady current.	**JUN-16**	**07**
6.	State and explain ampere's circuit law both in integral differential form as	**JUN-16**	**04**
7.	State of the Ampere circuital law.	**JUN-16**	**02**
8.	At the conductor-dielectric boundary Dt = 0 (True or False)	**NOV-16**	**02**
9.	Derive the point form of continuity equation	**NOV-16**	**04**
	EXAMPLES		
1.	**Given the current density $J=-10^4[\sin(2x)e^{-2y}\ a_x + \cos(2x)\ e^{-2y}\ a_y]$ kA/m²: (a) Find the total curent crossing the plane y=1 in the a_y direction in the region 0<x<1,0<z<2.(b)find the total current leaving the region 0<x,y<1,2<z<3 by integrating J*dS over the surface of the cube.(c)Repeat part (b),but use the divergence**	**-**	**07**
2.	Using data tabulated of carbon is about 3×10^4 S/m.(a) what size and shape sample of carbon has a conductance of 3×10^4S?(b)what is the conductance if every dimension of the sample found in part(a)is halved?	-	07

Chapter No.	Topic	Teaching Hrs.	Module Weightage
6	**Dielectrics and capacitance** The nature of dielectric materials, Boundary conditions for perfect dielectric materials, Capacitance, Several capacitance examples, Capacitance of a two wire line.	3	7

❖ **ATTEMPT ONE THEORY AND ONE EXAMPLE:**

SR NO.	QUESTION	YEAR	MARKS
1.	**Explain boundary condition for dielectric material.** **OR** **Explain boundary conditions between two perfect Dielectric materials.**	**DEC-11 JAN-13 MAY-12 JUNE-13 MAY-15 DEC-13 MAY-14 DEC-14 DEC-15**	**07**
2.	Write short note: Electrostatic boundary conditions between perfect dielectrics.	MAY-12	07
3.	If the voltage applied across the capacitor is increased, its capacitance value (a) increases (b) decreases (c) remains constant (d) becomes infinity	NOV-16	02
4.	Electric field in free space is (a) D/μ0 (b) D/ϵ0 (c) D ϵ0 (d) σ/ ϵ0	NOV-16	02
	EXAMPLES		
1.	**A dielectric-free space interface has the equation 3x + 2y + z = 12 m. The origin side of the interface has εr1 = 3 and E1 = 2āx + 5āz (V/m). Find E2.**	**MAY-12**	**07**

Chapter No.	Topic	Teaching Hrs.	Module Weightage
7	**Poisson's and Laplace's Equation** Derivation of Poisson's and Lapalce's equations, Uniqueness theorem, Example of the solution of Laplace's equation Example of solution of Poisson's equation.	3	8

❖ **ATTEMPT ONE THEORY:**

SR NO.	QUESTION	YEAR	MARKS
1.	**Derive Poisson's and Laplace's equation.**	**MAY-11 DEC-11 JAN-13 JUNE-13 MAY-15 MAY-14 DEC-14 DEC-15 JUN-16 NOV-16**	**07**
2.	Explain the uniqueness theorem and derive the required equation.	-	07
3.	Assuming that V satisfies Laplace's equation in cylindrical co-ordinate system, find the expression for V and E as a function of Φ.	**NOV-16**	04
	EXAMPLES		
4.	Let $V= 2xy^2z^3$ and $\varepsilon = \varepsilon_0$. Given point P(1,2,-1),find : (a)V at P; (b) E at P;(c) $\rho_v$at P;(d) the equation of equipotential surface passing through P;(e)the equation of stream line passing through P.(f) Does V satisfy Laplace's equation.	-	07

Chapter No.	Topic	Teaching Hrs.	Module Weightage
8	**The Steady Magnetic Field** BiotSavart law, Ampere's circuital law, Curl, Stoke's theorem, Magnetic flux and magnetic flux density, The scalar and vector magnetic potentials, Derivation of steady magnetic field laws.	4	10

❖ **ATTEMPT THREE THEORY AND ONE EXAMPLE:**

SR NO.	QUESTION	YEAR	MARKS
1.	**State and explain Biot-Savart's law. OR State and Explain Biot-Savart's law for magnetic field. Using this law derive expression for magnetic field intensity at a point due to a finite length current element carrying current 'I' lying on z-axis in cylindrical co-ordinates.**	**MAY-11 MAY-12 JAN-13 DEC-13 DEC-14**	**07**
2.	**Write short note on Stoke's theorem.**	**DEC-11 DEC-11 JAN-13 NOV-16**	**07**
3.	State and Explain Biot-Savart's law for magnetic field. Using this law derive expression for magnetic field intensity at a point due to a finite length current element carrying current 'I' lying on z-axis in cylindrical co-ordinates.	DEC-11	07
4.	**State and Explain Ampere circuital law.**	**DEC-11 MAY-12 JAN-13 JUNE-13 MAY-15 DEC-13 DEC-15**	**07**
5.	State and prove uniqueness theorem.	JUNE-13	07
6.	Write a short note on "Magnetic Resonance Imaging."	DEC-13	07
7.	Find the magnetic field intensity at a point P(r,ϕ,z) due to an infinitely long straight filament carrying a current I in the positive z direction.	MAY-14	07
8.	Derive the expression curl H = J.	JUN-16	03
9.	State and explain Biot-sawart's law for static magnetic fields as applied to different types of current distribution.	JUN-16	07

10.	Write the equation for curl of magnetic field intensity for conservative and non-conservative fields	NOV-16	02
11.	For steady magnetic fields, prove that $\nabla \times H = J$	NOV-16	07
	EXAMPLES		
1.	Given points A(x = 2, y = 3, z = -1) and B(ρ= 4, Φ = -50, z = 2), find a unit vector in cylindrical coordinates at point B directed towards point A.	MAY-11	07
2.	**Find the magnetic flux density at the center 'O' of a square of sides equal to 5 m and carrying 10 amperes of current.**	**MAY-12**	**07**

Chapter No.	Topic	Teaching Hrs.	Module Weight age
9	**Magnetic Forces, Materials and Inductance** Force on a moving charge, Force on a differential current element, Force between differential current elements, Force and torque on a closed circuit, The nature of magnetic materials, Magnetization and permeability, Magnetic boundary conditions, The magnetic circuit, Potential energy and forces on magnetic materials, Inductance and mutual inductance.	4	9

❖ **ATTEMPT THREE THEORY AND TWO EXAMPLES:**

SR NO.	QUESTION	YEAR	MARKS
1.	**Derive Lorentz force equation.**	**MAY-11 DEC-15**	**07**
2.	Write a note on ferrite core. Also list out various properties of ferrites.	MAY-11	07
3.	Write short-note on ' magnetic materials'	DEC-11	07
4.	**State and Explain Lorentz force equation on charge particle. Also Explain concept of magnetic torque.**	**JAN-13 DEC-14**	**07**
5.	Write a note on ferrite core. Also list out various properties of ferrites.	MAY-12	07
6.	What is inductance? Explain self inductance and mutual inductance.	JUNE-13	07
7.	**Explain force on a differential current element.**	**JUNE-13**	**07**
8.	State Lorentz force equation. Give the classification of magnetic materials.	DEC-13	07
9.	Explain concept of scalar magnetic potential and magnetic vector potential.	JUN-16	03
10.	Expression for the torque on a differential current loop in a magnetic field β when force and torque on a closed circuit.	JUN-16	04
11.	Derive the expression for force on a current carrying element placed in a magnetic field	NOV-16	07
12.	Explain scalar and vector magnetic potentials. With the help of an example prove that the value of scalar magnetic potential can be non-unique	NOV-16	07

1.	**EXAMPLES** A straight conductor of 0.2 m lies on the x- axis with one end at origin. The conductor is subjected to a magnetic flux density B= 0.04 ay T and velocity v = 2.5sin103t az m/s. Calculate the motional electric field intensity and emf induced in the conductor.	MAY-14	07
2.	**A negative point charge, Q = -40Nc, is moving with a velocity of 6*106 m/s in a direction specified by the unit vector av = - 0.48ax - 0.6ay + 0.64az. Find the magnitude of the vector force exerted on the moving particle by the field : (a) B = 2ax -3ay +5az Mt; (b) E = 2 ax – 3 ay +5az KV/m ; (c) B and E acting together.**	**MAY-14**	**07**
3.	**A loop of wire is constructed of three straight segments connecting (0,0,0) to (0.6,0,0) to (0.4,1,0.7) to (0,0,0). A current of 8mA is in the ax direction in the first segment. Given a uniform magnetic field B = 0.2ax -0.1ay +0.2az T, find (a) The total force on the loop; (b) the torque on the loop about an origin at (0,0,0).**	**MAY-14**	**07**
4.	A point charge, Q = −10 μC, is moving with a velocity of 6×10^6 m/s in a direction specified by the unit vector $\bar{a}_v = 0.5\bar{a}_x - 0.6\bar{a}_y + 0.2\bar{a}_z$. Find the magnitude of the vector force exerted on that moving charge by the field: (a) $\bar{B} = 2\bar{a}_x - 3\bar{a}_y + 5\bar{a}_z$ T; (b) $\bar{E} = 2\ \bar{a}_x - 3\ \bar{a}_y + 5\bar{a}_z$ kV/m; (c) $\bar{B}$ and $\bar{E}$ acting together.	MAY-15	07
5.	If a charge of 1C is moving with a velocity of 2ax in a magnetic field B = 1ay, the force experienced by the charge is (a) 2az (b) 1ay (c) 2ax (d) 1az	NOV-16	02

Chapter No.	Topic	Teaching Hrs.	Module Weightage
10	**Time Varying Fields and Maxwell's equation** Faraday's Law, Displacement current, Maxwell's equation in point form, Maxwell's equation in integral form.	3	7

❖ **ATTEMPT FOUR THEORY AND ONE EXAMPLE:**

SR NO.	QUESTION	YEAR	MARKS
1.	State Maxwell's equations in point form and explain physical significance of the equations.	MAY-11	07
2.	**Write Maxwell equation in point form and in integral form.**	**DEC-11 DEC-13 MAY-14**	**07**
3.	State and Explain Induction heating.	DEC-11	07
4.	**State and Explain Eddy current testing of materials.**	**DEC-11 May-14**	**07**
5.	State Maxwell's equations in point form and explain physical significance of the equations.	MAY-12	07
6.	Write a short note on Displacement Current.	JUN-13	07
7.	**Write and explain differential and integral forms of Maxwell's equations.**	**JUN-13 JUN-16**	**07**
8.	Derive the relation between I and J and explain the continuity equation of steady electric current in integral form and point form.	JUNE-13	07
9.	Explain the construction and working principle of Magneto Hydrodynamic (MHD) Generator.	DEC-13	07
10.	Derive the expression curl H= J.	MAY-14	07
11.	**State Maxwell's equations in point form and explain physical significance of the equations.**	**MAY-15**	**07**
12.	StateMaxwell'sequationsinintegralformandexplainphysicalsignificanceof the equations.	DEC-15	07
13.	**Derive the relation between *I* and *J*.**	**DEC-15**	**07**
	EXAMPLES		
1.	The magnetic Field intensity is given in certain region of space as : ***H = [(x + 2y) / z2] ay + (2/z) ay A/m. Find: (i)*** **∇x H (ii) J (iii) Use J** to find the total current passing through the surface z=4, 1 ≤ ***x*** ≤ 2, 3 ≤ **y** ≤ 5 in ***az***direction.	DEC-14	07
2.	**F = *x2 y ax – 2 z ay + (3z2+ xy) az* Find ∇x [∇.(∇.F)].**	**DEC-14**	**07**

Chapter No.	Topic	Teaching Hrs.	Module Weightage
11	**Transmission Lines** Physical description of transmission line propagation, The transmission line equation, Lossless propagation, Lossless propagation of sinusoidal voltages, Complex analysis of sinusoidal voltages, Transmission line equations and their solutions in phasor form.	4	8

❖ **ATTEMPT TWO THEORY AND ONE EXAMPLE:**

SR. NO.	QUESTION	YEAR	MARKS
1.	Derive general wave equations for the transmission line.	-	07
2.	Derive the propagation constant for loss less transmission line also discusses lossless propagation constant for sinusoidal voltages.	-	07
3.	Transmission line equation and their solution in Phasor form.	-	07
4.	**Explain lossless propagation of sinusoidal voltage in transmission line.**	**MAY-15**	**07**
5.	**Describe the physical description of transmission line propagation.**	**DEC-15**	**07**
6.	What are advantages of transmission lines? What are the most commons type of transmission lines?	**JUN-16**	**03**
7.	Explain the concept of wave propagation on transmission line. Assume line to be lossless	**NOV-16**	**03**
	EXAMPLES		
1.	**A lossless transmission line is 80cm long and operates at a frequency of 600MHz.the parameters are L=0.25 µH/m and C=100pF/m. find the characteristic impedance, the phase constant, and the phase velocity.**	**-**	**07**
2.	The parameters of a certain transmission line operating at 6×10^8 rad/s are L=0.4 µH/m,C=40pF/m,G=80µS/m,and R=20 ohm/m.(a) find γ,β,α and Z_0 (b) if a voltage wave travels 20m Down the line,what percentage of the original wave amplitude remains , and by how many degree is its phase shifted?	-	07
3.	60 ohm distortion less transmission line has a capacitance of 0.15 nF/m. The attenuation on the line is 1.15×10^{-3} Np/m. calculate: (a) the line parameter: resistance, inductance and conductance per meter of the line, (b) The velocity of wave propagation. (c) voltage at distance of 1km and 4km with respect to sending- end voltage	JUN-16	07

Chapter No.	Topic	Teaching Hrs.	Module Weightage
12	**Effects of Electromagnetic Fields** Electromagnetic Interference and Compatibility (EMI/EMC), EMI Sources, Effects of EMI, Methods to eliminate EMI, EMC Standards, Advantages of EMC standards, Biological effects of EMI/EMR (Electromagnetic Interference, Electromagnetic radiation).	3	8

❖ **ATTEMPT TWO THEORY:**

SR NO.	QUESTION	YEAR	MARKS
1.	Explain the effect of EMI in electrical system.	-	07
2.	**Write a short note on sources of EMI.**	**MAY-15 JUN-16**	**07**
3.	**Explain the different methods to eliminate EMI.**	**NOV-16**	**07**
4.	Write a short note on Biological effects of EMI/EMR.	-	07
5.	**Write a short note on EMI&EMC.**	**DEC-15**	**07**
6.	**State and explain in brief, various sources of EMI**	**NOV-16**	**04**