ELECTROMAGNETIC FIELD THEORY

Course Code	23ES1301	**Year**	II	**Semester(s)**	I
Course Category	Engineering Science	**Branch**	EEE	**Course Type**	Theory
Credits	3	**L-T-P**	3-0-0	**Prerequisites**	Differential Equations & Vector Calculus
Continuous Internal Evaluation:	30	**Semester End Evaluation:**	70	**Total Marks:**	100

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Compute electric fields and potentials using basic laws and solve Laplace's or Poisson's equations for various electric charge distributions. (L3)
CO2	Analyse the behaviour of conductors in electric fields, electric dipole, the capacitance and energy stored in dielectrics. (L4)
CO3	Calculate the magnetic field intensity due to current carrying conductor and understanding the application of Ampere's law, Maxwell's second and third law. (L3)
CO4	Estimate self and mutual inductances and the energy stored in the magnetic field. (L4)
CO5	Analyse the concepts of Faraday's laws, Displacement current, Poynting theorem and Poynting vector. (L4)
CO6	Able to write up findings in the areas of electrostatics, magnetostatics, and time-varying fields.

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3:High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												2	
CO2		3											2	
CO3	3												2	
CO4		3											2	
CO5		3											2	
CO6									3	3				

SYLLABUS

Unit No.	Contents	Mapped CO
I	**Electrostatics-I:** Coulomb's law and Electric field intensity (EFI) – EFI due to Continuous charge distributions (line charges – infinite line charge & Circular Ring, surface charges – infinite sheet of charge & Circular Disk), Electric flux density, Gauss's law (Maxwell's first equation, $\nabla.\vec{D} = \rho_v$), Applications of Gauss's law – infinite line charge, infinite sheet of charge, coaxial cable, spherical shell of charge and uniformly charged sphere,	**CO1,CO6**

II	**Electrostatics-II:** Electric Potential, Work done in moving a point charge in an electrostatic field (second Maxwell's equation for static electric fields,$\nabla \times \vec{E} = 0$), Potential gradient, Energy stored and density in a static electric field, Laplace's and Poison's equations, Electric dipole and dipole moment – Potential and EFI due to an electric dipole, Torque on an Electric dipole placed in an electric field, Current density-conduction and convection current densities, Ohm's law in point form, Continuity equation of current equation, Behaviour of conductors in an electric field, Polarization.	**CO1,CO2, CO6**
III	**Boundary Conditions and Capacitance:** Boundary conditions between conductor to dielectric, dielectric to dielectric and conductor to free space, Capacitance of parallel plate capacitor and parallel plate capacitor with composite dielectrics. **Magnetostatic Fields:** Biot - Savart's law and its applications viz. Straight current carrying filament, circular, square, and solenoid current carrying wire – Magnetic flux density and Maxwell's second Equation ($\nabla . \vec{B} = 0$), Ampere's circuital law and its applications viz. MFI due to an infinite sheet, long filament current carrying conductor, point form of Ampere's circuital law, Maxwell's third equation ($\nabla \times \vec{H} = \vec{J}$).	**CO2, CO3,CO6**
IV	**Magnetic Force in magnetic fields:** Magnetic force, moving charges in a magnetic field – Lorentz force equation, force on a current element in a magnetic field, force on a straight and a long current carrying conductor in a magnetic field, force between two straight long and parallel current carrying conductors, Magnetic dipole, Magnetic torque. **Self and mutual inductance:** Self and mutual inductance – determination of self-inductance of a solenoid, toroid, coaxial cable and mutual inductance between a straight long wire and a square loop wire in the same plane – Energy stored and energy density in a magnetic field.	**CO3, CO4,CO6**
V	**Time Varying Fields:** Faraday's laws of electromagnetic induction, Maxwell's fourth equation $\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$, integral and point forms of Maxwell's equations, statically and dynamically induced EMF, Displacement current, Modification of Maxwell's equations for time varying fields, Poynting theorem and Poynting vector.	**CO5,CO6**

Learning Resources
Text Books
1. Matthew N O Sadiku, "Elements of Electromagnetics" Oxford Publications, 7th edition, 2018. 2. William H. Hayt & John A. Buck, "Engineering Electromagnetics", Mc. Graw-Hill, 7th Editon.2006.

Reference Books

1. D J Griffiths, "Introduction to Electro Dynamics", Prentice-Hall of India Pvt. Ltd, 2nd edition.
2. Yaduvir Singh, "Electromagnetic Field Theory", Pearson India, 1st edition, 2011.
3. Sunil Bhooshan, "Fundamentals of Engineering Electromagnetics", Oxford University Press, 2012.
4. Joseph A. Edminister, MahamoodNavi, "Schaum's Outline of Electromagnetics" 4th Edition,2014.

Online Learning Resources:

1. https://nptel.ac.in/courses/117103065
2. Electromagnetic Theory - Course (nptel.ac.in)