ELECTROMAGNETIC FIELDS

Subject Code : EE302ES

Regulations : R18 - JNTUH

Class : II Year B.Tech EEE I Semester

Department of Electrical and Electronics and Engineering

BHARAT INSTITUTE OF ENGINEERING AND TECHNOLOGY

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ELECTROMAGNETIC FIELDS (EE302ES)

COURSE PLANNER

I. COURSE REVIEW:

The purpose of this course is to familiarize the students with concepts pertaining electric and magnetic fields and their applications. This will enable them to gain good understanding of the theory of power transmission lines and electrical machines

II. PREREQUISITE(S):

- Ordinary differential equations
- Applied Physics
- multivibral calculas concepts.

III. COURSE OBJECTIVES:

This course provides the students to demonstrate the ability

- To understand the basic laws of electromagnetism.
- To obtain the electric and magnetic fields for simple configurations under static conditions.
- To analyze time varying electric and magnetic fields.
- To understand Maxwell's equation in different forms and different media.
- To understand the propagation of EM waves.

IV. COURSE OUTCOME:

S.No	Description	Bloom's Taxonomy Level
1	To understand the basic laws of electromagnetism.	Knowledge, Understand (Level 1, Level 2)
2	To apply the electric and magnetic fields for simple configurations under static conditions. .	Applying (Level 3)
3	To analyze and understand time varying electric and magnetic fields.	Understand, analyze (Level 2, Level 4)
4	To understand and practice Maxwell's equation in different forms and different media	Knowledge, Applying (Level 1, Level 3)
5	To illustrate the propagation of EM waves.	Applying (Level 3)

V. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (PO)		Level	Proficiency assessed by
PO1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**3**	**Assignments**
PO2	**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**	**Assignments**
PO3	**Design/Development Analysis:** 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.	**2**	**Assignments**
PO4	**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.	**2**	**Assignments**
PO5	**Modern Toll 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.	**-**	**--**
PO6	**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.	**1**	**Assignments**
PO7	**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.	**-**	**--**
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	**-**	**--**
PO9	**Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	**-**	**--**
PO10	**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.		
PO11	**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.	**-**	**--**
PO12	**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.	**2**	**Research**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: None

VI. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSO)		Level	Proficiency assessed by
PSO1	Talented to analyze, design, and implement electrical & electronics systems and deal with the rapid pace of industrial innovations and developments.	**2**	**Lectures, Assignments**
PSO2	Skillful to use application and control techniques for research and advanced studies in Electrical & Electronics Engineering domain.	**2**	**Lectures, Assignments**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: None

VII. SYLLABUS:

UNIT – I

Static Electric Field: Review of conversion of a vector from one coordinate system to another coordinate system, Coulomb's law, Electric field intensity, Electrical field due to point charges. Line, Surface and Volume charge distributions. Gauss law and its applications. Absolute Electric potential, potential difference, Calculation of potential differences for different configurations. Electric dipole, Electrostatic Energy and Energy density.

UNIT - II

Conductors, Dielectrics and Capacitance: Current and current density, Ohms Law in Point form, Continuity equation, Boundary conditions of conductors and dielectric materials. Capacitance, Capacitance of a two-wire line, Poisson's equation, Laplace's equation, Solution of Laplace and Poisson's equation

UNIT - III

Static Magnetic Fields and Magnetic Forces: Biot-Savart Law, Ampere Law, Magnetic flux and magnetic flux density, Scalar and Vector Magnetic potentials. Steady magnetic fields produced by current carrying conductors. Force on a moving charge, Force on a differential current element, Force between differential current elements, Magnetic boundary conditions, Magnetic circuits, Self- inductances and mutual inductances.

UNIT - IV

Time Varying Fields and Maxwell's Equations: Faraday's law for Electromagnetic induction, Displacement current, Point form of Maxwell's equation, Integral form of Maxwell's equations, Motional Electromotive forces

UNIT - V

Electromagnetic Waves: Derivation of Wave Equation, Uniform Plane Waves, Maxwell's equation in Phasor form, Wave equation in Phasor form, Plane wave in free space and in a homogenous material. Wave equation for a conducting medium, Plane waves in lossy dielectrics, Propagation in good conductors. Poynting theorem

GATE SYLLABUS:

Gauss Theorem, electric field and potential due to point, line, plane and spherical charge distributions; Ampere's and Biot-Savart's laws; inductance; dielectrics; capacitance.

IES SYLLABUS:

Electric and magnetic fields, Gauss's Law & Amperes Law, Fields in dielectrics, conductors and magnetic materials, Maxwell's equations, Time varying fields, Plane-Wave propagating in dielectric and conducting media, Transmission lines.

SUGGESTED BOOKS:

TEXT BOOKS:

1. M. N. O. Sadiku, "Elements of Electromagnetics", Oxford University Publication, 2014.
2. W. Hayt, "Engineering Electromagnetics", McGraw Hill Education, 2012.

REFERENCE BOOKS:

1. A. Pramanik, "Electromagnetism-Problems with solution", Prentice Hall India, 2012.
2. G. W. Carter, "The electromagnetic field in its engineering aspects", Longmans, 1954.
3. W. J. Duffin, "Electricity and Magnetism", McGraw Hill Publication, 1980.
4. W. J. Duffin, "Advanced Electricity and Magnetism", McGraw Hill, 1968.
5. E. G. Cullwick, "The Fundamentals of Electromagnetism", Cambridge University Press, 1966.

6. B. D. Popovic, "Introductory Engineering Electromagnetics", Addison-Wesley Educational Publishers, International Edition, 1971.
7. A. Pramanik, "Electromagnetism - Theory and applications", PHI Learning Pvt. Ltd, New Delhi, 2009.

VIII. COURSE PLAN:

S.NO	Week	Unit	Topics	Course Learning Outcomes	Teaching Methodologies	Reference
Unit I – Static Electric Field						
1	1	1	Review of conversion of a vector from one coordinate system to another coordinate system	**Gain** the knowledge about three dimensional systems	Chalk &Talk	T1, T2
2			Coulomb's law	**understand** about Coulomb's law	Chalk &Talk	T1, T2
3			Electric field intensity & Electrical field due to point charges	**Gain** the knowledge about Electric field intensity **understand** about point charges	Chalk &Talk	T1, T2
4			Line charge distributions	**Gain** the knowledge about Line charge distributions	Chalk &Talk	T1, T2
5			surface charge distributions	**Gain** the knowledge about surface charge distributions	Chalk &Talk	T1, T2
6	2		volume charge distributions	**Gain** the knowledge about	Chalk	T1, T2

	&3			Volume charge distributions	&Talk	
7			Gauss law and its applications	**understand** about Gauss law	Chalk &Talk	T1, T2
8			. Absolute Electric potential, potential difference	**Understanding** . Absolute Electric potential, potential difference	Chalk &Talk	T1, T2
9			Calculation of potential differences for different configurations	**Gain** the knowledge about Calculation of potential differences for different configurations	Chalk &Talk	T1, T2
10			Electric dipole	**Gain** the knowledge about Electric dipole	Chalk &Talk	T1, T2
11	4		Electrostatic Energy	**Gain** the knowledge about Electrostatic Energy	Chalk &Talk	T1, T2
12			Energy density	**Understanding** the concept of Energy density	Chalk &Talk	T1, T2
13			**Revision and Problems on Unit I**	**Overview**	Chalk &Talk	T1, T2
14			**Mock Test – I**	**Testing the students' knowledge that how much they have learned**		T1, T2
	Unit II – Conductors, Dielectrics and Capacitance					
19	4	2	Current and current density	**Understanding** the Current and current density	Chalk &Talk	T1, T2, R3
20			Ohms Law in Point form	**Gathering** the knowledge about Ohms Law in Point form	Chalk &Talk	T1, T2, R3
21	5 &6		Continuity equation	**Compose & Understand** the knowledge about Continuity equation	Chalk &Talk	T1, T2, R3
22			**Tutorial / Bridge Class # 1**	**To clarify the doubts**		
23			Boundary conditions of conductors	**Compose & Demonstrate** the Boundary conditions of conductors	Chalk &Talk	T1, T2, R3
24			dielectric materials	**Gathering** the knowledge about dielectric materials	Chalk &Talk	
25			Capacitance, Capacitance of a two-	**Gathering** the knowledge	Chalk	T1, T2,

			wire line	about Capacitance, Capacitance of a two-wire line	&Talk	R3
26			Poisson's equation	**Gathering** the knowledge about Poisson's equation	Chalk &Talk	T1, T2, R3
	7		**Tutorial / Bridge Class # 2**	**To clarify the doubts**		
27			Laplace's equation	**Understanding** the Laplace's equation	Chalk &Talk	T1, T2, R3
28			Solution of Laplace and Poisson's equation.	**Demonstrate** the Solution of Laplace and Poisson's equation.	Chalk &Talk	T1, T2, R3
29			**Revision and Problems on Unit II**	**Overview**		
30			**Revision and Problems on Unit II**			
			Tutorial / Bridge Class # 3	**To clarify the doubts**		
	Unit III – Static Magnetic Fields and Magnetic Forces					
31			Biot-Savart Law	**To Gain** the knowledge about Biot-Savart Law	Chalk &Talk	T1, T2, R1
32			Ampere Law	**To Demonstrate** the knowledge about Ampere Law	Chalk &Talk	T1, T2, R1
33	8		Magnetic flux and magnetic flux density	**To Understand** Magnetic flux and magnetic flux density	Chalk &Talk	T1, T2, R1
34			Relation between magnetic flux density and magnetic field intensity	**To Understand** the relation between MFI and magnetic flux density	Chalk &Talk	T1, T2, R1
		3	**Tutorial / Bridge Class # 4**	**To clarify the doubts**		
			I Mid Examinations (Week 9)			
35			Scalar and Vector Magnetic potentials	**Gain** the knowledge about Scalar and Vector Magnetic potentials	Chalk &Talk	T1, T2, R1
36	10		Steady magnetic fields produced by current carrying conductors	**Demonstrate** the concept of Steady magnetic fields produced by current carrying conductors	Chalk &Talk	T1, T2, R1
37			Force on a moving charge	**To Understand** Force on a moving charge	Chalk &Talk	T1, T2, R1

38			Force on a differential current element	**To Understand** Force on a differential current element	Chalk &Talk	T1, T2, R1
39	11		Force between differential current elements	**To Understand** Force between differential current elements	Chalk &Talk	T1, T2, R1
40			Magnetic boundary conditions	**Demonstrate** the concept Magnetic boundary conditions	Chalk &Talk	T1, T2, R1
			Magnetic circuits	**Gain** the knowledge about Magnetic circuits	Chalk &Talk	T1, T2, R1
			Self- inductances and mutual inductances.	**Gain** the knowledge Self-inductances and mutual inductances.	Chalk &Talk	T1, T2, R1
			Revision and Problems on Unit II	**Overview**		
			Revision and Problems on Unit II			
			Tutorial / Bridge Class # 3	**To clarify the doubts**		
	Unit IV – Force in Magnetic Fields and Magnetic Potential					
46	12 & 13	4	Faraday's law for Electromagnetic induction	**Understanding** the concepts Faraday's law for Electromagnetic induction	Chalk &Talk	T1, T2
47			Displacement current	**Know** Displacement current	Chalk &Talk	T1, T2
48			Point form of Maxwell's equation	**Gathering knowledge** about Point form of Maxwell's equation	Chalk &Talk	T1, T2
49			Integral form of Maxwell's equations	**Gathering knowledge** Integral form of Maxwell's equations	Chalk &Talk	T1, T2
50			Force between 2 straight parallel current conductors	**Understanding** the concepts Force between 2 straight parallel current conductors	Chalk &Talk	T1, T2
			Tutorial / Bridge Class # 7	**To clarify the doubts**	Chalk &Talk	
51			Magnetic dipole & Magnetic dipole moment	**Know** about Magnetic dipole & Magnetic dipole moment	Chalk &Talk	T1, T2

	Unit V – Electromagnetic Waves					
61	14	5	Derivation of Wave Equation	**To know** about Derivation of Wave Equation	Chalk &Talk	T1,T2, R2
62			Maxwell's equation in Phasor form	**Demonstrate** the Maxwell's equation in Phasor form	Chalk &Talk	T1,T2, R2
63			Wave equation in Phasor form	**Understanding** the Wave equation in Phasor form	Chalk &Talk	T1,T2, R2
64			Plane wave in free space	**To know** about Plane wave in free space and a homogenous material	Chalk &Talk	T1,T2, R2
65			Plane wave in in a homogenous material		Chalk &Talk	T1,T2, R2
			Tutorial / Bridge Class # 9	**To clarify the doubts**	Chalk &Talk	
66	15 & 16		Wave equation for a conducting medium	**To know** about Wave equation for a conducting medium	Chalk &Talk	T1,T2, R2
67			Plane waves in lossy dielectrics	**Demonstrating** the Plane waves in lossy dielectrics	Chalk &Talk	T1,T2, R2
68			Propagation in good conductors	**Demonstrating** Propagation in good conductors	Chalk &Talk	
69			Poynting theorem	**To know** about Poynting theorem	Chalk &Talk	
70			**Revision**			
			Tutorial / Bridge Class # 10	**To clarify the doubts**		
71	17		**Revision**	**Overview on all Units**		
72			**Revision**			
73			**Revision**			
74			**Revision**			
75			**Revision**			
			Tutorial / Bridge Class # 11	**To clarify the doubts**		
76			**Revision**	**Overview on all Units**		
77			**Revision**			
78			**Revision**			
79			**Revision**			

80			**Revision**			
			Tutorial / Bridge Class # 12	**To clarify the doubts**		
	II Mid Examinations (Week 18)					

IX. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

	Program Outcomes												**Program Specific Outcomes**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**1**
CO2	**3**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**-**
CO3	**3**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**1**
CO4	**3**	**2**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**2**
CO5	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**1**	**1**	**-**
AVG	**3**	**2.2**	**1.6**	**1.6**	**0.8**	**-**	**-**	**-**	**-**	**0.2**	**-**	**1**	**1.4**	**0.8**

X. QUESTION BANK (JNTUH):

UNIT I

Long Answer Questions-

S.No	**Question**	**Blooms Taxonomy Level**	**Course Outcome**
1	State and explain Curl, Gradient and Divergence. Also find the potential due to an electric dipole	Understand	1
2	Check validity of the divergence and curl theorem considering the field $D=2xya_x+2xa_y$ c/m^2 and the rectangular parallel piped formed by the planes x=0, x=1, y=0, y=2 & z=0, z=3.	Applying	2
3	Derive poisons and Laplace equations.	Understand	1

4	State and prove Gauss law and explain applications of Gauss law.	Understand	1
5	Define the potential difference and electric field. Give the relation between potential and filed intensity. Also derive an expression for potential due to infinite uniformly charged line and also derive potential due to electric dipole.	Knowledge	1
6	State and explain a. Stokes theorem b. Divergence theorem c. The electric flux density	Understand	1
7	Find the electric field due to n-charges, and also establish the relation between potential and electric field.	Applying	4
8	Derive an expression for the electric field intensity at any point due to a uniformly line charge with density rlc/m	Applying	4
9	Derive an expression for the electric field intensity at any point due to auniformly charged sheet with density rsc/m2.	Applying	2
10	Derive an expression for the electric field intensity at any point due to a volume charge with density rvc/ m3.	Applying	2
11	State gauss law for the electric and magnetic fields. Derive its integral and differential forms. Make at least two conclusions?	Understand	1
12	Define and explain the terms: i. Electric field intensity ii. Electric potential	Knowledge	1
13	Derive the relation between electric field and electric potential in rectangular co-ordinates.	Applying	3
14	Define potential difference and derive the expression for potential differenceV_{AB}.	Understand	1

Short Answer Questions-

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	State and explain Coulomb's law	Knowledge	1
2	Two small identical conducting spheres have charge of 2nC and -0.5 nC respectively. When they are placed 4 cm apart, what is the force between them? If they are brought into contact and then separated by 4 cms, what is the force between them?	Applying	2
3	Define the term ``potential difference V(A)-V(B), between points A and B in a static electric field." Explain the concept of reference point and comment on its location.	Understand	3
4	State and explain Gauss law.	Knowledge	1
5	Using Gauss's law, find E at any point due to long infinite wire	Understand	1
6	Derive $\nabla.D = \rho_v$ from fundamentals	Applying	2
7	State and explain Laplace's and Poisson's equations	Knowledge	1

UNIT II

Long Answer Questions-

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	Derive the boundary conditions of the normal and tangential components of electric field at the Interface of two media with different dielectrics	Understand	1
2	Derive the expression for electric potential due to Dipole.	Knowledge	1
3	Derive an expression for energy stored and energy density in an Electro static field	Applying	2
4	Find the expression for the cylindrical capacitance using Laplace equation.	Understand	1

5	Find the capacitance of a two concentric spherical shells.	Understand	1
6	Derive the expression for co-efficient of coupling.	Applying	2
7	Derive the expression for the energy stored in the parallel plate capacitor.	Applying	2
8	Derive an expression for the capacitance of a spherical capacitor with conducting shells of radius a and b.	Applying	2
9	Derive the expression for the continuity equation of current in differential form and derive the express on for inductance of a solenoid with N turns and l meter length carrying a current of I amperes.	Applying	3
10	Derive the expression for torque on an Electric dipole placed in electric field	Applying	3
11	Derive the expression for potential energy stored in the system of n-point charges	Understand	3

Short Answer Questions-

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	What is an electric dipole? And write down the potential due to an electric dipole	Knowledge	4
2	What is displacement current?	Knowledge	4
3	What is magnetic dipole moment?	Knowledge	4
4	Define magnetization?	Knowledge	4
5	Define magnetic susceptibility?	Knowledge	4
6	What is the relation between relative permeability and susceptibility?	Knowledge	4
7	What is capacitor? Define the capacitance of a capacitor and state its units	Understand	3

8	Define dielectric strength?	Knowledge	4
9	Define B-H curve for classifying magnetic materials	Knowledge	4
10	Classify the magnetic materials	Knowledge	4
11	Write the expression for energy stored in inductor	Understand	3

UNIT III

Long Answer Questions-

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	Derive the magnetic field intensity and magnetic flux density due to finite and infinite line.	Understand	3
2	Derive the expressions for magnetic field intensity and magnetic flux density due to circular coil	Applying	4
3	Derive an expression for force between two current carrying conductors	Applying	4
4	Derive the expression for torque developed in a rectangular closed circuit carrying current I in a uniform field.	Understand	3
5	Derive the magnetic field intensity developed in a triangular closed circuit carrying current I in a uniform field.	Understand	3
6	Derive the magnetic field intensity developed in a square loop carrying current I in a uniform field. Also state Lorentz force equation for a moving charge and explain its applications	Applying	4
7	Derive the expression for coefficient of coupling in terms of mutual and self-inductances	Applying	4
8	Derive the expression for curl H=J?	Understand	3
9	Explain the concepts of scalar and vector magnetic potential? Find the maximum torque on an 85 turns rectangular coil with dimensions (0.2x0.3)m carrying	Understand	3

	current of 5 A in a field B=6.5T		
10	State and explain ampere circuital law	Understand	3
11	Define magnetic induction, magnetic field, magnetic flux density, magnetic field intensity, magnetic permeability and magnetic susceptibility.	Understand	3
12	State and explain Biot Savarts law. Use the same to find an expression for the magnetic field intensity due to a long current carrying conductor	Understand	3
13	Using Biot Savarts Law, find H at any point on the axis of a circular current carrying coil.	Applying	4

Short Answer Questions-

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	Define Lorentz law of force.	Knowledge	4
2	State Biot-Savart Law	Knowledge	4
3	What is the difference between scalar and vector magnetic potential	Knowledge	4
4	Define magnetic movement	Knowledge	4
5	What is magnetic dipole movement?	Understand	4
6	Define magnetic vector potential	Knowledge	4
7	Define flux density or energy density in a magnetic circuit	Knowledge	4
8	What is the relation between magnetic flux density and magnetic circuit?	Understand	3
9	Write down the magnetic boundary conditions?	Knowledge	4

10	Give the force on a current element carrying 10A if the separation of two plates is 1m?	Applying	3
11	Define magnetization vector?	Knowledge	4
12	A current of 3A flowing through inductor of 100 mH. What is the energy stored in inductor?	Applying	3
13	Write Lorentz equation?	Knowledge	4
14	What is solenoid?	Knowledge	4
15	Define magnetic field intensity?	Knowledge	4
16	Give the torque experienced by a current carrying loop placed in a magnetic field?	Understand	3

UNIT IV

Long Answer Questions-

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	Discuss motion of charged particle in magnetic field	Understand	3
2	Derive the expression for Lorentz force equation	Understand	3
3	Derive the expression for force on a straight current carrying conductor placed in a magnetic field.	Applying	4
4	Derive the expression for the force between two current carrying conductors in the same direction.	Applying	4
5	Derive the expression for the torque on a current loop placed in a magnetic field	Applying	4
6	Define magnetic dipole? What is magnetic moment? Describe how a differential current loop behaves like a magnetic dipole.	Understand	3
7	Derive the expression for self-inductance of solenoid and torrid.	Understand	3
8	Derive the expression for energy stored and energy	Understand	3

	density in a magnetic field.		
9	Derive the general wave equations? And also discuss the wave motion in good conductors?	Applying	6
10	With reference to electro-magnetic waves, explain the following a. Linear polarization b. Circular polarization c. Elliptical polarization and also derive the expression for standing wave. Find the location of nodes and antinodes in E and H fields.	Applying	6

Short Answer Questions-

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	What is motion of charged particle in magnetic field?	Applying	5
2	Define magnetic dipole.	Knowledge	4
3	Define self-inductance.	Knowledge	4
4	Define mutual inductance.	Knowledge	4
5	What is scalar magnetic potential?	Knowledge	4
6	What is vector magnetic potential?	Knowledge	4
7	Define propagation constant.	Knowledge	4
8	Define Polarization of uniform plane wave.	Knowledge	4
9	Write down the expression for instantaneous power flow in electromagnetic field and instantaneous Pointing vector?	Applying	5
10	Define circular Polarization?	Knowledge	4
11	Define Elliptical and Linear Polarization?	Knowledge	4
12	Write Helmholtz equation?	Knowledge	4

UNIT V

Long Answer Questions-

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	Explain about induced E.M.F. and Derive the expressions for statically induced E.M.F and dynamically induced E.M.F	Applying	5
2	What do you mean by displacement currents? Write down the expression for the total current density?	Applying	5
3	Explain briefly about the motional emfand derive an expression for it?	Understand	6
4	Discuss the pointing vector and pointing theorem? Also derive the ampere circuital law.	Knowledge	4
5	Define faradays laws. What are the different ways of emfgeneration? Explain with governing equation and suitable example for each? Also derive the differential and integral form of faradays law.	Understand	6
6	Define Brewster angle and derive its expression?	Knowledge	4
7	Derive the relationship between electric and magnetic fields?	Applying	3
8	Explain complex, average and instantaneous pointing vector.	Applying	5
9	Derive the modified form of ampere circuit all a win integral and differential forms.	Knowledge	4
10	Derive an expression for displacement current density.	Applying	5

Short Answer Questions-

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	Explain faraday's law of electromagnetic induction.	Understand	6

2	What is statically induced E.M.F.	Applying	5
3	What is dynamically induced E.M.F.	Applying	5
4	What is significance of displacement current density?	Understand	6
5	What is motional E.M.F?	Applying	5
6	What is the E.M.F produced by moving loop in time varying field?	Understand	6
7	State Pointing Theorem.	Understand	6
8	Give the expression for lifting force of an electromagnet.	Knowledge	3
9	What is conduction and displacement current density?	Understand	6

OBJECTIVE QUESTIONS:

UNIT I

Choose the correct alternative/ fill in the blanks:

1.The direction of the electric field intensity is same as the direction of
A)Force B) Current C) Voltage D)Power
2.The unit of surface charge density
A)Coulomb B)Coulomb/m^2
3._____ of the current is based on the principle of conservation of charge
A) Laplace equation B)Poisson's equation C)Continuity equation D)None
4. The expression for MFI at the center of a circular current loop is _____
A) H=1/2A B) H=1/A C) H=√3/2A D) H=5/2A
5.Gauss law is useful to find _____
6.The gradient of potential function is _____
7.Current density is a _____ quantity.

UNIT II

1. If d is the distance between two charges –Q and +Q, then dipole moment P is
A)Q^2d B)Qd C)Q/d D)Q/d^2
2. The differential form of Gauss's Law is
Div D=ρs B) Div D=ρv C) Curl D=ρs D)Curl D=ρv

3. Two equal and opposite charges small in magnitude and separated by a small distance constitute
   A) Magnetic dipole B) Electric dipole C) Both D) None
4. _____ is current per unit provided the area is held normal to the flow of charge
   A)Current density B) Flux density C) Both D) None
5. _____ states that the net electric flux through any closed surface is equal to the total charge enclosed by that surface
   A) Coulomb's law B) Gauss's law C) Ampere's law
6. A conductor is said to be perfect if its conductivity is _____
   A) Zero B)Unity C) Finite
7. The electric dipole moment per unit volume is called as _____

UNIT III

1. The line integral of H about any closed path is exactly equal to _____ enclosed by that path.
2. The expression for Biot-Savart's Law in integral form is _____
3. The relationship between magnetic field intensity H and magnetic flux density B is _____
4. In a current carrying conductor, Biot-Savart's law is used to determine
   A) H B) MMF C) S D) B
5. Maxwell's second equation is _____
6. Point form of Ampere's circuital law: _____
7. Maxwell's third equation is _____

UNIT IV

1. Lorentz force equation: _____
2. A magnetic field can exert _____ only on a moving charge.
3. Force due to ____ fields is experienced between two current elements.
4. Lorentz force equation relates ____ force to electrical force.
5. The magnetic field B is defined as the ____ per unit current element.
6. The magnetic dipole moment is the product of _____ an area of the loop.
7. A small _____ loop may be regarded as a magnetic dipole.
8. Magnetic dipole moment per unit volume is called ____.

UNIT V

1. Stationary charges constitute _____ fields.
2. Steady currents constitute ____ fields.
3. Time-varying currents constitute ____ fields.
4. Any ____ current will produce radiation.
5. A static magnetic field produces ____ current flow.
6. Induced emf in any closed circuit is ___ to the time rate change of the magnetic flux by the circuit.
7. The emf induced by time-varying current in a stationary loop is often referred to as __ emf.

8. A time-harmonic field is one that varies periodically with ___.
9. A phasor is a ____ number that contains the amplitude and phase of a sinusoidal oscillation.
10. When emf is induced in a coil or conductor by virtue of movement of either the conductor or the magnetic field, the emf is called ____ induced EMF

GATE QUESTIONS:

1. The flux density at a point in space is given by $B=4xa_x+2kya_y+8a_z Wb/m^2$. The value of constant k must be equal to

A) -2 B) -0.5 C)+0.5 D) +2

2. A dielectric slab with 500 mm x 500 mm cross-section is 0.4 m long. The slab is subjected to a uniform electric field of $E=6a_x+8a_y$ kV/mm. The relative permittivity of the dielectric material is equal to 2. The value of constant ϵ_0 is $8.85x10^{-12}$ F/m. The energy stored in the dielectric in Joules is

A) 8.85x10-11 ^{Z} B) 88.5 C)885

3. A capacitor is made with a polymeric dielectric having an ϵ_r of 2.26 and a dielectric breakdown strength of 50 kV/cm. The permittivity of free space is 8.85 pF/m. If the rectangular plates of the capacitor have a width of 20 cm and a length of 40 cm, then the maximum electric charge in the capacitor is

A)2 µC B) 4 µC C) 8 µC D) 10 µC

4. Two point charges Q_1=10 µC and Q_2=20 mC are placed at coordinates (1,1,0) and (-1,-1,0) respectively. The total electric flux passing through a plane z = 20 will be

A) 7.5 µC B) 13.5 µC C) 15 µC D)22.5 µC

5. Divergence of the vector field $V(x,y,z)=-(x\cos xy+y)i+(y\cos xy)j+(\sin z^2+x^2+y^2)k$ is

A) $2z\cos z^2$ B) X sin xy-cos z C)None of these

6. A solid sphere made of insulating material has a radius R and has total charge Q distributed uniformly in its volume. What is the magnitude of the electric field intensity, E, at a distance r (0<r<R) inside the sphere?

A) $\frac{1}{4\pi\varepsilon_0}\frac{Qr}{R^3}$ B) $\frac{3}{4\pi\varepsilon_0}\frac{Qr}{R^3}$ C) $\frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$ D) $\frac{1}{4\pi\varepsilon_0}\frac{QR}{r^3}$

7. Which of the following statement holds for the divergence of electric field and magnetic flux densities?

A) Both are zero
B) These are zero for static densities but non zero for time varying densities
C) It is zero for the electric flux density
D) It is zero for the magnetic flux density

8. If E is the electric density, $\nabla(\nabla XE)$ is equal to

A) E B)$|E|$ C) Null vector D)Zero

IES QUESTIONS:

1. A steady flow of 10A is maintained in a thin wire placed along the *X*-axis from (0, 0, 0) to (2, 0, 0) to find the value of the magnetic field intensity *H* at (0, 0, 5). When end effects are ignored, *H* is

A) -59.1 a_y mA/m B) 59.1 a_y mA/m C)-118.2 a_y mA/m D)118.2 a_y mA/m

2. A hollow metallic sphere of radius *R* is charged to a surface density of *sigma*. The strength of the electric field inside the sphere at a radius *r*(<*R*) is
   A) $\frac{\sigma}{\pi r^2}$ B)$\frac{\sigma}{2\pi r^2}$ C) $\frac{\sigma}{4\pi r^2}$ D) 0
3. Gauss's theorem states that total electric flux φ emanating from a closed surface is equal to
   A) Total current density on the surface
   B) Total charged enclosed by that surface
   C) Total current on the surface
   D) Total charge density within the surface
4. $\nabla X\bar{H} = \sigma E + \varepsilon\left(\frac{\partial E}{\partial t}\right)$ is
   A) Modified Faraday's law B) Gauss's law C) Biot-Savart law
   B) Modified Ampere's law
5. ``Electric flux enclosed by a surface surrounding a charge is equal to the amount of charged enclosed." This is the statement of
   A) Faraday's law B) Lenz's law C) Modified Ampere's law D) Gauss's law

XI. WEBSITES:

1. http://www.nptel.iitm.ac.in/video.php?subjectId=108106073
2. http://nptel.iitk.ac.in/courses/Webcourse-contents/IIT-%20Guwahati/em/index.htm
3. https://www.youtube.com/watch?v=K-8nCXY-iSI&list=PL74058E54264993C8

XII. EXPERT DETAILS:

1. Prof. Harishankar Ramachandarn IIT Madras
2. Prof. Ratnajit Bhattacharjee and Electrical Engineering IIT, Guwahati, Assam

XIII. JOURNALS:

1. http://ieeexplore.ieee.org/xpl/periodicals.jsp?item=M
2. http://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=5962381

XIV. SMALL PROJECTS

1. Xerography – Electrostatic Imaging
2. Lightning Rod
3. Faraday Cage
4. Electrostatic Speakers
5. Electrostatic Filters

LIST OF JOURNALS:

1. **Renewable Energy: An International Journal**
   URL:http://www.journals.elsevier.com/renewable-energy
2. **Journals in Green and Renewable Energy**

URL:http://www.springer.com/energy/renewable+and+green+energy?SGWID=0-1721214-12-812104-0

3. **Renewable & Sustainable Energy Reviews**
   URL: http://www.journals.elsevier.com/renewable-and-sustainable-energy-reviews
4. **Energy Procedia**
   URL: http://www.journals.elsevier.com/energy-procedia
5. **Journal of Solar Energy Engineering**
   URL: http://solarenergyengineering.asmedigitalcollection.asme.org/journal.aspx
6. **Geothermal Energy Journal**
   URL: http://geothermal-energy-journal.springeropen.com/
7. **Wind Energy Journal**
   URL: http://onlinelibrary.wiley.com/journal/10.1002/(ISSN)1099-1824
8. **Biomass and Bioenergy**
   URL: http://www.journals.elsevier.com/biomass-and-bioenergy
9. **IEEE Transactions on Sustainable Energy**
   URL: http://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=5165391
10. **International Journal of Marine Energy**
    URL: http://www.journals.elsevier.com/international-journal-of-marine-energy
11. **Journal of Ocean Engineering and Marine Energy**
    URL: http://www.springer.com/engineering/civil+engineering/journal/40722
12. **International Journal of Electrical Power & Energy Systems**
    URL:http://www.journals.elsevier.com/international-journal-of-electrical-power-and-energy-systems/
13. **IEEE Power Engineering Journal**
    URL: http://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=2224
14. **Journal of Renewable and Sustainable Energy**
    URL: http://scitation.aip.org/content/aip/journal/jrse
15. **Energy Economics Journal**
    URL: http://www.journals.elsevier.com/energy-economics
16. **IET Renewable Power Generation**
    URL: http://digital-library.theiet.org/content/journals/iet-rpg

WEBSITES:

1. **Renewable Energy News & Information**
   URL: http://www.renewableenergyworld.com/index.html
2. **Renewable Energy Focus**
   URL: http://www.renewableenergyfocus.com/
3. **Indian Renewable Energy Development Agency Limited (IREDA)**
   URL: http://www.ireda.gov.in/

4. **Ministry of New and Renewable Energy, Govt. of India.**
   URL: http://www.mnre.gov.in/
5. **National Renewable Energy Laboratory**
   URL: http://www.nrel.gov/
6. **Solar Energy Society of India**
   URL: http://www.sesi.in/
7. **U.S. Department of Energy**
   URL: http://www.energy.gov/
8. **American Wind Energy Association**
   URL: http://www.awea.org/
9. **International Renewable Energy Agency**
   URL: http://www.irena.org/home/index.aspx?PriMenuID=12&mnu=Pri
10. **European Biomass Industry Association**
    URL: http://www.eubia.org/
11. **Ocean Energy Europe**
    URL: http://www.oceanenergy-europe.eu/
12. **Geothermal Energy Association**
    URL: http://www.geo-energy.org/
13. **Association of European Renewable Energy Research Centers**
    URL: http://www.eurec.be/en/
14. **Energy Labs Inc.**
    URL: https://www.energylabs.com/web2/index.html
15. **Alternative Energy**
    URL: http://www.alternative-energy-news.info/

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   Wind and Photovoltaic Systems, Department of Electrical Engineering,
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5. **Dr. Abdus Samad**

Wave Energy Systems, Department of Oceanic Engineering,
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   Indian Institute of Technology, Roorkee, India.
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   Small Hydro Power Plants, Alternative Hydro Energy Centre,
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8. **Dr. Kalyan Kumar B**
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9. **Dr. Priyanka Kaushal**
   Biomass Energy System Modelling, Department of Energy & Environment
   The Energy Research Institute (TERI School of Advanced Studies), Delhi, India.
10. **Dr. Kalyan Kumar B**
    Wind Energy Generators, Department of Electrical Engineering
    Indian Institute of Technology, Madras, India.

LIST OF TOPICS FOR STUDENT SEMINARS:

1. Solar cell / Photovoltaic Cell
2. Solar water heater
3. PV sun-tracking systems
4. Solar cooker
5. Renewable ocean energy conversion systems
6. Small & micro wind & hydel turbines
7. Hybrid systems (Wind-Solar)
8. Renewable technologies for on-grid electricity generation
9. Wind Grabber - vertical axis - ducted type wind turbine system
10. Renewable conversion technologies
11. Renewable energy (RE) potential and status in India
12. Solar roads
13. Analysis of solar thermal power generation
14. Wind tower
15. Solar thermal energy collectors
16. Wind generator driven doubly fed IG
17. Solar cooling
18. Photovoltaics and other innovative solar systems
19. Wind and solar power forecast for grid operation
20. Integration of renewable energy devices
21. Floating platforms for offshore wind systems
22. Impacts of renewables on energy systems

23. Tidal turbine technology
24. Technical impacts on energy system
25. Development of renewable electricity generation
26. Wind blade repair
27. Oceanic energy systems and their modelling
28. Geothermal energy potential and its applications

CASE STUDIES

1. **Case Studies for Renewable Energy Systems in Hospitality Sector in India.**
   URL:http://www.teriin.org/ResUpdate/Hospitality_Case_Studies.pdf
2. **Sustainable biomass power for rural India: Case study of biomass gasifier for village electrification**.
   URL:https://www.researchgate.net/publication/237263887_Sustainable_biomass_power_for_rural_India_Case_study_of_biomass_gasifier_for_village_electrification
3. **Case studies of successful decentralized renewable energy projects that have not only ensure energy access but also improved livelihoods of people.**
   URL:http://www.vasudha-foundation.org/wp content/uploads/10)%20Reader%20Friendly%20Paper%20for%20USO_Case%20studies%20of%20successful%20decentralised%20RE%20Projects%20for%20energy%20access%20in%20India.pdf
4. **Grid integration of wind power: A case study of Tamil Nadu**
   URL:https://www.academia.edu/183182/Grid_Integration_of_Wind_Power_A_Case_Study_of_Tamil_Nadu
5. **Case study of India's accelerated depreciation policy for wind energy**
   URL:https://www.iisd.org/sites/default/files/publications/india-accelerated-depreciation-policy-wind-energy-case-study.pdf

SMALL PROJECTS

1. Develop a regression based Matlab code for estimating solar radiation.
2. Estimate power curve of a wind turbine.
3. Design and develop a standalone model for analyzing the characteristics of a PV Module.
4. Implementation of a standalone solar power generating unit.
5. Design of a solar thermal energy system for various applications.
6. Design and fabricate a horizontal and vertical axis wind energy system.
7. Modelling and implementation of ducted type wind turbine system.
8. Simulation models of solar power plant and wind energy power plant.

9. Mathematical analysis of biogas production using different feedstock.
10. Design of oceanic energy system using buoy and other floating type energy harvesters.
11. Design of a biogas digester for utilizing the kitchen waste as a fuel for cooking.
12. A brief study on the geothermal energy applications.
13. Modelling of a hybrid renewable energy system.
14. Development of a pumped storage system.
15. Design and construction of a mini-hydel power plant.