BS-119A	Introduction to Electromagnetic Theory						
L	**T**	**P**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	**1**	**-**	**4**	**75**	**25**	**100**	**3h**

Purpose	**To introduce the fundamentals of electromagnetic theory to the students for applications in Engineering field.**
Course Outcomes	
CO 1	**To study basic concepts of Electrostatics in vacuum.**
CO 2	**To study basic concepts of Magnetostatics in vacuum.**
CO 3	**To discuss electrostatics in linear dielectric medium.**
CO 4	**To discuss magnetostatics in linear magnetic medium.**
CO 5	**To make to the students aware of Faraday's laws and Maxwell's equations in vacuum & matter.**
CO 6	**To study electromagnetic waves and their propagation in vacuum & matter.**

Unit - I

Electrostatics in Vacuum: Calculation of Electric Field: Coulomb's law, Continuous charge distribution; Divergence and Curl of Electrostatic Fields: Field lines, flux, Gauss's law, Applications of Gauss's law; Electrostatic Potential: Comments on potential, Poisson's and Laplace's Equation, the potential of a localized charge distribution; Electrostatic Boundary Conditions; Work and Energy in Electrostatics: the work done to move a charge, the energy of a point and continuous charge distribution.

Unit - II

Electrostatics in a Linear Dielectric Medium: Polarization: dielectrics, induced dipoles, alignments of polar molecules; The field of a Polarized Object: bound charges and its physical interpretation; The Filed Inside a Dielectric; The Electric Displacement: Gauss's law in the presence of dielectrics, A deceptive parallel, Boundary conditions; Linear Dielectrics: Susceptibility, Permittivity, dielectric constant, Boundary value problems with linear dielectrics, Energy in dielectric systems, Forces in dielectrics.

Unit - III

Magnetostatics: The Lorentz Force Law: magnetic fields, magnetic forces, currents; Biot- Savart law, Divergence and Curl of magnetic field, Magnetic Vector Potential: vector potential, magnetostatic boundary conditions, multiple expansion of vector potential.

Magnetostatics in a linear magnetic: Magnetization: Effect of magnetic field on atomic orbits; The Field of a Magnetized Object: Bound currents, Physical interpretation of bound currents; The Auxiliary Magnetic Field:

Ampere's law in magnetized materials, A deceptive parallel, Boundary conditions; Linear and Nonlinear Media: magnetic susceptibility and permeability, ferromagnetism.

Unit - IV

Faraday's law: Electromotive Force: Ohm's law, Motional emf; Electromagnetic Induction: Faraday's law, The induced electric field, inductance, energy in magnetic fields.

Maxwell's Equations: Electrodynamics before Maxwell, How Maxwell fixed Ampere's law, Maxwell's equations, Maxwell's equations in matter.

Electromagnetic Waves: Electromagnetic Waves in Vacuum: the wave equation for electric and magnetic field; Electromagnetic Waves in Matter: propagation in linear media.

Suggested Books:

1. David J. Griffiths, Introduction to Electrodynamics, Pearson Education.
2. Halliday and Resnick, Physics
3. W. Saslow, Electricity, Magnetism and Light

Note: The paper setter will set the paper as per the question paper templates provided.

Lecture Plan

Lecture	Topic /chapter covered
Day 1	**Electrostatics in Vacuum**: Calculation of Electric Field: Coulomb's law
Day 2	Continuous charge distribution
Day 3	Divergence and Curl of Electrostatic Fields: Field lines, Flux
Day 4	Gauss's law
Day 5	Applications of Gauss's law
Day 6	Electrostatic Potential
Day 7	Comments on Potential
Day 8	Poisson's and Laplace's Equation
Day 9	The potential of a localized charge distribution
Day 10	Electrostatic boundary conditions
Day 11	Work and Energy in Electrostatics; The work done to move a charge
Day 12	The energy of a point charge distribution
Day 13	The energy of a continuous charge distribution.
Day 14	**Electrostatics in a Linear Dielectric Medium**: Polarization: dielectrics, Induced dipoles
Day 15	Alignments of polar molecules
Day 16	The field of polarized object: bound charges and its physical interpretation
Day 17	The field inside a Dielectric
Day 18	The Electric Displacement: Gauss's law in the presence of dielectrics
Day 19	A deceptive parallel
Day 20	Boundary conditions
Day 21	Linear Dielectrics: Susceptibility, Permittivity, dielectric constant
Day 22	Boundary value problem with linear dielectrics
Day 23	Energy in dielectric systems
Day 24	Forces in dielectrics.
Day 25	**Magnetostatics:** The Lorentz Force Law; Magnetic fields
Day 26	Magnetic forces

Day 27	Currents
Day 28	Biot- Savart law
Day 29	Divergence and Curl of magnetic filed
Day 30	Magnetic Vector Potential: vector potential
Day 31	Magnetostatic boundary conditions
Day 32	Multiple expansion of vector potential.
Day 33	**Magnetostatics in a linear magnetic:** Magnetization
Day 34	Effect of magnetic field on atomic orbits
Day 35	The Field of a Magnetized Object: Bound currents
Day 36	Physical interpretation of bound currents
Day 37	The Auxiliary Magnetic Field: Ampere's law in magnetized materials, A deceptive parallel, Boundary conditions
Day 38	Linear and Nonlinear Media: magnetic susceptibility and permeability
Day 39	Ferromagnetism.
Day 40	**Faraday's law:** Electromotive Force: Ohm's law
Day 41	Motional emf
Day 42	Electromagnetic Induction: Faraday's law, The induced electric field
Day 43	Inductance
Day 44	Energy in magnetic fields.
Day 45	**Maxwell's Equations:** Electrodynamics before Maxwell, How Maxwell fixed Ampere's law
Day 46	Maxwell's equations, Maxwell's equations in matter.
Day 47	**Electromagnetic Waves:** Electromagnetic Waves in Vacuum
Day 48	The wave equation for electric and magnetic field
Day 49	Electromagnetic Waves in Matter: propagation in linear media.

TUTORIAL SHEET – 1

Q.1. State and prove Coulomb's law.

Q.2. State and prove Gauss's law in differential form.

Q.3. Derive Poisson's and Laplace's Equation.

Q.4. Derive expression for energy in electrostatics.

Q. 5. Write short note on Divergence and Curl of Electrostatic field.

TUTORIAL SHEET – 2

Q. 1. Derive the expression for Gauss's law in the presence of dielectrics.

Q. 2. Write short note on

(1) A Deceptive Parallel

(2) Electric Susceptibility

(3) Permittivity

(4) Dielectric constant.

Q. 3. Define Polarization. Explain how a dielectric acquires polarization.

Q. 4. Derive expression for energy & force in dielectric system.

TUTORIAL SHEET - 3

Q. 1. Explain magnetic force and current using Lorentz force law.

Q. 2. Explain Biot- Savart law.

Q. 3. Write short note on Divergence and Curl of magnetic field.

Q. 4. Explain the concept of vector magnetic potential and multipole expansion of the vector potential.

Q. 5. Discuss effect of a magnetic field on atomic orbits.

Q. 6. Explain Ampere's law in magnetized materials.

TUTORIAL SHEET - 4

Q. 1. Write Maxwell's equations in integral and differential form.

Q. 2. Deduce the expression for energy in magnetic fields.

Q. 3. Explain Faraday's law of electromagnetic induction.

Q.4. Deduce the equation for the propagation of plane electromagnetic waves in vacuum.

Q. 5. Deduce the equation for the propagation of plane electromagnetic waves in linear media.

Roll **BT-1/D-18** **31036**

INTRODUCTION TO ELECTROMAGNETIC THEORY

Paper: BS-119A

Opt. (ii)

Time: [Three hours] [Max Marks: 75]

Note: Attempt five questions in all by selecting at least one question from each unit.

UNIT-I

1. (a) Find the expression for Electric field for both inside and outside a thin spherical shell of radius 'a' which has a positive charge 'Q' evenly distributed over its whole surface. (10)

(b) Explain the divergence of a vector field and its significance. (5)

2. (a) Explain the Poisson's and Laplace equations with their computational importance. (8)

(b) Prove that energy density (energy/volume) in a region of a uniform electric field 'E' in vacuum is Given by (½)$\epsilon_0 E^2$. (7)

UNIT-II

3. Write short note on:

(a) Linear dielectrics (5)

(b) Permitivity (5)

(c) Forces in dielectrics (5)

4. (a) Define Polarization. Explain how a dielectric acquires polarization. (9)

(b) What do you mean by Electric Displacement vector? Give it significance. (6)

Unit-III

5. Write short notes on:

(a) Divergence of magnetic field. (5)

(b)Deceptive Parallel (5)

(c) Physical interpretation of bound currents. (5)

6. (a) Explain the concept of vector magnetic potential. What is its unit? Explain, why being potential, it is a vector quantity. (10)

(b) Explain Biot Savart's Law. (5)

UNIT-IV

7. Write down the Maxwell's equations in integral and differential forms time varying fields and discuss the point wise physical significance/circuit relations or concept possessed by each equation. (15)

8. (a) Deduce the equation for the propagation of plane electromagnetic waves in vacuum. (10)

(b) Draw a neat and labelled diagram of a plane electromagnetic wave. (5)

BS-121LA	Electromagnetics Lab						
L	**T**	**P**	**Credit**	**Practical**	**Minor Test**	**Total**	**Time**
-	**-**	**3**	**1.5**	**30**	**20**	**50**	**3h**
Purpose	**To give the practical knowledge of handling the instruments.**						
Course Outcomes							
CO 1	**To make the students familiar with induced e.m.f.**						
CO 2	**To study self inductance and mutual inductance.**						
CO 3	**To study variation of magnetic field.**						
CO 4	**To make students aware of Faraday & Lenz's law of induction.**						
CO 5	**Study of equipotential lines by bar & ring electrodes.**						
CO 6	**To make students aware of growth & decay of current in a LR circuit.**						

Note: Student will be required to perform at least 10 experiments out of the following list.

1. To study the variation of magnetic field with distance and to find the radius of coil by Stewart and Gee's apparatus.
2. To study induced e.m.f. as a function of velocity of magnet.
3. To study the growth and decay of current in a LR circuit using magnetic core inductor.
4. To find the coefficient of self-inductance by Rayleigh's method.
5. To find the coefficient of mutual inductance of two coils.
6. To determine the magnetic induction field between the pole pieces of an electromagnet.
7. To study Bio-Savart's law.
8. To study the dependency of magnetic field on coil diameter and number of turns.
9. To investigate the equipotential liens of electric fields.
10. To draw the equipotential lines of bar electrode.
11. To draw the equipotential lines for ring electrode.
12. Verification of Faraday and Lenz's law of induction by measuring the induced voltage as function of time.
13. Measurement of induced voltage impulse as a function of the velocity of magnet.
14. To determine the dielectric constant of different dielectric materials.
15. To measure the spatial distribution of the magnetic field between a pair of identical coils in Helmholtz arrangement.
16. To investigate the spacing between coils at which magnetic field is uniform and to measure its spatial distribution.

Suggested Books:

1. C.L.Arora, B. Sc. Practical Physics, S. Chand.
2. B.L. Worshnop and H, T, Flint, Advanced Practical Physics, KPH.
3. S.L. Gupta & V. Kumar, Practical Physics, PragatiPrakashan.