JEPPIAAR ENGINEERING COLLEGE
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION OF INSTITUTION

To build Jeppiaar Engineering College as an institution of academic excellence in technology and management education, leading to become a world class University.

MISSION OF INSTITUTION

- To excel in teaching and **learning, research and innovation** by promoting the principles of scientific analysis and creative thinking.
- To participate in the production, **development, dissemination of knowledge** and interact with **national and international communities.**
- To equip students with ethical **values, and life skills** that would enrich their lives and enable them to meaningfully contribute to the **progress of the society.**
- To prepare students for **higher studies and lifelong learning,** enrich them with the **practical and entrepreneurial skills** necessary to excel as future professionals and contribute to **Nation's economy.**

PROGRAM OUTCOMES (POs)

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11 **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12 **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

VISION OF THE DEPARTMENT

The Department of Electrical and Electronics Engineering strives to be a Centre of Excellence in education and technical research, in the endeavour of which the Department will continually update the teaching methodologies, progress in the emerging technologies and continue to play a vital role in the development of the society.

MISSION OF THE DEPARTMENT

M1	To develop the ability to **learn** and work creatively that would enhance the ability of both students and faculty to do **innovative research**.
M2	To **create** and maintain state-of-the art facilities which provide students and faculty with opportunities to analyse, apply and **disseminate knowledge globally**.
M3	To impart the knowledge in essential interdisciplinary fields which will enhance the **interpersonal skills**, team work, professional **ethics** and make them work effectively for their own benefit and the **betterment of the society**.
M4	Prepare students for **lifelong learning** of theoretical and **practical concepts** to face intellectual, **economical** and career challenges.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO 01	Strengthen the knowledge in Electrical and Electronics Engineering to enable them **work** for modern industries by promoting energy conservation and sustainability.
PEO 02	Enrich analytical, creative and critical **logical reasoning** skills to solve problems faced by emerging domains of electrical and electronics engineering industries worldwide.
PEO 03	Develop effective communication and inter-personal skills to work with enhanced team spirit in multidisciplinary projects with a broader **ethical**, professional, economical and **social** perspective.
PEO 04	Prepare the students either to establish **start ups** or to pursue **higher education** at reputed institutions.

PROGRAM SPECIFIC OUTCOME (PSOs)

PSO 1	**Professional Skills:** Apply the knowledge of Mathematics, Science and Engineering to solve real time problems in the field of **Power Electronics, Electrical Drives, Power Systems, Control Systems and Instrumentation**.
PSO 2	**Research and Innovation:** Analyze and synthesize circuits by solving complex engineering problems to obtain the **optimal solution** using effective software tools and hardware prototypes in the field of robotics and renewable energy systems.
PSO 3	**Product development:** Develop concepts and **products** by applying ideas of electrical domain into other diversified engineering domains.

EE8391 ELECTROMAGNETIC THEORY **LT P C**
3 1 0 4

OBJECTIVES:

- To introduce the basic mathematical concepts related to electromagnetic vector fields
- To impart knowledge on the concepts of electrostatics, electrical potential, energy density and their applications.
- To impart knowledge on the concepts of magnetostatics, magnetic flux density, scalar and vector potential and its applications.
- To impart knowledge on the concepts of Faraday's law, induced emf and Maxwell's equations
- To impart knowledge on the concepts of Concepts of electromagnetic waves and Pointing vector.

UNIT I ELECTROSTATICS – I **9**

Sources and effects of electromagnetic fields – Coordinate Systems – Vector fields –Gradient, Divergence, Curl – theorems and applications - Coulomb's Law – Electric field intensity – Field due to discrete and continuous charges – Gauss's law and applications.

UNIT II ELECTROSTATICS – II **9**

Electric potential – Electric field and equipotential plots, Uniform and Non-Uniform field, Utilization factor- Electric field in free space, conductors, dielectrics - Dielectric polarization – Dielectric strength - Electric field in multiple dielectrics – Boundary conditions, Poisson's and Laplace's equations, Capacitance, Energy density, Applications.

UNIT III MAGNETOSTATICS **9**

Lorentz force, magnetic field intensity (H) – Biot–Savart's Law - Ampere's Circuit Law – H due to straight conductors, circular loop, infinite sheet of current, Magnetic flux density (B) – B in free space, conductor, magnetic materials – Magnetization, Magnetic field in multiple media – Boundary conditions, scalar and vector potential, Poisson's Equation, Magnetic force, Torque, Inductance, Energy density, Applications.

UNIT IV ELECTRODYNAMIC FIELDS **9**

Magnetic Circuits - Faraday's law – Transformer and motional EMF – Displacement current - Maxwell's equations (differential and integral form) – Relation between field theory and circuit theory – Applications.

UNIT V ELECTROMAGNETIC WAVES **9**

Electromagnetic wave generation and equations – Wave parameters; velocity, intrinsic impedance, propagation constant – Waves in free space, lossy and lossless dielectrics, conductors- skin depth - Poynting vector – Plane wave reflection and refraction – Standing Wave – Applications.

TOTAL : 45 PERIODS

OUTCOMES:

- Ability to understand and apply basic science, circuit theory, Electro-magnetic field theory control theory and apply them to electrical engineering problems.

TEXT BOOKS:

1. Mathew N. O. Sadiku, 'Principles of Electromagnetics', 4 th Edition ,Oxford University Press Inc. First India edition, 2009.
2. Ashutosh Pramanik, 'Electromagnetism – Theory and Applications', PHI Learning Private Limited, New Delhi, Second Edition-2009.
3. K.A. Gangadhar, P.M. Ramanthan ' Electromagnetic Field Theory (including Antennaes and wave propagation', 16th Edition, Khanna Publications, 2007**.**

REFERENCES:

1. Joseph. A.Edminister, 'Schaum's Outline of Electromagnetics, Third Edition (Schaum's Outline Series), Tata McGraw Hill, 2010
2. William H. Hayt and John A. Buck, 'Engineering Electromagnetics', Tata McGraw Hill 8^{th} Revised edition, 2011.
3. Kraus and Fleish, 'Electromagnetics with Applications', McGraw Hill International Editions, Fifth Edition, 2010.
4. Bhag Singh Guru and Huseyin R. Hiziroglu "Electromagnetic field theory Fundamentals", Cambridge University Press; Second Revised Edition, 2009.

Course code& Name: **EE8391 Electromagnetic Theory**
Degree/Programme: **B.E/EEE** Semester: **III** Section: **A, B**
Duration: **DEC – APRIL 2018** Regulation: **2013/AUC**
Name of the Staff:

AIM: Ability to understand and apply basic science, circuit theory, Electro-magnetic field theory control theory and apply them to electrical engineering problems.

OBJECTIVES:

- To introduce the basic mathematical concepts related to electromagnetic vector fields
- To impart knowledge on the concepts of electrostatics, electrical potential, energy density and their applications.
- To impart knowledge on the concepts of magnetostatics, magnetic flux density, scalar and vector potential and its applications.
- To impart knowledge on the concepts of Faraday's law, induced emf and Maxwell's equations
- To impart knowledge on the concepts of Concepts of electromagnetic waves and Pointing vector.

COURSEOUTCOMES:

C	Course Outcomes
C2 3.1	Understand the concepts of electromagnetic vector fields and various transformation techniques
C2 3.2	Interpret the concepts of electrostatics, electrical potential, energy density and their applications.
C2 3.3	Apply the concepts of magneto statics, magnetic flux density, scalar and vector potential and its applications.
C2 3.4	Understand the concepts of Faraday's law, induced emf and Maxwell's equations to analyze the electrodynamics fields.
C2 3.5	Interpret the concepts of electromagnetic waves and Pointing vector.

Mapping of Course Outcomes(COs), Course(C),ProgramSpecificOutcomes (PSOs)with Program Outcomes. (POs)– [Levels of correlation:3 (High),2 (Medium), 1(Low)]

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C2 3.1	3	3	2	3	-	-	-	-	-	-	-	2	3	3	2
C2 3.2	3	3	3	3	-	1	-	-	-	-	-	2	3	3	3
C2 3.3	3	3	3	3	-	1	-	-	-	-	2	2	3	3	3
C2 3.4	3	3	3	3	-	1	-	-	-	-	2	2	3	3	3
C2 3.5	3	3	3	3	-	1	-	-	-	-	-	2	3	3	3

UNIT - I	ELECTROSTATICS – I					Target Periods: 9
Sl N o	**Contents**	**CO Statement**	**Book Reference & Page No**	**Delivery method**	**Delivery Periods**	**Knowledge Level**
1	Sources and effects of electromagnetic fields	C2 3.1	TB1: 3-19	Chalk & board / PPT	**1**	R & U
2	Coordinate Systems,	C2 3.1	TB1: 29-46	Chalk & board / PPT	**1**	R & U
3	Vector fields, Gradient, Divergence, Curl, theorems and applications	C2 3.1	TB1: 65-90	Chalk & board / PPT	**2**	R, U, An, A
4	Coulomb’s Law, Electric field intensity	C2 3.1	TB1: 106-111	Chalk & board / PPT	**2**	R,U, An
5	Field due to discrete and continuous charges	C2 3.1	TB1: 113-124	Chalk & board / PPT	**2**	R, U, An
6	Gauss’s law and applications	C2 3.1	TB1: 124-134	Chalk & board / PPT	**1**	R, U, A

UNIT II	ELECTROSTATICS – II					Target Periods:9
Sl No	**Contents**	**CO Statement**	**Book Reference & Page No**	**Delivery method**	**Delivery Hrs**	**Knowledge Level**
1	Electric potential	C2 3.2	TB1: 135-144	Chalk & board / PPT	**1**	R, U
2	Electric field and equipotential plots	C2 3.2	TB1: 688-690	Chalk & board / PPT	**1**	R, U, An
3	Uniform and Non-Uniform field, Utilization factor, Electric field in free space, conductors,	C2 3.2	TB1: 170-175	Chalk & board / PPT	**2**	R, U, A, An
4	Electric field in dielectrics Dielectric polarization, Dielectric strength, Electric field in multiple dielectrics	C2 3.2	TB1: 179-182	Chalk & board / PPT	**2**	R, U, A, An
5	Boundary conditions, Poisson’s and Laplace’s equations,	C2 3.2	TB1: 190-198 TB1: 209-210	Chalk & board / PPT	**1**	R, U, A, An
6	Capacitance, Energy density, Applications.	C2 3.2	TB1: 148-152 TB1: 233- 246	Chalk & board / PPT	**2**	R, U,A, An

UNIT III	MAGNETOSTATICS					Target Periods: 9
Sl No	**Contents**	**CO Statement**	**Book Reference & Page No**	**Delivery method**	**Delivery Hrs**	**Knowledge Level**

1	Magnetic field intensity (H), Biot–Savart's Law	C2 3.3	TB1: 274- 276	Chalk & board / PPT	**1**	R, U
2	straight conductors, circular loop	C2 3.3	TB1: 277- 282	Chalk & board / PPT	**1**	R, U, A
3	Ampere's Circuit Law, H due to infinite sheet of current	C2 3.3	TB1: 285- 288	Chalk & board / PPT	**1**	R, U, A, An
4	Magnetic flux density (B), B in free space, conductor	C2 3.3	TB1: 293- 294	Chalk & board / PPT	**1**	R, U,An,A,
5	scalar and vector potential, Lorentz force	C2 3.3	TB1: 296- 298 TB1: 319-322	Chalk & board / PPT	**1**	R,U
6	magnetic materials – Magnetization, Magnetic field in multiple media	C2 3.3	TB1:331- 344	Chalk & board / PPT	**1**	R, U, A,
7	Boundary conditions, Poisson's Equation, Inductance, Applications.	C2 3.3	TB1: 344- 353	Chalk & board / PPT	**1**	R, U, A, An
8	Energy density,	C2 3.3	TB1: 353- 361	Chalk & board / PPT	**1**	R,U
9	Magnetic force, Torque	C2 3.3	TB1: 381- 382	Chalk & board / PPT	**1**	R,U

UNIT IV **ELECTRODYNAMIC FIELDS** **Target Periods:9**

Sl No	Contents	CO Statement	Book Reference & Page No	Delivery method	Delivery Hrs	Knowledge Level
1	Magnetic Circuits	C2 3.4	TB1: 361- 368	Chalk & board / PPT	**1**	R, U
2	Faraday's laws	C2 3.4	TB1: 386- 387	Chalk & board / PPT	**1**	R,U
3	Transformer and motional EMF	C2 3.4	TB1: 388- 391	Chalk & board / PPT	**2**	R, U
4	Displacement current	C2 3.4	TB1: 397- 399	Chalk & board / PPT	**2**	R,U
5	Maxwell's equations (differential and integral form)	C2 3.4	TB1: 400- 402	Chalk & board / PPT	**2**	R, U, A, An
6	Relation between field theory and circuit theory Applications.	C2 3.4	TB1: 400- 404	Chalk & board / PPT	**1**	R, U

UNIT V **ELECTROMAGNETIC WAVES** **Target Periods: 9**

Sl No	Contents	CO Statement	Book Reference & Page No	Delivery method	Delivery Hrs	Knowledge Level
1	Electromagnetic wave generation and equations	C2 3.5	TB1: 430- 432	Chalk & board / PPT	**2**	R, U, An
2	Wave parameters; velocity, intrinsic impedance, propagation constant	C2 3.5	TB1: 436- 437	Chalk & board / PPT	**2**	R, U, An
3	Waves in free space, lossy and lossless dielectrics, conductors, skin depth	C2 3.5	TB1: 436- 445	Chalk & board / PPT	**2**	R, U, A, An
4	Poynting vector	C2 3.5	TB1: 454- 458	Chalk & board / PPT	**1**	R, U, A, An
5	Plane wave reflection and refraction, Standing Wave, Applications.	C2 3.5	TB1: 459- 462	Chalk & board / PPT	**2**	R, U, A, An

R- Remember, U- Understand, A- Apply, An- Analyze, E- Evaluate & C- Create.

Books:Text/Reference:

S.No		Title of the Book	Author	Publisher	Year
1	**TB1**	Principles of Electromagnetics	Mathew N. O. Sadiku	4 th Edition ,Oxford University Press Inc. First India edition.	2009
2	**TB2**	Electromagnetism– Theory and Applications	Ashutosh Pramanik	PHI Learning Private Limited, New Delhi, Second Edition.	2009
3	**TB3**	Electromagnetic Field Theory	K.A. Gangadhar, P.M. Ramanthan	16th Edition, Khanna Publications	2007
4	**RB1**	Schaum's Outline of Electromagnetics	Joseph. A.Edminister	Third Edition Tata McGraw Hill	2010
5	**RB2**	Engineering Electromagnetics	William H. Hayt and John A. Buck,	Tata McGraw Hill 8th Revised edition	2011
6	**RB3**	Electromagnetics with Applications	Kraus and Fleish	McGraw Hill International Editions, Fifth edition	2010
7	**RB4**	Electromagnetic field theory Fundamentals	Bhag Singh Guru and Huseyin R. Hiziroglu	Cambridge University Press; Second Revised Edition	2009

Comments Given by the Scrutinizing Committee Members	
Signature of the Scrutinizing	
Signature of the HOD	

UNIT – I
ELECTROSTATICS – I

PART - A

1. Define scalar and vector.

Scalar: A quantity that is characterized only by magnitude is called a scalar.

Vector: A quantity that is characterized both by magnitude and direction is called a vector.

2. Define Scalar multiplication.

Scalar multiplication of two vectors is a scalar quantity whose magnitude is the product of the magnitudes of the vectors multiplied by the cosine of the angle between them. It is referred as Dot product. $\overline{A} \cdot \overline{B}$ = ABcosθ.

3. Define Vector multiplication.

The vector product of two vectors is defined as a vector whose magnitude is the product of the magnitudes of the two vectors and the sine of the angle between them. This multiplication is called "Cross Product". $\overline{A}$ x $\overline{B}$ = ABsinθ

4. Show that the two vectors $\overline{A}=6\overline{a}_x+\overline{a}_y-5\overline{a}_z$ and $\overline{B}=3(\overline{a}_x+\overline{a}_y-\overline{a}_z)$ are perpendicular to each other. **(Apr 15)**

$\overline{A}=6\overline{a}_x+\overline{a}_y-5\overline{a}_z$

$\overline{B}=3(\overline{a}_x+\overline{a}_y-\overline{a}_z)$

$\overline{A} \cdot \overline{B}$ = 6 x 5 – 2 x 5 – 5 x 4 = 0

$\therefore$ *Vector* $\overline{A}$ and $\overline{B}$ are perpendicular to each other.

5. Show that the two vectors $\overline{A}=4\overline{a}_x-2\overline{a}_y+2\overline{a}_z$ and $\overline{B}=-6\overline{a}_x+3\overline{a}_y-3\overline{a}_z$ are parallel to each other.

$\overline{A}=4\overline{a}_x-2\overline{a}_y+2\overline{a}_z$; $\overline{B}=-6\overline{a}_x+3\overline{a}_y-3\overline{a}_z$

$$\overline{A} \times \overline{B} = \begin{vmatrix} \overline{a_x} & \overline{a_y} & \overline{a_z} \\ 4 & -2 & 2 \\ -6 & 3 & -3 \end{vmatrix}$$

$= \overline{a}_x(6-6) - \overline{a}_y(-6+6) + \overline{a}_z(12-12) = 0$

$\therefore$ *Vectors* $\overline{A}$ and $\overline{B}$ are parallel to each other.

6. Define Gradient.

The gradient of any scalar function is the maximum space rate of change of that function. If the scalar V represents electric potential, ∇V represents potential gradient.

$\nabla V = \frac{\partial V}{\partial x}\overline{a}_x + \frac{\partial V}{\partial y}\overline{a}y + \frac{\partial V}{\partial z}\overline{a}z$. This operation is called the gradient.

7. Define divergence.

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. $\nabla \cdot A = Lt_{V\to 0} \frac{1}{v}\oint\!\!\oint_S A \cdot \overline{n}\, ds$. $\nabla \cdot A = \frac{\partial A_X}{\partial x} + \frac{\partial A_Y}{\partial y} + \frac{\partial A_Z}{\partial z}$. This operation is called divergence. Divergence of a vector is a scalar quantity.

8. Define Curl.

The curl of a vector 'A' at a any point is defined as the limit of its cross product with normal over a closed surface per unit volume as the volume shrinks to zero.

$$\nabla \times A = Lt_{V\to 0} \frac{1}{v} \oint\!\!\oint_S \bar{n} \times A ds.$$

9. Show that the vector $\overline{H} = 3y^4z\,\bar{a}_x + 4x^3z^2\,\bar{a}_y + 2x^3y^2\,\bar{a}_z$ is solenoidal.

$$\nabla.H = \left(\frac{\partial}{\partial x}\bar{a}_x + \frac{\partial}{\partial y}\bar{a}y + \frac{\partial}{\partial z}\bar{a}z\right).(3y^4z\,\bar{a}_x + 4x^3z^2\,\bar{a}_y + 2x^3y^2\,\bar{a}_z)$$

$$= \frac{\partial}{\partial x}(3y^4z) + \frac{\partial}{\partial y}(4x^3z^2) + \frac{\partial}{\partial z}(2x^3y^2) = 0 + 0 + 0 = 0;$$ Hence $\overline{H}$ is solenoidal.

10. Find the Dot products of the vectors A and B if A= $2\bar{a}_x - 3\bar{a}_y + 4\bar{a}_z$, $B = -\bar{a}_x + 2\bar{a}_y + 2\bar{a}_z$

$A.B = A_xB_x + A_yB_y + A_zB_z = 2(-1)-3(2)+4(2) = 0$

11. Given A= $4\bar{a}_y + 8\bar{a}_z$ and $B = -2\bar{a}_y + 6\bar{a}_z$ find A . B

A.B = AxBx +AyBy +AzBz = 4(-2) + 8(6) =40

12. Write down the expression for conversion of Cartesian to Cylindrical system. **(APR 15)**

The Cartesian co-ordinates (x, y, z) can be converted into Cylindrical co-ordinates (r , Φ , z).

Given	Transform
x	$r = \sqrt{x^2 + y^2}$
y	$\Phi = \tan^{-1}(y/x)$
z	z = z

13. Write down the expression for conversion of Cylindrical to Cartesian system.

The Cylindrical co-ordinates (r , Φ , z) can be converted into Cartesian co-ordinates (x, y, z).

Given	Transform
r	x = r cosθ
Φ	y = r sinθ
z	z = z

14. Write down the expression for conversion of Cartesian to Spherical system.

The Cartesian co-ordinates (x, y, z) can be converted into Spherical co-ordinates (r , θ , Φ).

Given	Transform
x	$r = \sqrt{x^2 + y^2 + z^2}$
y	$\theta = \cos^{-1}\left(\frac{z}{\sqrt{x^2+y^2+z^2}}\right)$
z	$\Phi = \tan^{-1}(y/x)$

15. Write down the expression for conversion of Spherical to Cartesian system.

The Spherical co-ordinates (r , θ , Φ) can be converted into Cartesian co-ordinates (x, y, z).

Given	Transform
r	x = rsinθ.cosΦ
θ	y = r sinθ.sin Φ
Φ	z = rcosθ

16. Transform the Cartesian co-ordinates x = 2, y = 1, z = 3 into spherical co-ordinates.

Given	Transform
x = 2	$r = \sqrt{x^2 + y^2 + z^2} = \sqrt{4+1+9} = 3.74$
y = 1	$\theta = \cos^{-1}\left(\frac{z}{\sqrt{x^2+y^2+z^2}}\right) = \cos\text{-}1\left(\frac{3}{\sqrt{14}}\right) = 36.7^o$
z = 3	$\Phi = \tan^{-1}(y/x) = \tan^{-1}(1/2) = 26.56^o$

The spherical co-ordinates are (3.74, 36.7^o, and 26.56^o).

17. Give the Cartesian co-ordinates of a point whose cylindrical are r = 1, Φ =45^o , z=2.

Given	Transform
r = 1	x = r cosθ = 1.cos45 = 0.707
Φ =45^o	y = r sinθ = 1.sin45 = 0.707
z = 2	z = z = 2

The Cartesian co-ordinates are (0.707, 0.707, 2)

18. Define Divergence theorem.

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.

$$\iiint_v \nabla.AdV = \oiint_S A.dS$$

19. Define Stoke's Theorem. **(Nov 2013,2016,2017)(May/June 14)**

The line integral of a vector around a closed path is equal to the surface integral of the normal component of its equal to the integral of the normal component of its curl over any closed surface.

$$\oint H.dl = \iint_S \nabla xHdS$$

20. Express the value of differential volume in rectangular and cylindrical co-ordinates systems.

For rectangular co-ordinate

dv = dxdydz

For cyclindrical co-ordinate

dv = rdrdθdz.

21. Write the expression for differential length in cylindrical and spherical co-ordinates. **(NOV 15)**

For cylindrical co-ordinates

dl = $\sqrt{(dr)^2 + (rd\Phi)^2 + (dz)^2}$

For spherical co-ordinates

dl = $\sqrt{(dr)^2 + (rd\theta)^2 + (r\sin\theta d\Phi)^2}$

22. Define unit vector.

A unit vector in a given direction is a direction in that direction divided by its magnitude.

$$a_r = \frac{r}{|r|}$$

23. Find the distance from A (1,2,3) to B (2,0,-1) in rectangular co-ordinates.

r = $\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2}$ = $\sqrt{(2-1_1)^2 + (0-2)^2 + (-1-3)^2}$

= $\sqrt{1+4+16}$ = $\sqrt{21}$

24. What is the divergence of curl of a vector?

$$\nabla.\nabla xH = 0$$

$\nabla x \nabla x A =$ ______________

$\nabla x \nabla x A = \nabla\nabla.A - \nabla^2 A$

25. What is the physical significance of divergence of $\overline{D}$?

The divergence of the vector flux density $\overline{D}$ is the outflow from a small closed surface per unit volume as the volume shrinks to zero. $\nabla.\overline{D} = \underset{\Delta v \to 0}{LT} \frac{\oint D.ds}{\Delta v}$

26. Express the divergence of a vector in the three system of orthogonal co-ordination.

For rectangular co-ordinate system, $\nabla . B = \frac{\partial Bx}{\partial x} + \frac{\partial By}{\partial y} + \frac{\partial Bz}{\partial z}$;

For cylindrical co-ordinate system, $\nabla . B = \frac{1}{r}\frac{\partial (rBr)}{\partial r} + \frac{1}{r}\frac{\partial B\Phi}{\partial \Phi} + \frac{\partial Bz}{\partial z}$

For spherical co-ordinate system, $\nabla . B = \frac{1}{r^2 \sin\theta}\left(\frac{\partial (r^2 \sin\theta Br)}{\partial r} + \frac{1}{r}\frac{\partial (r\sin\theta B\theta)}{\partial \theta} + \frac{\partial rB\Phi}{\partial \Phi}\right)$

27. Show that the two vectors $\overline{A}=6\overline{a_x}+\overline{a_y}-5\overline{a_z}$ and $\overline{B}=3(\overline{a_x}-\overline{a_y}+\overline{a_z})$ are perpendicular to each other. (APR15)

$\overline{A}\cdot\overline{B}$ = (6x3) + (1x-3) + (-5x-3)=18-3-15 = 0.

28. Given two vectors P=3i+5j+2k and Q=2i-4j+3k.Determine the angular separation between them.(November 2011,2016)

P. Q= IPI IQI cosθ, P.Q=-8, IPI =6.1644 IQI =5.38516, Cosθ=-0.2409, Θ = 103.94.

29. What is the physical significance of curl of a vector field? (Nov 2011)

The curl of a vector is an axial vector whose magnitude is the maximum circulation of A per unit area as the area tends to zero and whose direction is the direction normal direction of the area when the area 9is oriented to make the circulation maximum.

30. Two vector quantities A=4i+3j+5k and Q=i-2j-2k.are oriented in two different directions. Determine the angular separation between them. (**May 2012,Nov 16)**

A.B=IAI.IBICosθ

Θ=Cos^{-1}[A.B/(IAI.IBI)]=67.84^o.

31. State the condition for the vector to be solenoidal and irrotational. (Nov 2012)

A.B=0 and AX B=0

32. What are the different sources of Electromagnetic fields? (May 2012) **(Nov 2011, 2017)**

Electromagnetic fields are present everywhere in our environment but are invisible to the human eye. Electric fields are produced by the local build-up of electric charges in the atmosphere associated with thunderstorms. The earth's magnetic field causes a compass needle to orient in a North-South direction and is used by birds and fish for navigation.

33. Two vector quantities A= 4i +3j + 5k and B= i-2j+2k are known to be oriented in two unique directions.Determine the angle of separation between them. (Nov 2012)

A.B=IAI.IBICosθ

θ=Cos-1[A.B/(IAI.IBI)]=67.84

34. How are the unit vectors defined in cylindrical co-ordinate systems? (Nov 2013)

A vector A in cylindrical coordinates can be written as

$$(A_\rho, A_\phi, A_z) \text{ or } A_\rho \mathbf{a}_\rho + A_\phi \mathbf{a}_\phi + A_z \mathbf{a}_z$$

where a_ρ, a_ϕ and a_z are unit vectors in the ρ, ϕ and z directions.

35. Define electric flux and electric flux density.

Electric flux: The lines of electric force are known as electric flux. It is denoted by χ.

χ = Q (charge) Coulomb.

Electric flux density: Electric flux density or displacement density is defined as the electric flux per unit area. D = Q/A

36. State Gauss's law.

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

37. State the point form of Gauss's law.

The divergence of electric flux density is equal to the volume charge density. $\nabla . D = \rho_v$.

38. State Coulomb's law.

Coulomb's law states that the force between two very small charged objects separated by a large distance compared to their size is proportional to the charge on each object and inversely proportional to the square of the distance between them. $F \alpha Q_1Q_2$

$$F \alpha \frac{1}{r^2}$$

$$F \alpha \frac{Q1Q2}{r^2} = \frac{Q1Q2}{4\pi\varepsilon r^2}\overline{a_{12}} \text{ Newton.}$$

39. Name a few application of Gauss's law in electrostatics. (Nov 2013)

Gauss's law is applied to determine the electric field intensity from a closed surface. (e.g) Electric field can be determined for shell, two concentric shell or cylinders, etc.

40.Define electric field intensity or electric field.

Electric field intensity is defined as the electric force per unit positive charge. It is denoted by E.

$$E = \frac{F}{Q} = \frac{Q}{4\pi\varepsilon r^2} \text{ V/m.}$$

41.What is the relation between intensity of electric field $\overline{E}$ and electric flux density $\overline{D}$ in free space?

D=εE c/m^2 Where ε – Permittivity of the medium. $\varepsilon = \varepsilon_o \varepsilon_r$

42.What is the electric field intensity at a distance of 20cm from a charge of 20μc/m^2 lying on the z=0 plane. in vacuum? **(Nov14) (Nov 15)**

$$E = \frac{\rho_s}{2\varepsilon_0} a_z = \frac{20x10^{-6}}{2x8.854x10^{-12}} a_z = 1.12 \times 10^6 a_z \text{ V/m.}$$

43. Points P and Q are located at (0,2,4) and (-3,1,5). Calculate the distance vector from P to Q. **(N/D14)**

$R_{pq} = r_q - r_p$ = (-3,1,5) – (0,2,4) = (-3,-1,1)

44. What are the practical applications of electromagnetic fields? **(Nov 15)**

PART -B

1. Explain the method of converting a vector from Spherical to Cartesian system. T1 24-31
2. Explain the method of converting a vector from Cartesian to Cylindrical system. T1 24-31
   Transform the vector A=3i-2j-4k at p(x=2, y=3, z=3) to Cylindrical System. **(Nov 16)**
3. What are the sources and effects of electromagnetic fields? T1 512-516 **(Nov 2011,2017)**
4. Explain the different coordinate systems used to represent field vectors. T1 24-31 (Nov 2011)
5. State and prove Divergence theorem T2 8-22 **(Nov 2011, 2012,2016) (May 2012)**
6. State and prove Stoke's theorem. T2 8-22 **(Nov 2011,2017)**

7) If $G(r) = 10e^{-2z}(\rho a_\rho + a_z)$, determine the flux of G out of the entire surface of the cylinder ρ=1, 0≤z≤1. Confirm the result using the divergence theorem.

8. Write short notes on the following (i) Gradient (ii) Divergence (iii) Curl and (iv) Strokes theorem. T2 8-22 **(Nov 16)**
9. Obtain the curl in the spherical co ordinate system. T1 24-31 **(Nov 2016, Nov 2013)**
10. Transform $4a_x - 2a_y - 4a_z$ at (2,3,5) to cylindrical co ordinates.
11. Derive the expression for electric field intensity due to uniformly charged circular disc of σ c/m^2. **T1 31-50 (Nov 16)**

12. Find the force on a charge Q1 of 20 µC at (0.1.2) m due to Q2 of 300 µC at (2,0,0)m. **(Nov 16)**
13.Given that A=30 e^{-r} a_r - 2z a_z in cylindrical coordinates, evaluate both sides of divergence theorem for the volume enclosed by r=2,z=0 and z=5. **(Nov 16)**
14. State and prove Gauss law T2 55-68 **(Apr 15,17)**
Obtain the expression for electric field intensity due to a uniformly charged line of length ‘l
(Apr 15,17)

UNIT – II
ELECTROSTATICS - II

PART - A

1. What is a point charge?
Point charge is one whose maximum dimension is very small in comparison with any other length
2. What do you understand by linear, surface and volume charge densities?
Linear Charge density: It is the charge per unit length (Col / m) at a point on the line of charge.

$$\rho_l = Lt_{\Delta l \to 0} \left(\frac{\Delta Q}{\Delta l}\right)$$

Surface charge density: It is the charge per surface area (C/m^2) at a point on the surface of the charge.

$$\rho_s = Lt_{\Delta s \to 0} \left(\frac{\Delta Q}{\Delta s}\right)$$

Volume charge density: It is the charge per volume (C/m^3) at a point on the volume of the charge.

$$\rho_V = Lt_{\Delta v \to 0} \left(\frac{\Delta Q}{\Delta v}\right)$$

3. Define potential and potential difference. (Nov 2012) (May2012) (Nov 2013)
Potential: Potential at any point as the work done in moving a unit positive charge from infinity to that point in an electric field = $\frac{Q}{4\pi\varepsilon r}$ Volts.
Potential Difference: Potential difference is defined as the work done in moving a unit positive charge from one point in an electric field..V= $\frac{Q}{4\pi\varepsilon}\left(\frac{1}{r_A} - \frac{1}{r_B}\right)$ Volts.
4. Give the relationship between potential gradient and electric field.
E = $-\nabla V$;E = -$\left(\frac{\partial}{\partial x}\bar{a}_x + \frac{\partial}{\partial y}\bar{a}y + \frac{\partial}{\partial z}\bar{a}z\right)$ V.
5. Find the electric potential at a point (4 , 3) m due to a charge of 10^{-9} C located at the origin in free space.
V= $\frac{Q}{4\pi\varepsilon_O r}$;r = $\sqrt{4^2+3^2}$ = 5m. V= $\frac{10-9}{4\pi x 8.854 x 10-12 x(5)}$ = 1.8V
6. What is the physical significance of div D?
$\nabla . D = \rho_v$. 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.
7. Write the Poisson’s equation and Laplace equation.(M/J14)
Poisson equation; $\nabla^2 V = -\rho/\varepsilon$
where ρ – Volume charge density , ε Permittivity of the medium, ∇^2 - Laplacian operator.

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

Laplace equation: $\nabla^2 V = 0$; $\frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial Y^2} + \frac{\partial^2 V}{\partial z^2} = 0$

8. Represent in unit vector along a vector $\overline{R} = 6\overline{a_x} + 8\overline{a_y}$

Unit Vector $\overline{a_R} = \frac{\overline{R}}{|\overline{R}|} = \frac{6\overline{a_x} + 8\overline{a_y}}{\sqrt{36+64}} = 0.6\overline{a_x} + 0.8\overline{a_y}$

9. A uniform line charge , infinite in extent , with ρ_l = 20nc/m lines along the z axis. Find E at (6,8,3)m.

$$|r| = \sqrt{6^2 + 8^2 + 3^2} = \sqrt{36+64+9} = \sqrt{109}$$

E = $\rho_l / 2\pi\varepsilon_o r$ = $\frac{20x10^{-9}}{2\pi x 8.854 x 10^{-12} x \sqrt{109}}$ = 34.48V/m

10. State the condition for the vector $\overline{F}$ to solenoid.

The vector F is said to be irrotational if $\nabla x \overline{F} = 0$

11. Define dipole and dipole moment.

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 (spacing) is known as dipole moment. It is denoted by m where Q is the charge and l is the length (m) =Q. l C/m .

12. Define capacitor.

A capacitor is an device which consists of two conductors are separated by a dielectric medium.

13. Define Capacitance.

The capacitance of two conducting planes is defined as the ratio of magnitude of charge on either of the conductor to the potential difference between conductors. It is given by, $C = \frac{Q}{V}$ Farad.

14. Determine the capacitance of a parallel plate capacitor with two metal plates of size 30cm x 30cm separated by 5mm in air medium.

Given data: A = 0.3 X0.3 = 0.09m^2; d=5 x 10^{-3}m.

ε_o = 8.854 x 10^{-2};C=$\frac{A}{2}$ ε_o = $\frac{0.09X8.854X10^{-12}}{5X10^{-3}}$ = 15.9Nf

15. Express the value of capacitance for a co-axial cable.

C=$\frac{2\pi\varepsilon_o\varepsilon_r}{\ln\frac{b}{a}}$; Where b – outer radius:.a – inner radius.

16. Write the expression for the energy density in electro static field.

$\frac{\Delta W}{\Delta v} = \frac{1}{2}\varepsilon E^2 = \frac{1}{2}DE$ J/m^3.

17. Find the energy stored in a parallel plate capacitor of 0.5m by 1m has a separation of 2cm and a voltage difference of 10V. (NOV 15)

C= ε_o $\frac{A}{d}$ = $\frac{8.854x10^{-12}x0.5x1}{2x10^{-2}}$ =2.2135x10^{-10} F

Energy stored in a capacitor E=1/2 CV^2 =1/2 X 2.2135 X 10^{-10} X10^2 =1.10675 X 10^{-8}Joules.

18. Write down the expression for the capacitance between two co-axial cylinders.

C= $\frac{\pi\varepsilon_o}{\ln\frac{d}{a}}$ Where d – distance between two transmission lines, a – radius of cylinders.

19. State the boundary conditions at the interface between two perfect dielectrics.
a) The tangential component of electric field E is continuous at the surface. That is E is the same just outside the surface as it is just inside the surface.$E_{t1} = E_{t2}$
b) The normal component of electric flux density is continuous if there is no surface charge density. Otherwise D is discontinuous by an amount equal to the surface charge density. $D_{n1} = D_{n2}$

20. A parallel plate capacitor has a charge of 10-3 C on each plate while the potential difference between the plates is 1000V.Calaculate the value of capacitance. (Nov 2012) (May2012)

Given data, Q = 10-3C, V = 1000V,C = $\frac{Q}{V} = \frac{10^{-3}}{10^{3}}$ = 1μF.

21. State point form of ohm's law.
Point form of Ohm's law states that the field strength within a conductor is proportional to the current density.J α E; J = σE; Where σ is conductivity of the material.
22. What is meant by conduction current?
Conduction current is nothing but the current flows through the conductor. Conduction current density is given by Jc = σE Amp / m^2.
23. What is meant by Displacement current density?
Displacement current is nothing but the current flows through the Capacitor.

Displacement current density is given by $J_d = \frac{\partial D}{\partial t}$ Amp / m^2

24. Define polarization in dielectric material.

Polarization is defined as dipole moment per unit volume. P= $Lt_{\Delta v \to 0} \frac{1}{\Delta v} \sum_{i=1}^{n\Delta v} P_i$

25. What is meant by conservative property of Electric field? (Nov 2011)
The line integral of electric field along a closed path is zero. Physically this implies that no net work is done in moving a charge along a closed path in an electrostatic field. Thus an electrostatic field is said to have conservative property .
26. Give the significant physical difference between Poisson's and Laplace equation.
(Nov 2011,2014,2016)

Poisson equation: $\nabla^2 V = -\rho/\varepsilon$

Where ρ – Volume charge density, ε – Permittivity of the medium, ∇^2 - Laplacian operator.

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

Laplace equation: $\nabla^2 V = 0$; $\frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial Y^2} + \frac{\partial^2 V}{\partial z^2} = 0$

The Laplace equation is defined only for the region which is free of charges.
27. State the properties of electric flux lines.(N/D14)
(i) It must be independent of the medium.
(ii) Its magnitude solely depends upon the charge from which it originates,
(iii) If a point charge is enclosed in an imaginary sphere of radius R, the electric flux must pass perpendicularly and uniformly through the surface of the sphere and
(iv) The electric flux density, the flux per unit area is then inversely proportional to R^2.
28. Find the capacitance of an isolated spherical shell of radius **a**. **(Nov 16)**

29. Find the magnitude of D for a dielectric material in which E=0.15 MV/m and ε_r =5.25 **(Nov 16)**
30. What is the practical significance of Lorentz force. **(Apr 15)**
31. Find the electric field intensity in free space if D= 30 a_x C/m^3
32. Obtain the electric potential due to electric dipole **(Nov 16)**
33. What is a conservative field **(Nov 17)**

PART – B

1. Derive an expression for Electric field intensity due to a line charge which has a uniform linear charge density of ρ_L C/m. Also extend it to a conductor of infinite length. T2 81-110 **(Nov 16)**
2. State and explain the applications of Gauss Law. T2 55-68
3. Derive the expression for the electric field intensity at a point P which is situated 'h' meter away from the disc along its axis. The disc is charged uniformly with a charge density of ρ_L c/m^2 T2 81-110
4. Planes X=2 and Y=-3 respectively carries charges 10 nC/m^2 and 15 nC/m^2.If the line X=0,Z=2 carries charge 10 π n C/m .Calculate E at (1,1,-1) due to all the three charge distributions.
5. Derive the expression for energy and energy density in the static electric field. **(May-2012)(Nov 2013)**
6. Deduce an expression for the capacitance of a parallel plate capacitor with two dielectrics of relative permittivity $\varepsilon 1$ and ε_2 respectively interposed between the plates. T3 157-168 **(Nov2013,17)** **(Apr 15)**
7. State and explain Coulomb's law of force. T1 35-39 (Nov 2011)
8. Derive the electrostatic boundary conditions at the interface between two dielectrics and a conductor to dielectric medium. T1 59-65 **(Nov2011,12,13,17)**
9. Two extensive homogeneous isotropic dielectrics meet on plane z=0.For $Z\geq0$,ε_{r1}=4 and for $z\leq0$,ε_{r2}=3.A uniform electric field E1 = $5a_x-2a_y+3a_z$ KV/m exists for $z\geq0$.Find a)E2 for $z\leq0$. b)The angles E_1 and E_2 make with interference. c)The Energy densities in J/m^3d) the energy within a cube of side 2m centered at (3,4,-5).
10. Derive the expression for energy stored and energy density. T3 157-168 (Nov 2012)
11.a) Find the potential at r_A=5 m with respect to r_B=15m due to point charge Q =500pC at the origin and zero reference at infinity. **(Nov 2016)**
b) Find the capacitance of parallel plate capacitor with dielectric ε_{r1}=1.5 and ε_{r2}=3.5 each occupy one half of the space between the plates of area 2m^2 and d=10^{-3}m **(Nov 2016)**
12. a) In spherical coordinates V= -25V on a conductor at r=2cm and V=150V at r=35cm. the space between the conductor is a dielectric of ε_r=3.12. Find the surface charge densities on the conductor **(Nov 2016)**
13. Explain the polarization and thus obtain electric field intensity and potential of a dipole. T3 149-154 **(Apr 15)**

UNIT – III
MAGNETOSTATICS

PART - A

1. Define magnetic flux .

Magnetic flux is defined as the flux passing through any area. Its unit is Weber .

$$\Phi = \int_a B.da \text{ Weber.}$$ /

2. Define magnetic flux density.

Magnetic flux density is defined as the magnetic flux density passing per unit area. Its unit is Weber / meter or Tesla. $B=\frac{\Phi}{A}$ B=μH

3. Define magnetic Gauss's Law.

The total magnetic flux passing thorough any closed surface is equal to zero. $\oint_a B.da = 0$

4. State Biot- Savart law. **(Apr 17)**

It states that the magnetic flux density at any point due to current element is proportional to the current element and sine of the angle between the elemental length and the line joining and inversely proportional to the square of the distance between them. $dB = \frac{\mu_o Idl \sin\theta}{4\pi r^2}$

5. Give the force on a current element.

The force on a current element Idl is given by

dF = I x B dl = BI dl sinθ Newton.

6. State the Lorentz force equation. (Nov 2013)

The force on a moving particle due to combined electric and magnetic field is given by

F = Q [$\left[\vec{E} + \vec{V} x \vec{B}\right]$.This force is called Lorentz force.

7. State Ampere's circuital law. **(May14)(Nov 16)**

Ampere's circuital law states that the line integral of magnetic field intensity H about any closed path is exactly equal to the direct current enclosed by the path.

$$\oint H.dl = I$$

8. What is field due to toroid and solenoid?

a) Toroid $H = \frac{NI}{2\pi r}$ b) Solenoid $H = \frac{I}{l}$

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

$$H = \frac{I}{2a}$$

10. Define scalar magnetic potential.

It is defined as dead quantity whose negative gradient gives the magnitude intensity if there is no current source present.

$$H = -\nabla V_m$$

where Vm is the magnetic scalar potential.

$$V_m = -\int H.dl$$

11. Define magnetic vector potential. **(Apr 17)**

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

$B = \nabla$ x A; where A is the magnetic vector potential.

$$A = \frac{\mu}{4\pi}\iiint_V \frac{J}{r} dr \quad \text{Web / m}$$

12. Distinguish between diamagnetic, paramagnetic and ferromagnetic materials.

Diamagnetic: In diamagnetic materials magnetization is opposed to the applied field. It has magnetic field.

Paramagnetic: In paramagnetic materials magnetization is in the sane direction as the field. It has weak magnetic field. Ferromagnetic: In Ferromagnetic materials is in the same direction as the field. It has strong magnetic field.

13. A solenoid with a radius of 2cm is wound with 20 turns per cm length and carries 10mA. Find H at the centre if the total length is10cm.

Given data,

N=nl = 20 x 10 = 200 turns.

l =10 X 10^{-2} m; I = 10 x 10^{-3}A; $H = \frac{NI}{l}$ = 20AT/m.

14. Define mechanical moment.

The tangential force multiplied by the radial distance at which it act is called Torque or mechanical moment on the loop.

15. Define magnetic moment.

The magnetic moment is defined as the maximum torque on loop per unit magnetic induction (Flux density). m=IA; where A is Area.

16.Give the force on a current element.

The force on a current element Idl is given by

dF=I x Bdl =BI dl sinθ

17.Give torque on closed circuits.

The torque on closed circuit in a magnetic field is

T=BIA cosθ=T=mBcosθ

where m is magnetic moment

In vector form T = m x B

18. Give torque on a solenoid.

Torque on a solenoid in a magnetic field is

T= $\frac{n}{2}$. 2IAB = nBIA =mB Where m=nIA.

19. Give four similarities between Electrostatic field and Magnetic field.(N/D14)

Electrostatic field	Magnetic field
Electric field intensity E (volts/m)	Magnetic field intensity H (Amp/m)
Electric flux density D=εE c/m	Magnetic flux density B=μH (web / m^2)
Energy stored is $1/2CV^2$	Energy stored is $1/2LI^2$
Charges are rest	Charges are in motion

20. Determine the force per unit length between two long parallel wires separated by 5 cm in air and carrying currents 40A in the same direction.

Force / length = $\frac{\mu_o I_1 I_2}{2\pi D} = \frac{40X40}{2\pi x 5x10^{-2}} x4\pi x10^{-7}$ =6.4 x 10^{-3} N/m.

21. Define magnetic dipole.

A small bar magnet with pole strength Q_m and length l may be treated as magnetic dipole whose magnetic moment is Q_ml.

22. Define Magnetization.

Magnetization is defined as the ratio of magnetic dipole moment to unit volume.

M= $\frac{Magnticdipole}{Volume} = \frac{Qm-}{A}a$ A/m

23.Define magnetic susceptibility.

Magnetic susceptibility is defined as the ratio of magnetization to the magnetic field intensity. It is dimensionless quantity.

$$\chi_m = \frac{M}{H}$$

24.What is the relation between relative permeability and susceptibility?

$\mu_r = 1 + \chi_m$ Where μ_r is relative permeability; χ_m is susceptibility

25. What are the different types of magnetic materials?

The magnetic materials can be classified into three groups according to their behavior. They are diamagnetic, paramagnetic and ferromagnetic materials.

26. Write down the magnetic boundary conditions. (Nov 2013)

1. The tangential component of magnetic field intensity is continuous across the boundary. $H_{t1} = H_{t2}$. 2. The normal component of magnetic flux density is continuous across the boundary. $B_{n1} = B_{n2}$

27. Define self inductance. (APR 15)

The self induction of a coil is defined as the ratio of total magnetic flux linkage in the circuit to the current through the coil (L) = $\frac{N\Phi}{i}$ Where Φ is magnetic flux; N is number of turns of coil; i is the current.

28. Define mutual inductance. (APR 15)

The mutual inductance between two coils is defined as the ratio of induced magnetic flux linkage in one coil to the current through in other coil(M) = $\frac{N_2\Phi_{12}}{i_1}$; Where N_2 is number of turns in coil 2; Φ_{12} is magnetic flux links in coil 2 and i_1 is the current through coil 1.

29. Define co-efficient coupling.

The fraction of the total flux produced by one coil linking the second coil is called the co-efficient of coupling (K). K = $\frac{\Phi_{12}}{\Phi_1} = \frac{\Phi_{21}}{\Phi_2}$; Where Φ_1 is the flux produced by coil 1; Φ_{12} is flux links coil 2; $K \le 1$;

$$K = \frac{M}{\sqrt{L_1L_2}}$$

30. What will be effective inductance, if two inductors are connected in (a) series and (b) parallel?

(a) For series $L = L_1 + L_2 \pm 2M$ + sign for aiding

(b) For Parallel $L = \frac{L_1L_2 - M^2}{L_1 + L_2 \pm 2M}$ - sign for opposition

31. Give the expression for inductance of a solenoid.

$L = \frac{\mu_o N^2 A}{l}$; Where N is number of turns; A is area of cross-section; l is length of solenoid; μ_o is free space permeability.

32. Give the expression for inductance of a toroid.

$L = \frac{\mu_o N^2 A}{2\pi R} = \frac{\mu_o N^2 r^2}{2R}$; where N is number of turns; r is radius of the coil; R is radius of toroid; μ_o is free space permeability.

33. Give the expression for inductance per unit length of a co-axial transmission line.

$L = \frac{\mu_o}{2\pi}\ln\left(\frac{b}{a}\right)$ H/m. Where a is the radius of inner conductor; b is the radius of outer conductor.

34. Distinguish between solenoid and toroid.

Solenoid: 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.

Toroid: If a long, slender solenoid is bent into the form of a ring and thereby closed on itself, it becomes toroid.

35. What is the mutual inductance of two inductively tightly coupled coils with self inductance of 25mH and 100mH. (NOV 15)

L_1 = 25mH, L_2 = 100mH, M=K $\sqrt{L_1 L_2}$ $= \sqrt{25X100}$ =50mH

36.Define magnetostatic energy density. (Nov 2011)

It is defined as the ratio of magnetic energy per unit volume.

37.State the law of conservation of magnetic flux. (Nov 2011)

An isolated magnetic charge does not exist. Thus the total flux through a closed surface is zero.

$\iint B.ds = 0$ .This is called as law of conservation of magnetic flux.

38.State Ohm's law for magnetic circuits. (Nov 2012, N/D14)

Sum of Magnetic motive force (mmf) in a closed path is zero.

39. Write the expression for the H at the centre of a circular coil carrying a current of I Amps.

H=NI/2a; where N is number of turns: a is the radius of the coil;

40. State Lorentz Law of force. (May 2012)(NOV 15)

When a current carrying conductor is placed in a magnetic field, it experiences a force given by ,dF = I x B dl = BI dl sinθ Newton.

41. State the boundary condition at the interface between two magnetic materials of different permeability. (May 2012)

Ht1=Ht2, Bn1=Bn2

Ht1,Ht2 are the tangential magnetic field in region 1 and 2 respectively.

Bn1,Bn2 are the normal magnetic flux density in region 1 and 2 respectively.

42. Write the expression for the inductance per unit length of a long solenoid of N turns and having a length 'L' meter carrying a current of I amperes.(M/J14)

$$H = \frac{NI}{2l}[Cas\theta_2 - Cos\theta_1]$$

43. Determine the value of magnetic field intensity at the centre of a circular loop carrying a current of 10A. The radius of the loop is 2m. (N/D14)

$$H = \frac{I}{2a} = \frac{10}{2x2} = 2.5A/m$$

44. Distinguish between magnetic scalar potential and magnetic vector potential.(N/D14)

Sl.no	magnetic scalar potential	magnetic vector potential
1	It is defined as dead quantity whose negative gradient gives the magnetic intensity if there is no current source present	It is defined as that quantity whose curl gives the magnetic flux density
2	$H = -\nabla V_m$	$B = \nabla x A$

45. A conductor 4m long lies along the y-axis with the current of 10 A in ay direction, if the field is B=0.05 a_x tesla calculate the force on the conductor**.** **(Nov 16)**

46. Find the force of interaction between two charges $4*10^{-8}$ and $6*10^{-5}$ spaced 10 cm apart in kerosene (ε_r=2) **(Apr 15)**

46. Find the maximum torque on an 100 turns rectangular coil of 0.2m by 0.3m carrying current of 2A in the field of flux density 5 Web / m^2.

PART-B

1. Derive an expression for the magnetic field intensity at a point P in a medium of permeability 'μ' due to an infinitely long current carrying conductor at a distance 'r' meters from the point. T1 87-88

(Nov 2011,12,15,16) (Apr 17)

2. A solenoid of length 'l' and radius a consists of N turns of wire carrying a current of 'I' Amps.
3. A circular loop of radius ' ρ ' meters ,carries a current of I amperes along a_φ .Find the magnetic field intensity at (0,0,h) due to the circular loop. T2 210-239
4. Derive an expression for self inductance of a coaxial cable of inner radius a and outer radius b.
5. If a magnetic vector potential A= $\frac{5i}{x^2 + y^2 + z^{\ 2}}$ then find flux density. (Nov 2011)

6. What is magnetization? Explain the classification of magnetic materials with examples. T2 404-412 (Nov 2011)
7. Derive the magnetostatic boundary conditions. T2 281-283 **(Apr 15,17)**
8. Derive an expression for force on a current carrying element and force between two current carrying element. T1 400-404 **(Nov2013,Apr 17)**
9. Derive Biot-savart's Law and Ampere's Law from concept of magnetic vector potential.T1 81-85 (Nov 2012 & 2013) (May2012)
10. Explain the classification of magnetic materials with Example. T1 404-412
11. a) Determine H for a solid cylindrical conductor of radius a, where the current I is uniformly distributed over the cross section. T2 210-239

    b) Calculate the inductance of a ring shaped coil of mean diameter 20 cm wound on a wooden core 2 cm diameter containing 200 turns. **(Nov 16)**
12. Obtain the expression for inductance and torque on a long solenoid coil. T1 89-96 **(Apr 15)**

UNIT – IV
ELECTRO DYNAMIC FIELDS

PART - A

1. State Faraday's law of electromagnetic induction. (**nov 16**)

Faraday's law states that electromagnetic force induced in a circuit is equal to the rate of change of magnetic flux linking the circuit. emf= $\frac{d\Phi}{dt}$

2. Define mmf.

Magnetic motive force (mmf) is given by mmf = flux x reluctance

mmf = $\Phi\,\Re$ Amp.turns.

3. Define reluctance.

Reluctance is the ratio of mmf of magnetic circuit to the flux through it.

$\Re = \frac{mmf}{flux(\Phi)}$. It is also written as $\Re = \frac{l}{\mu A}$;Where l is the length, A is the area of cross- section, μ is permeability

4. In a solenoid with an inductance of 5mH current is increasing at the rate of 100A/sec. What is the value of induced emf?

emf = $L\frac{di}{dt}$ =5x10^{-3}x100=0.5V.

5. Give the expression for lifting force of an electro magnet.

F= $\frac{B^2 A}{2\mu_o}$;Where B is flux density, A is area of air gap between the poles of the magnet, μ_o is permeability of free space.

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

$W = \frac{1}{2}LI^2$;Where L is the inductance , I is the current.

7.What is energy density in the magnetic field?

Energy density (w) = $\frac{1}{2}BH = \frac{1}{2}\mu H^2$

8.Write down the general, integral and point form of Faraday's law.

emf $v = -\frac{d\Phi}{dt}$ (General) , $\oint E.dl = -\iint \frac{\partial B}{\partial t}ds$ (Integral)

$\nabla X E = -\frac{\partial B}{\partial t}$ (Point form)

9. Distinguish between transformer emf and motional emf. **(Nov 2013) (APR 15,17)**

The emf induced in a stationary conductor due to the change in flux linked with it, is called transformer emf or static induced emf. emf = - $\iint \frac{\partial B}{\partial t}.ds$ eg. Transformer.

The emf induced due to the movement of conductor in a magnetic field is called motional emf or dynamic induced emf. emf =- $\oint_c vXB.dl$ eg. Generator

10.State Lenz's law.

Lenz's law states that the induced emf in a circuit produces a current which oppose the change in magnetic flux producing it.emf = - $\frac{d\Phi}{dt}$

11. State Dot rule.

If both the currents enter dotted ends of coupled coils or if the both currents enter undotted ends, then the sign on the M will be same as the sign on the L.If one current enters a dotted end and the other an undotted end , the sign on the M will be opposite to the sign on the L.

12.Mention four similarities between electric circuit and magnetic circuit. (N/D14)

Electric circuit	Magnetic circuit
1. emf (volts)	mmf (Amp-turns)
2.current = $\frac{emf}{resistance}$	magnetic flux = $\frac{mmf}{reluctance}$
3.resistance R = $\frac{\rho l}{A}$	Reluctance $\Re = \frac{l}{\mu A}$
4.Conductance G = $\frac{1}{R}$	Permeance P = $\frac{1}{\Re}$

13.A region in free space has a magnetic field intensity of B web/m^2. What is the energy stored per m^3 of space?

Energy density = Energy per volume = $\frac{1}{2}\frac{B^2}{\mu}$ Joules / m^3;where,μ – is the permeability of the medium.

14.Write down the Maxwell's equation in integral form.

From Ampere's Law

$\oint H.dl = \iint_S \left(J + \frac{\partial D}{\partial t}\right)ds$, From Faraday's Law $\oint E.dl = -\iint_S \frac{\partial B}{\partial t}ds$

From Electric Gauss's Law

$\oiint_s D.ds = \iiint_v \rho dv$, From Magnetic Gauss's Law $\oiint_s B.ds = 0$

15.Write down the Maxwell's equation in point form.

From Ampere's Law

$\nabla X H = J + \frac{\partial D}{\partial t}$, From Faraday's Law $\nabla X E = -\frac{\partial B}{\partial t}$

From Electric Gauss's Law, $\nabla . D = \rho$,

From Magnetic Gauss's Law $\nabla . B = 0$

16. What is meant by Displacement current ? (Nov 2013)

Displacement current is nothing but the current flows through the Capacitor.Ic=C dV/dt.

17. State Ampere's circuital law. Must the path of integration be circular? Explain.

The integral of the tangential component of the magnetic field strength around a closed path is equal to the current enclosed by the path. $\oint H.dl = I$ .The path of integration must be enclosed one. It must be any shape and it need not be circular alone.

18. Write the fundamental postulate for electromagnetic induction and explain how its leads to Faraday's Law.

A changing magnetic flux (Φ) through a closed loop, produces an emf or voltage at the terminals as given by $v = -\frac{d\Phi}{dt}$ where the voltage is the integral of the electric field E around the loop.For uniform magnetic field Φ = B.A where B is the magnetic flux density and A is the area of the loop. $v = \oint E.dl = -\iint \frac{\partial B}{\partial t} ds$ .This is Faraday's law. It states that the line integral of the electric field around a stationary loop equals the surface integral of the time rate of change of the magnetic flux density B integrated over the loop area.

19. Explain the significance of displace current . Write the Maxwell's equation in which it is used.

The displacement current i_D through a specified surface is obtained by integration of the normal component of J_D over the surface. $i_D = \int_S J_D.ds = \int_S \frac{\partial D}{\partial t}.ds = \varepsilon \frac{\partial E}{\partial t} ds$

This is a current which directly passes through the capacitor.

Maxwell's equation

$\nabla x H = J_C + J_D$

$= \sigma E + \varepsilon \frac{\partial E}{\partial t}$ (Differential form)., $\oint_C H.dl = \int_S (J + \frac{\partial D}{\partial t}) ds$ (Integral form)

20.Find the total current in a circular conductor of radius 4mm if the current density varies according to J $= \frac{10^4}{r} A/m^2$.

Solution = $\frac{10^4}{r} A/m^2$, Current I = $\int J.ds = \int_{\Phi=0}^{2\pi} \int_{r=0}^{0.004} \frac{10^4}{r}.r dr d\Phi = 10^4 \int_{\Phi=0}^{2\pi} r \Big|_0^{0.004} d\Phi$ $=10^{-4}$ x 0.004 x $[\Phi]_0^{2\pi}$ = 80π.

21. Write down the Maxwell's equations in point phasor forms.

$$\nabla x H = J + j\omega D = (\sigma + j\omega\varepsilon)E$$
$$\nabla x E = -j\omega B = -j\omega\mu H$$
$$\nabla . D = \rho$$
$$\nabla . B = 0$$

22. Explain why $\nabla . B = 0$

$\nabla . B = 0$ states that there is no magnetic charges. The net magnetic flux emerging through any closed surface is zero.

23. Explain why $\nabla x E = 0$.

In a region in which there is no time changing magnetic flux, the voltage around the loop would be zero. By Maxwell's equation, $\nabla X E = -\frac{\partial B}{\partial t}$ =0 (irrotational).

24. Explain why $\nabla . D = 0$?

In a free space there is no charge enclosed by the medium . The volume charge density is zero. By Maxwell's equation $\nabla . D = \rho_v = 0$.

25. Compare the relation between Circuit theory and Field theory.(N/D14)

Circuit Theory	Field Theory
1. This analysis originated by its own.	Evolved from Transmission theory.
2. Applicable only for portion of RF range.	Beyond RF range (Microwave)
3. The dependent and independent parameters I, V are directly obtained for the given circuit.	Not directly , through E and H.
4. Parameters of medium are not involved.	Parameter of medium (permittivity and permeability) are involved in the analysis.
5. Laplace Transform is employed.	Maxwell's equation is employed
6. Z, Y, and H parameters are used .	S parameter is used.
7. Low power is involved.	Relatively high power is involved.
8. Simple to understand.	Needs visualization ability
9. Two dimensional analysis	Three – dimensional analysis
10.Frequency is used as reference.	Wave length is used as reference
11. Lumped components are involved	Distributed components are involved.

26..Find the emf induced in a circuit having an inductance of 700μH if the current through it varies at the rate of 5000A/sec. (Nov 2011)

E=L di/dt = 700 μH X 5000A/sec.=3.5 volts

27.Distinguish between conduction and displacement current. (Nov 2011)

Conduction current.	Displacement current
Conduction current is nothing but the current flows through the conductor.	Displacement current is nothing but the current flows through the Capacitor.
$I_c = \sigma E$.	$I_d = \quad = \int_S \frac{\partial D}{\partial t} . ds$

28. A conductor of 1m length is moved with a velocity of 100m/sec. Perpendicular to a field of 1 tesla. What is the value of emf induced? **(Nov 2012,Apr 17)**

$E_{induced}$=ulB, where u=100m/sec, l=1m, B=1 tesla, Therefore $E_{induced}$=100x1x1 =100V

29. What is the significance of displacement current? (Nov 2012)

The displacement current I_D through a specified surface is obtained by integration of the normal component of J_D over the surface.

$$I_D = \int_S J_D . ds$$

$$= \int_S \frac{\partial D}{\partial t} . ds$$

$$i_D = \varepsilon \frac{\partial E}{\partial t} ds$$

This is a current which directly passes through the capacitor.

30.A loop is rotating about the Y axix in a magnetic field B= B_0sinwt i web/m^2. What is the type the voltage induced in the loop? (May 2012)

Motional or Generator emf is induced in the conductor as the conductor position varies with respect to time.

31.Write the expression for total current density? (May 2012)

$J = J_C + J_D$

J_C is conduction current density, J_D is displacement current density.

32. Moist soil has conductivity of 10^{-3} s/m and ε_r=2.5, determine the displacement current density if E=6*10^{-6}sin (9*10^9)t **(NOV 16)**

PART – B

1. Explain a) Transformer emf b) Generator emf. T2 306-313
2. Derive an expression for displacement current density. T2 313-317 **(Apr 15)**
3. State Maxwell's equation in both point and integral form for conducting medium and free space.T1 112-115 **(Nov 16) (Apr 15,17)**
4. State the boundary conditions of time varying fields at the interface between two dielectric media between a dielectric medium and a perfect metal.
5. Briefly explain the similarities between electric circuit and magnetic circuit.
6. State and derive the time –harmonic Maxwell's equations in point and integral form. Why are Maxwell's equation not completely symmetrical? T1 112-115 (Nov2011& 2013)
7. By means of simple RLC series circuit, Explain the relationship between the field theory and circuit theory. Also explain the limitations of the circuit theory. T2 317-321 **(Nov 2011)(Apr 15,17)**
8. a) Explain the concept of emf induction in static and time varying magnetic field. T2 306-313

   b) In a material for which σ=5.0 s/m and ε_r=1 with E=250sin 10^{10}t (v/m).Find J_c and J_d and also the frequency at which they equal magnitudes. **(Nov 16)**

9. A circular loop conductor having radius of 0.15 m is placed in x-y plane. This loop consists of a resistance of 20 ohm. If the magnetic flux density is B=0.5 sin$10^3$$a_x$ Tesla. find the current through the loop. **(Apr 17)**

10.Problem

The electric field and magnetic field in free space are given by

$$\mathbf{E} = \frac{50}{\rho}\cos(10^6 t + \beta z)\,\mathbf{a}_\phi \text{ V/m}$$

$$\mathbf{H} = \frac{H_o}{\rho}\cos(10^6 t + \beta z)\,\mathbf{a}_\rho \text{ A/m}$$

Express these in phasor form and determine the constants H_o and β such that the fields satisfy Maxwell's equations.

10.In a medium characterized by σ=0, μ = μ0, ε=ε0 and E=20Sin(10^8 t-βz)ay V/m. Calculate β and H.

11. Obtain the expression for energy stored in the magnetic field and also derive the expression for magnetic energy density. T1 96-104 (Nov 2013)

UNIT – V

ELECTROMAGNETIC WAVES

PART - A

1. Define a wave.

If a physical phenomenon that occurs at one place at a given time is reproduced at other places at later times , the time delay being proportional to the space separation from the first location , then the group of phenomenon constitutes a wave.

2. Mention the properties of uniform plane wave.

The properties of uniform plane wave are as follows:

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 vary harmonically with the time and at the same frequency, every where 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.

3. Write down the wave equations for E and H in a non-dissipative (free space) medium.

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

4. Write down the wave equations for E and H in a conducting medium. (May 2012)

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

5. Define plane wave.

If the phase of a wave is the same for all points on a plane surface it is called plane wave.

6. Define uniform plane wave.

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

7. What is the properties uniform plane wave? (Nov 2013,16)

1.At every point is space electric field (E) and magnetic field (H) are perpendicular to each other and to the direction of travel. 2.The fields vary harmonically with time and at the same frequency, everywhere in space 3..Each field has the same direction, magnitudes and phase at every point in any plane perpendicular to the direction of wave travel.

8. Define intrinsic impedance or characteristic impedance.

It is the ratio of electric field to magnetic field. Or It is the ratio of square root of permeability to permittivity of the medium. $\eta = \frac{E}{H} = \sqrt{\frac{\mu}{\varepsilon}}$ Ohms

9. Calculate intrinsic impedance or characteristic impedance of free space. (Nov 2011)

$$\eta = \frac{E}{H} = \sqrt{\frac{\mu_o}{\varepsilon_o}} = \sqrt{\frac{4\pi x 10^{-7}}{8.854 x 10^{-12}}} = 120\pi = 377 \text{ ohms}$$

10. Define propagation constant.

The propagation constant (γ) is a complex number, and it is given by

$\gamma = \alpha + j\beta$; where α is attenuation constant , β is phase constant, $\gamma = \sqrt{j\omega\mu(\sigma + j\omega\varepsilon}$

11. Define skin depth or depth of penetration. **APRIL 2017**

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

$$\delta = \frac{1}{\alpha} = \sqrt{\frac{2}{\omega\mu\sigma}} \quad \text{for good conductor.}$$

12. Define polarization.

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.

13. Define linear polarization.

If x and y component of electric field Ex and Ey are present and are in phase, the resultant electric field has a direction at an angle of $\tan^{-1}(\frac{E_Y}{E_X})$ and if this angle is constant with time , the wave is said to be linearly polarized.

14. Define circular polarization.

If x and y component of electric field Ex and Ey have equal amplitude and 90^o phase difference, the locus of the resultant electric field E is a circle and the wave is said to be circularly polarized.

15. Define Elliptical polarization.

If x and y component of electric field Ex and Ey have different amplitude and 90^o phase difference, the locus of the resultant electric field E is a ellipse and the wave is said to be elliptically polarized.

16. Fine the skin depth at a frequency of 2MHz is Aluminum where σ = 38.2M s/m and $\mu_{r=}1$.

Solution:

Given data:σ = 38.2M s/m = 38.2 x 10^6 s/m;$\mu_{r=}1$; $\omega = 2\pi f = 2\pi x 2 x 10^6$

For Good conductor, Skin depth $\delta = \frac{1}{\alpha} = \sqrt{\frac{2}{\omega\mu\sigma}} = \sqrt{\frac{2}{2\pi x 2 x 10^6 x 1 x 4\pi x 10^{-7} x 38.2 x 10^6}}$ =5.758 x 10^{-5} m.

17. At what frequencies may earth be considered a perfect, if σ=6 x 10^{-3} s/m, μ_r =1 and $\varepsilon_{r=}10$.

$\frac{\sigma}{\omega\varepsilon} = 1$ This is the boundary line between dielectric and conductor $\frac{\sigma}{\omega\varepsilon} < 1$

$$\frac{\sigma}{\omega\varepsilon} = \frac{6X10^{-3}}{\omega x 8.854 x 10^{-12}} = \frac{6 x 36\pi x 109 x 10^{-3}}{2\pi f} = \frac{108 x 10^6}{f} = 1$$

f = 108 x 10^6 Hz.if frequency is greater than 108MHz , it act as dielectric.

18.A uniform plane wave in free space is described by E = $100e^{-(\pi z/3)}$ a_x Determine the frequency and wave length.

E=100 $e^{-(\pi z/3)}$ $\overline{a_x}$;B = $\frac{2\pi}{\lambda} = \frac{\pi}{3}$; $\lambda = 6m$; $f = \frac{e}{\lambda} = \frac{3x10^8}{6} = 50MHz$

19.Write Helmholtz's equation.

$\nabla^2 E - \gamma^2 E = 0$;where $\gamma = \sqrt{j\omega\mu(\sigma + j\omega\varepsilon)}$

20. Define Poynting vector. (M/J14)

The pointing vector is defined as rate of floe of energy of a wave as it propagates. It is the vector product of electric field and magnetic field. P = E x H

21.Write down the expression for average power flow in electromagnetic field and average pointing vector.

Average power Wav = $\frac{|V||I|}{2} COS\theta$, Average Poynting vector Pav = 1 / 2Real part of [E x H*]

22.Write down the complex Poynting vector in rectangular co-ordinates.

Px = ½ [Ey Hz* - EzHy*]

23. State Slepian vector.

Slepian vector is a vector which defined at every point such that its flux coming out of any volume is zero. $(\nabla .S) = 0$. Slepian vector is given by $S = \nabla x(\nabla H)$

Where, V is electric potential, H is magnetic field intensity.

24. State Poynting theorem. (Nov 2013)

The vector product of electric field intensity at any point is a measure of the rate of energy flow per unit area at that point. P = E x H

25. State Snell's law.

When a wave is travelling from one medium to another medium , the angle of incidence is related to angle of reflection as follows. $\frac{\sin\theta_i}{\sin\theta_t} = \sqrt{\frac{\eta_1}{\eta_2}} = \sqrt{\frac{\varepsilon_2}{\varepsilon_1}}$ ($\mu_1 = \mu_2 = \mu_0$)

Where θ_i is angle of incidence; θ_t is angle of refraction; ε_1 is dielectric constant of medium 1

ε_2 is dielectric constant of medium 2 .

26. What is Brewster angle?

Brewster angle is an incident angle at which there is no reflect wave for parallel polarized wave.

$$\theta = \tan^{-1}\sqrt{\frac{\varepsilon_2}{\varepsilon_1}}$$

Where, ε_1 is dielectric constant of medium 1, ε_2 is dielectric constant of medium 2

27. Define Surface impedance.

Surface impedance is defined as the ratio of tangential component of electric field at the surface of a conductor to the linear current density.

$Zs = \frac{E_{\tan}}{J_s} = \frac{\gamma}{\sigma}$; Where γ is propagation constant σ is conductivity medium.

28. Write the expression for plane electromagnetic waves propagating in a dielectric media in a direction x with respect to origin (0, 0 , 0)

The equation for plane electromagnetic waves propagating in a dielectric medium is given by

$$\frac{\partial^2 E_y}{\partial t^2} = \frac{1}{\mu\varepsilon}\frac{\partial^2 E_y}{\partial x^2} \quad \text{OR} \quad \frac{\partial^2 H_y}{\partial t^2} = \frac{1}{\mu\varepsilon}\frac{\partial^2 H_y}{\partial x^2}$$

29.In a time varying situation how do you define a good conductor and lossy dielectric ? Define loss tangent of a medium.

For good conductor, $\frac{\sigma}{\omega\varepsilon} >> 1, \quad \alpha = \beta = \sqrt{\frac{\omega\mu\sigma}{2}} = \sqrt{\pi f\mu\sigma}$

α and β are large i.e., the wave is attenuated greatly as it propagates through the conductor.

For lossy dielectric, dielectric current becomes complex, $\varepsilon = \varepsilon' - \varepsilon''$, $\frac{\sigma}{\omega\varepsilon} << 1, \alpha = \frac{\sigma}{2}\sqrt{\frac{\mu}{\varepsilon}}$ and $\beta = \omega\sqrt{\mu\varepsilon}$

Loss tangent of the medium is defined as $\tan\delta = \frac{\varepsilon''}{\varepsilon'} = \frac{\sigma}{\omega\varepsilon}$

30.What do you meant by total internal reflection?

When a wave is incident from the denser medium to rarer medium at an angle equal to or greater than the critical angle, the wave will be totally internally reflected back. This phenomenon is called Total internal reflection.

31.Write the expression for pointing theorem in point form?

$$-\nabla.\overline{P} = \sigma E^2 + \frac{1}{2}\frac{\partial}{\partial t}[\mu H^2 + \varepsilon E^2]$$

32. Write the expression for pointing theorem in integral form?

$$-\oint_S P.ds = \int_V \sigma E^2 + \frac{\partial}{\partial t}\int_V \frac{1}{2}\frac{\partial}{\partial t}[\mu H^2 + \varepsilon E^2]$$

33. Define normal incidence and oblique incidence.

Normal incidence: When a uniform plane wave incidences normally to the boundary between the media , then it is known as normal incidence.

Oblique incidence: When a uniform plane wave incidences obliquely to the boundary between the two media, then it is known as oblique incidence.

34. Define standing wave ratio.

It is defined as the ratio of maximum to minimum amplitudes of voltage.

$$S = \frac{E_{1s\max}}{E_{1s\min}} = \frac{1+|\Gamma|}{1-|\Gamma|}$$

35.Define skin depth and its significance at low frequency and at very high frequency (micro wave frequency) applications to conductors.

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

$\delta = \frac{1}{\alpha} = \sqrt{\frac{2}{\omega\mu\sigma}}$ for good conductor. $\delta = \sqrt{\frac{1}{\pi f\mu\sigma}}$; $\delta \; \alpha \; \frac{1}{f}$

For low frequency, the skin depth δ is large. For High or microwave frequency range, the skin depth δ is small.

36.Define voltage reflection coefficient at the load end of the transmission line. (Nov 2011)

It is defined as the ratio of the magnitude of the reflected wave to that of the incident wave.

37. Calculate the characteristics impedance of free space? (Nov 2012)

$$\eta = \frac{E}{H} = \sqrt{\frac{\mu_o}{\varepsilon_o}}$$

$= \sqrt{\frac{4\pi x 10^{-7}}{8.854x10^{-12}}}$ = 120π = 377 ohms

38. What is 'standing wave ratio' ? **(Nov 2012, M/J14) (Nov 16)**

It is defined as the ratio of maximum to minimum amplitudes of voltage.

$$S = \frac{E_{1s\max}}{E_{1s\min}} = \frac{1+|\Gamma|}{1-|\Gamma|}$$

39. Determine propagation constant δ of a material having $\mu_{r\,=\,1}$, ε_r=8 and σ =0.25 Pico-Mho/m. if the frequency is 1.6 Mhz.

α =ß =ωμ σ=1.25

40. The capacitance and inductance of an overhead transmission line are 0.0075μF/km and 0.8mH/km respectively. Determine the characteristic impedance of the line.(N/D14)

The characteristic impedance of a transmission line is equal to the square root of the ratio of the line's inductance per unit length divided by the line's capacitance per unit length $Z_0 = \sqrt{\frac{L}{C}}$ =326.5Ω

41. If a plane wave is incident normally from medium 1 to medium2, write the reflection and transmission co-efficients. (N/D14)

Reflection Co-efficients $Er_0 = \frac{\eta_2 - \eta_1}{\eta_2 + \eta_1} Ei_0$ Transmission Co-efficients $Et_0 = = \frac{2\eta_2}{\eta_2 + \eta_1} Ei_0$

42. Compare the equi potential plots of uniform and non uniform fields.

43.What is the wavelength and frequency of a wave propagation in free space when β=2

44.Find the velocity of a plane wave in a lossless medium a relative permittivity 2 and relative permeability 1. (**APRIL 17)**

PART – B

1. Derive the electromagnetic wave equation for electric field. T1 119-143
2. Derive the electromagnetic wave equation for magnetic field. . T1 119-143 (Nov 2013)
3. Obtain the electromagnetic wave equation for conducting and perfect dielectric medium. (Nov 2012) (nov 16)(apr 15) T2 396-430
4. Obtain the electromagnetic wave equation for free space in terms of magnetic field T2 396-430 (**Apr 17)**
5. A uniform plane wave propagating in a medium has $E=2\, e^{-\alpha z}\mathrm{Sin}(10^{8}\, t - \beta z)a_y$ V/m.If the medium is characterized by ε_r=1, μ_r= 20, σ=3 mhos/m, Find α, β and H.
6. For the copper coaxial cable let a= 2 mm, b=6mm, and t=1mm, Calculate the resistance of 2m length of the cable at dc and at 100 MHz.
7. How is power flow referred by using Poynting vector? Explain Poynting's theorem. Explain its significance. T2 396-430 **(Nov 2011) (May2012,15,17)**
8. An EM wave travels in free space with the electric field component $E=100\, e^{j(0.866y+0.5z)}\, a_x$ V/m.Determine a)ω and λ b) The magnetic field component c)The time average power in the wave.

9. Define Brewster angle and derive its expression. T2 396-430 (Nov 2013)

10.A6580 mhz uniform plane wave is propagating in a materisl medium of ε_r=2.25. if the amplitude of the electric field intensity of lossless medium is 500 v/m. Calculate the phase constant, propagation constant, velocity, wavelength and intrinsic impedance. (**Nov 16**)

11. A plane wave travelling in +z direction in free space (z<0) is normally incident at z=0 on a conductor (z>0) for which σ =61.7 MS/m μ_r=1. The free space E wave has a frequency f=1.5MHZ and an amplitude of 1 V/m at the interface it is given by E(0,t)=1.0 sin 2πft a_y V/m. Analyse the wave and predict magnetic wave H9z,t) at z>0. (**Nov16**)

Reg. No. : 3 1 0 8 1 5 1 0 5 0 1 2

Question Paper Code : 40992

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2018
Third Semester
Electrical and Electronics Engineering
EE 6302 – ELECTROMAGNETIC THEORY
(Regulations 2013)

Time : Three Hours | Maximum : 100 Marks

Answer ALL questions

PART – A (10×2=20 Marks)

1. Find the unit vector extending from the origin toward the point P(3, – 1, – 2).
2. Determine the electric field intensity in free space if $\vec{D} = 30\vec{a}_x \ C/m^2$.
3. Mention the properties of electric flux lines.
4. State the electrostatic boundary conditions at the interface between two dielectrics.
5. What is the total force acting on a moving charge, Q in the presence of both electric and magnetic fields.
6. Compare magnetic scalar potential and magnetic vector potential.
7. Define Reluctance and Permeability.
8. Distinguish between conduction and displacement currents.
9. Mention the practical importance of 'Skin depth'.
10. What is 'Standing Wave Ratio' ?

PART – B (5×13=65 Marks)

11. a) i) With neat diagrams, explain the spherical system with co-ordinates (R, θ, ϕ). **(6)**

ii) Apply Coulomb's law to find the electric field intensity at any point P due to a straight, uniformly charged wire of linear charge density + λ C/m. The point P is at a distance of 'h' m above the wire. **(7)**

(OR)

b) i) Explain the divergence of a vector field and divergence theorem. **(6)**

ii) By mean of Gauss's law, determine the electric field intensity inside and outside a spherical shell of radius R. The shell contains a total charge Q uniformly distributed over the surface. **(7)**

12. a) i) Two point charges – 4 μC and 5 μC are located at (2, – 1, 3) and (0, 4, – 2) respectively. Find the potential at (1, 0, 1) assuming zero potential at infinity. **(6)**

ii) A parallel plate capacitor has a plate separation t. The capacitance with air only between the plates is C. When a slab of thickness t' and relative permitivity ε' is placed on one of the plates, the capacitance is C' Show that $\frac{C'}{C} = \frac{\varepsilon' t}{(t' + \varepsilon' (t - t'))}$. **(7)**

(OR)

b) i) Explain briefly the polarization in dielectrics. **(6)**

ii) Derive Laplace's and Poisson's equations from Gauss's law for a linear material medium. State the importance of these equations. **(7)**

13. a) i) By means of Biot-Savart's law, derive an expression for the magnetic field intensity at any point on the line through the centre at a distance 'h' from the centre and perpendicular to the plane of a circular loop of radius 'ρ' and carrying current 'I.' **(6)**

ii) An iron ring, 0.2 m in diameter and 10 cm^2 sectional area of the core, is uniformly wound with 250 turns of wire. The wire carries a current of 4 A. The relative permeability of iron is 500. Determine the value of self-inductance and the stored energy. **(7)**

(OR)

b) i) What is 'Magnetization' ? Explain the classification of magnetic materials. (6)

ii) What is the maximum torque on a square loop of 1000 turns in a field of uniform flux density of 1 Tesla ? The loop has 10 cm sides and carries a current of 3 A. What is the magnetic moment of the loop ? (7)

14. a) An iron ring with a cross-sectional area of $3cm^2$ and a mean circumference of 15 cm is wound with 250 turns of wire carrying a current of 0.3 A. The relative permeability of the ring is 1500. Calculate the flux established in the ring. (13)

(OR)

b) i) Write a technical note on 'Transformer EMF and Motional EMF'. (6)

ii) Describe the relationship between field theory and circuit theory. (7)

15. a) i) The electric field intensity associated with a plane wave travelling in a perfect dielectric medium is given by $E_x(z, t) = 10\cos(2\pi \times 10^7 t - 0.1\pi z)$ V/m. What is the velocity of propagation ? (6)

ii) Derive the Poynting theorem and state its significance. (7)

(OR)

b) Write short notes on the following : (4+4+5)

i) Plane waves in lossless dielectrics.

ii) Plane waves in free space.

iii) Plane waves in good conductors.

PART – C (1×15=15 Marks)

16. a) Step by step, develop a condition between

i) Conductor and dielectric.

ii) Dielectric and dielectric. (15)

(OR)

b) From the basics, derive the expressions for Maxwell's equation in differential and integral form. (15)

Reg. No. : 3 1 0 8 1 6 1 0 5 0 3 2

Question Paper Code : 50474

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2017

Third Semester

Electrical and Electronics Engineering

EE 6302 – ELECTROMAGNETIC THEORY

(Regulations 2013)

Time : Three Hours Maximum : 100 Marks

Answer ALL questions

PART – A (10×2=20 Marks)

1. State Coulomb's law.
2. Define gradient. What does it indicate ?
3. State Poisson's and Laplace's equations.
4. Define dielectric strength.
5. State Ampere's circuital law.
6. What is inductance ? Give its formula in electrical parameters.
7. What is displacement current ?
8. State any two major differences between circuit theory and field theory.
9. Define skin depth.
10. What is intrinsic impedance ?

PART – B

(5×13=65 Marks)

11. a) i) A charge 20 μC is located at A(– 6,4,7) and another charge 50 μC is at B(5, 8, –2) in free space. If distances are given in metres, determine the vector force exerted by the first charge on the second one. (4)

ii) A 50 cm length coaxial cable having an inner radius 1 mm and an outer radius 4 mm, has its inner space between the conductors filled with air. The total charge on the inner conductor is 30 nC. Find the charge density on each conductor. (4)

iii) State the divergence theorem and explain its significance. (5)

(OR)

b) i) A charge of 0.3 μC is located at A(25, – 30, 15) (in cm) and a second charge of 0.5 μC is at B(–10, 8, 12) cm. Find the Electric field intensity at the origin. (4)

ii) Find the total charge enclosed in an incremental volume of 10^{-9} m^3 located at the origin, if $D = e^{-x} \sin y a_x + 2z a_z$ C/m^2. (4)

iii) State Gauss's law and give any two of its applications. (5)

12. a) i) State and prove electrostatic boundary conditions. (7)

ii) Describe the concept of dielectric polarization. (6)

(OR)

b) i) Derive the energy density of capacitance. (7)

ii) Discuss in detail, the electric field in multiple dielectrics. (6)

13. a) i) Derive the H due to current 'I' flowing in a circular loop. (6)

ii) State and prove magnetostatic boundary conditions. (7)

(OR)

b) i) Describe magnetic materials. (5)

ii) Compare and contrast scalar and vector potentials. (4)

iii) Define Torque and Magnetic force. (4)

14. a) Derive all the Maxwell's equations, in both differential and integral form. (13)

(OR)

b) i) Describe the function of a transformer starting from fundamental principles. (6)

ii) Describe the applications where circuit theory is used and applications, where field theory is used. (7)

15. a) i) Derive wave equation from Maxwell's equations. (7)
ii) Describe the wave propagation in free space. (6)

(OR)

b) i) Describe plane wave reflection. (7)
ii) Derive Poynting vector and state its significance. (6)

PART – C

(1×15=15 Marks)

16. a) Consider an Antenna radiating signals from a Transmitter section. Also, there exists an Amplifier which is actually used in a Receiver section to boost the very weak signals. Compare the role played/not played by Field theory and/or Circuit theory in both these electronic equipments. Clearly bring out a deeper analysis of both the modules with the relevant theory. Hence validate "Both field theory and circuit theory are equally important".

(OR)

b) Clearly bring out the distinction between a 'Standing wave' and a 'propagating wave'. What difference does it mean, in terms of power flow given by Poynting vector in both these kinds of waves ? In detail, bringout the concepts behind the two waves. Is standing wave finding an application anywhere ? Why ?

Question Paper Code : 71765

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2017.

Third Semester

Electrical and Electronics Engineering

EE 6302 — ELECTROMAGNETIC THEORY

(Regulations 2013)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are the sources of electromagnetic fields?
2. State Stoke's theorem.
3. The electric potential near the origin of a system of co-ordinates is $V = 5x^2 + 8y^2 + 10z^2$. Find the electric field at (1,2,3).
4. What is a conservative field?
5. What is vector magnetic potential?
6. Define Biot-Savart's law.
7. Find the emf induced in a conductor of length 1m moving with a velocity of 100 m/s perpendicular to a field of 1 Tesla.
8. Differentiate transformer and motional emf.
9. Find the velocity of a plane wave in a lossless medium having a relative permitivity 2 and relative permeability of unity.
10. What is skin depth?

PART B — (5 × 13 = 65 marks)

11. (a) (i) State and prove Gauss divergence theorem. (6)

(ii) Derive an expression for electric field intensity due to infinite line charge using Coulomb's law. (7)

Or

(b) Evaluate D and E in all regions for a concentric spherical shell containing charge Q on it. Assume the charge distributions are infinite in extent. (13)

12. (a) (i) Derive the electric potential due an uniformly charged infinite line with uniform charge distribution. (8)

(ii) Obtain the electric potential due to electric dipole. (5)

Or

(b) (i) Derive the electrostatic boundary conditions. (8)

(ii) Derive the expression for capacitance of a parallel plate capacitor. (5)

13. (a) (i) Obtain an expression for the magnetic field intensity due to straight finite conductor carrying current I amperes using Biot Savart's law. (8)

(ii) State and prove Ampere's law. (5)

Or

(b) (i) State and prove magnetic boundary conditions. (7)

(ii) Find the torque about y-axis for the two conductors of length 'l' carrying current in opposite directions separated by a fixed distance 'w' in an uniform magnetic field in x-direction. (6)

14. (a) Derive the Maxwell's equations both in integral and point forms. (13)

Or

(b) (i) Explain the relation between field theory and circuit theory in detail. (6)

(ii) A circular loop conductor having a radius of 0.15m is placed in X-Y plane. This loop consists of a resistance of $20\,\Omega$. If the magnetic flux density is $B = 0.5 \sin 10^3 \vec{a}_z$ Tesla, Find the current through the loop. (7)

15. (a) Deduce the equation of the propagation of the plane electromagnetic waves in free space. (13)

Or

(b) State and prove Poynting theorem. (13)

PART C — (1 × 15 = 15 marks)

16. (a) Given that $D = 5r^2/4\ \vec{a}_r\ C/m^2$. Evaluate both the sides of divergence theorem for the volume enclosed by $r = 4m$ and $\theta = \pi/4$. (15)

Or

(b) A free space – silver interface has E (incident) = 100 V/m on the free space side. The frequency is 15 MHz and the silver constants are $\varepsilon_r - \mu_r = 1, \sigma = 61.7$ MS/m. Determine E (reflected) and E (transmitted) at the interface. (15)

Reg. No. : 3 1 0 8 1 5 1 0 5 1 1 2

Question Paper Code : 80367

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016.

Third Semester

Electrical and Electronics Engineering

EE 6302 — ELECTROMAGNETIC THEORY

(Regulations 2013)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Determine the angle between $A = 2\vec{a}_x + 4\vec{a}_y$ and $B = 6\vec{a}_y - 4\vec{a}_z$.
2. State Stoke's Theorem.
3. Find the capacitance of an isolated spherical shell of radius a.
4. Find the magnitude of D for a dielectric material in which $E = 0.15$ MV/m and $\varepsilon_r = 5.25$.
5. State Ampere's Circuital Law.
6. A conductor 4 m long lies along the y-axis with the current of 10 A in a_y direction, if the field is $B = 0.05\,a_x$ Tesla calculate the force on the conductor.
7. Moist soil has conductivity of 10^{-3} S/m and $\varepsilon_r = 2.5$, determine the displacement current density if $E = 6.0 \times 10^{-6} \sin 9.0 \times 10^9 t \ (V/m)$.
8. State Faraday's Law.
9. Define standing wave ratio.
10. State the properties of uniform plane wave.

PART B — (5 × 13 = 65 marks)

11. (a) (i) State and Prove Divergence theorem (8)

(ii) Transform $4\vec{a}_x - 2\vec{a}_y - 4\vec{a}_z$ at (2, 3, 5) to cylindrical coordinates. (5)

Or

(b) (i) Derive the expression for electric field intensity due to uniformly charged circular disc of σ c/m². (8)

(ii) Find the force on a charge Q_1 of 20 μC at (0, 1, 2)m due to Q_2 of 300 μC at (2, 0, 0)m. (5)

12. (a) (i) Find the potential at $r_A = 5$ m with respect to $r_B = 15$ m due to point charge $Q = 500$ pC at the origin and zero reference at infinity. (6)

(ii) Find the capacitance of a parallel plate capacitor with dielectric $\varepsilon_{r1} = 1.5$ and $\varepsilon_{r2} = 3.5$ each occupy one half of the space between the plates of area 2 m² and $d = 10^{-3}$ m. (7)

Or

(b) (i) In spherical coordinates $V = -25\ V$ on a conductor at $r = 2$ cm and $V = 150\ V$ at $r = 35$ cm. The Space between the conductor is a dielectric of $\varepsilon_r = 3.12$. Find the surface charge densities on the conductor. (10)

(ii) Define Laplace and Poisson's equation. (3)

13. (a) Derive the expression for magnetic field intensity due to infinitely long straight conductor carrying a current of I amps along Z-axis. (13)

Or

(b) (i) Determine H for a solid cylindrical conductor of radius a, where the current I is uniformly distributed over the cross section. (5)

(ii) Calculate the inductance of a ring shaped coil of mean diameter 20 cm, wound on a wooden core of 2 cm diameter containing 200 turns. (8)

14. (a) Derive Maxwell's equation in both point and integral form for conducting medium and free Space. (13)

Or

(b) (i) Explain the concept of emf induction in static and time varying magnetic field. (8)

(ii) In a material for which $\sigma = 5.0$ S/m and $\varepsilon_r = 1$ with $E = 250 \sin 10^{10} t$ (V/m). Find J_c and J_D and also the frequency at which they equal magnitudes. (5)

15. (a) Derive the expression for electromagnetic wave equation for conducting and perfect dielectric medium. (13)

Or

(b) A 6580 MHz uniform plane wave is propagating in a material medium of $\varepsilon_r = 2.25$. If the amplitude of the electric field intensity of lossless medium is 500 V/m. Calculate the phase constant, propagation constant, velocity, wavelength and intrinsic impedance. (13)

PART C — (1 × 15 = 15 marks)

16. (a) A plane wave travelling in $+z$ direction in free space ($z < 0$) is normally incident at $z = 0$ on a conductor ($z > 0$) for which $\sigma = 61.7$ MS/m, $\mu_r = 1$. The free space E wave has a frequency f = 1.5 MHZ and an amplitude of 1.0 V/m at the interface it is given by $E(0, t) = 1.0 \sin 2\pi f t\, a_y$ (V/m). Analyse the wave and predict magnetic wave $H(z, t)$ at $z > 0$. (15)

Or

(b) Given that $A = 30e^{-r}\bar{a}_r - 2z\bar{a}_z$ in cylindrical coordinates, evaluate both sides of divergence theorem for the volume enclosed by $r = 2$, $z = 0$ and $z = 5$. (15)

Reg. No. :

Question Paper Code : 77124

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2015.

Third Semester

Electrical and Electronics Engineering

EE 6302 — ELECTROMAGNETIC THEORY

(Regulation 2013)

Time : Three hours — Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

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

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

3. What is the practical significance of Lorentz's Force?

4. Find the electric field intensity in free space if $D = 30\ a_x$ C/m³.

5. Find the force of interaction between two charges $4*10^{-8}$ and $6*10^{-5}$ spaced 10 cm apart in kerosene ($\varepsilon_r = 2.0$).

6. Find the maximum torque on an 100 turns rectangular coil of 0.2 m by 0.3 m, carrying current of 2 A in the field of flux density 5 Web./m².

7. Define mutual inductance and self inductance.

8. Distinguish between transformer emf and motional emf.

9. Compare the equi-potential plots of uniform and non-uniform fields.

10. What is the wavelength and frequency of a wave propagation in free space when $\beta = 2$?

15. (a) (i) State Poynting theorem and thus obtain an expression for instantaneous power density vector associated with electromagnetic field. (12)

(ii) A plane wave travelling in air is normally incident on a block of paraffin with $\varepsilon_r = 2.2$. Find the reflection coefficient. (4)

Or

(b) Obtain an expression for electromagnetic wave propagation in lossy dielectrics. (16)

Question Paper Code : 27207

Anna University Chennai

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2015.

Third Semester

Electrical and Electronics Engineering

EE6302 - ELECTROMAGNETIC THEORY

1. What are the practical applications of electromagnetic fields?

2. Give the differential displacement and volume in spherical co-ordinate system.

3. What is the electric field intensity at a distance of 20 cm from a charge of 2 μC in vacuum?

4. Calculate the capacitance per Km between a pair of parallel wires each of diameter 1 cm at a spacing of 50 cms.

5. What is the mutual inductance of the two inductively coupled coils with self inductance of 25 mH and 100 mH?

6. What is the practical significance of Lorentz's Force?

7. Find the characteristics impedence of the medium whose relative permittivity is 3 and relative permeability is 1.

8. A parallel-plate capacitor with plate area of 5 cm^2 and plate separation of 3 mm has a voltage 50 sin $10^3 t$ V applied to its plates. Calculate the displacement current assuming $\varepsilon = 2\varepsilon_0$.

9. What is practical significance of skin depth?

10. A plane wave travelling in air is normally incident on a block of paraffins with $\varepsilon_r = 2.3$. Find the reflection co-efficient.

PART B – (5 × 16 = 80 marks)

11. (a) (1) Verify the divergence theorem for a vector field $D= 3x^{2} a_x+(3y+z) a_y+(3z-x)a_z$ in the region bounded by a cylinder $x^2+y^2=9^2$ and the planes x=0,y=0,z=0 and z=2. (12)

(2) A novel printing technique is based upon electrostatic deflection principle. Justify . (4)

(or)

(b) (1) State and prove Coulomb's law . (6)

(2) Obtain expression for electric field intensity due to uniformly charged line of length 'I'. (10)

12. (a) (1) Derive the expression for energy and energy density in static electric fields. (10)

(2) State and prove electro-static boundary conditions. (6)
(or)
(b) (1) Derive an expression for capacitance of concentric spheres . (8)

(2) Derive an expression for polarization 'P'. (8)

13. (a) (1) Obtain an expression for magnetic flux density and magnetic field intensity at any point along the axis of a circular coil. (12)

(2) Distinguish between scalar and vector magnetic potential (6)

(or)

(b) (1) An air co-axial transmission line has a solid inner conductor of radius 'a' and a very thin outer conductor of inner radius 'b'.Determine the inductance per unit length of the line. (12)

(2) Compare the different magnetic materials. (4)

14. (a) (1) A circular loop of wire is placed in a uniform magnetic field of flux density 0.5 wb/m^2. The wire has 200 turns and frequency of rotation of 1000 revolutions/minute. If the radius of the coil is 0.2 m, Determine (1) the induced emf, when the plane of the coil is 60° to the flux lines and (2) the induced emf, when the plane of the coil is perpendicular to the field. (8)

(2) Explain in detail about the difference between conduction and displacement currents. (8)

(or)

(b) Derive the set of Maxwell`s equation with solutions in integral form from fundamental laws for a free space. (16)

15. (a) Obtain the electromagnetic wave equation for free space in terms of electric field and explain the wave propagation with necessary parameters. (16)

Or

(b) (i) Derive Poynting theorem from Maxwell's equation and explain. (8)

(ii) A uniform plane wave propagating in a medium has

$$E = 2e^{-\alpha z} \sin\left(10^8 t - \beta z\right) a_y V/m$$

If the medium is characterized by $\varepsilon_r = 1$, $\mu_r = 20$ and $\sigma = 3S/m$, find α, β and H. (8)

Reg. No. :

Question Paper Code : 97065

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2014.

Third Semester

Electrical and Electronics Engineering

EE 6302 — ELECTROMAGNETIC THEORY

(Regulation 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

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

2. Determine the electric flux density at a distance of 20 cm due to an infinite sheet of uniform charge $20\mu C/m^2$ lying on the $z=0$ plane.

3. State the properties of electric flux lines.

4. Give the significant physical differences between Poisson's and Laplace's equations.

5. Determine the value of magnetic field intensity at the centre of a circular loop carrying a current of 10 A. The radius of the loop is 2 m.

6. Distinguish between magnetic scalar potential and magnetic vector potential.

7. State Ohm's law for magnetic circuits.

8. Give the two important equations that provide a connection between field and circuit theory.

9. The capacitance and inductance of an overhead transmission line are $0.0075\mu F/km$ and $0.8\ mH/km$ respectively. Determine the characteristic impedance of the line.

10. If a plane wave is incident normally from medium 1 to medium 2, write the reflection and transmission coefficients.

PART B — (5 × 16 = 80 marks)

11. (a) (i) If $\vec{B} = y\vec{a}_x + (x-z)\vec{a}_y$ and a point Q is located at (-2, 6, 3), express

(1) The point Q in cylindrical and spherical coordinates,

(2) $\vec{B}$ in spherical coordinates. (10)

(ii) State and explain Coulomb's law of force. (6)

Or

(b) (i) Explain the divergence of a vector field and Divergence theorem. (10)

(ii) By means of Gauss's law, determine the electric field intensity at a point P distant 'h' m from an infinite line of uniform charge $\rho_l\, C/m$. (6)

12. (a) (i) A dielectric slab of flat surface with $\varepsilon_r = 4$ is disposed with its surface normal to a uniform field with flux density 1.5 C/m^2. The slab occupies a volume of 0.08 m^3 and is uniformly polarized. Determine

(1) Polarization in the slab,

(2) Total dipole-moment of slab. (6)

(ii) At an interface separating dielectric $1(\varepsilon_{r1})$ and dielectric $2(\varepsilon_{r2})$, show that the tangential component of $\vec{E}$ is continuous across the boundary, whereas the normal component of $\vec{E}$ is discontinuous at the boundary. (10)

Or

(b) (i) Distinguish between electric potential and electric potential difference. Two point charges $-4\mu C$ and $5\mu C$ are located at (2,-1,3) and (0, 4, -2) respectively. Find the potential at (1, 0, 1) assuming zero potential at infinity. (2+6)

(ii) A capacitor consists of two parallel metal plates 30 cm × 30 cm surface area, separated by 5 mm in air. Determine its capacitance. Find the total energy stored by the capacitor and the energy density if the capacitor is charged to a potential difference of 500 V? (8)

13. (a) (i) Describe the classification of magnetic materials and draw a typical magnetization (B-H) curve. (6+2)

(ii) Derive an expression for torque in a rectangular loop which is carrying a current of 'I' amperes and is situated in a uniform magnetic field 'B' Wb/m^2. (8)

Or

(b) (i) Develop an expression for magnetic field intensity both inside and outside a solid cylindrical conductor of radius 'a' carrying a current 'I' with uniform density, and sketch the variation of field intensity as a function of distance from the conductor axis. (8+2)

(ii) A very long solenoid with 2 × 2cm cross section has an iron core ($\mu_r = 1000$) and 400 turns / meter. If it carries a current of 500 mA, find

(1) Its self-inductance per meter,

(2) The energy per meter stored in its field. (6)

14. (a) (i) A parallel plate capacitor with plate area of 5 cm² and plate separation of 3 mm has a voltage of $50 \sin 10^3 t$ V applied to its plates. Calculate the displacement current assuming $\varepsilon = 2\varepsilon_0$. (6)

(ii) Derive the Maxwell's equations in both point and integral forms from Ampere's law and Faraday's law of electromagnetic induction. (10)

Or

(b) (i) The magnetic circuit of an iron ring with mean radius of 10 cm has a uniform cross- section of 10^{-3} m². The ring is wound with two coils. If the circuit is energized by a current $i_1(t) = 3\sin 100\,\pi t$ A in the first coil with 200 turns, find the induced emf in the second coil with 100 turns. Assume that $\mu = 500\mu_0$. (4)

(ii) Explain how the circuit equation for a series RLC circuit is derived from the field relations. (12)

15. (a) (i) Find the velocity of a plane wave in a loss-less medium having $\varepsilon_r = 5$ and $\mu_r = 1$. (4)

(ii) Show that the total power flow along a coaxial cable will be given by the surface integration of the Poynting vector over any closed surface. (12)

Or

(b) Describe the concept of electromagnetic wave propagation in a linear, isotropic, homogeneous, lossy dielectric medium. (16)
