COURSE TITLE	**FIELD THEORY**
COURSE CODE	**01EE1407**
COURSE CREDITS	**4**

Objective:

1 Students will be able to analyze the behavior of electrostatic and electromagnetic fields in free space and in different materials which in the future will help to understand its applications in Electrostatic generators, Electric power transmission, Lighting protection, Electro deposition, Magnetic separators, Development of motors, Transformers, Electromagnetic pump and so on

Course Outcomes: After completion of this course, student will be able to:

1 Apply Coulomb's law and Gauss' law to different charge configurations.

2 Estimate electric field intensity by using divergence theorem and boundary conditions for electrostatic field.

3 Interpret property of conductors and dielectric medium

4 Apply laws of steady and time varying magnetic field

5 Calculate force and torque produced by the magnetic fields

Pre-requisite of course: None

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
3	0	2	50	30	20	25	25

Contents : Unit	Topics	Contact Hours
1	**Vector Analysis** Scalars and Vectors, Vector Algebra, The rectangular co-ordinate system, Vector components and unit vectors, The distance vector, The vector field, The dot product, The cross product, Circular cylindrical co-ordinates, Spherical co-ordinate system	5
2	**Coulomb's law and Electric Field Intensity** The experimental law of Coulomb, Electric field intensity, Field due to a continuous volume charge distribution, Field of a line charge, Field of a sheet charge	5
3	**Electric Flux Density, Gauss' law and Divergence** Electric flux density, Gauss' law, Application of Gauss' law: some symmetrical charge distributions, Application of Gauss' law to differential volume element, Divergence, Maxwell's first equation, The divergence theorem	5

DR. AMIT DILIPKUMAR VED
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Contents : Unit	Topics	Contact Hours
4	**Energy and Potential** Energy expended in moving a point charge in electric field, The line integral, Definition of potential and potential difference,, The potential field of a point charge, The potential field of a system of charges, Potential gradient, The dipole, Energy density in the electrostatic field	4
5	**Current and Conductors** Current and current density, Continuity of current, Metallic conductors, Conductor properties and boundary conditions, Semiconductors	3
6	**Dielectrics and capacitance** The nature of dielectric materials, Boundary conditions for perfect dielectric materials, Capacitance, Several capacitance examples, Capacitance of a two-wire line	3
7	**Poisson's and Laplace's Equation** Poisson's equation, Laplace's equation, Uniqueness theorem, Solution of Poisson's and Laplace's equation, Application of Poisson's and Laplace's equations	3
8	**The Steady Magnetic Field** Biot Savart law, Ampere's circuital law, Curl, Stoke's theorem, Magnetic flux and magnetic flux density, The scalar and vector magnetic potentials, Derivation of steady magnetic field laws	5
9	**Magnetic Forces, Materials, and Inductance** Force on a moving charge, Force on a differential current element, Force between differential current elements, Force and torque on a closed circuit, The nature of magnetic materials, Magnetization and permeability, Magnetic boundary conditions, The magnetic circuit, Potential energy and forces on magnetic materials, Inductance, and mutual inductance	6
10	**Time Varying Fields and Maxwell's equation** Faraday's law, Transformer and motional electromotive forces, Displacement current, Maxwell's equations in integral and point form, Time varying potentials	3
Total Hours		**42**

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
1	**Experiment-1** Experiment on correlation with electric field intensity due to point charge, line charge, volume charge, surface charge etc	2
2	**Experiment-2** To verify hysteresis loop	2
3	**Experiment-3** To verify Bio-savart's law	2

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Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
4	**Experiment-4** To draw the equipotential lines using different shape of electrodes.	2
5	**Experiment-5** To verify faraday's law of electromagnetic induction.	2
6	**Experiment-6** To simulate electrostatic potential of point charge	2
7	**Experiment-7** To design electromagnet and find out magnetic field and flux distribution	2
8	**Experiment-8** To simulate various boundary conditions	2
9	**Experiment-9** To find solution of 2nd order Laplace equation.	2
10	**Experiment-10** To design transmission line and find its inductance matrix.	2
11	**Experiment-11** To find solution of 2nd order poisson's equation	2
12	**Experiment-12** To design a parallel plate capacitor, find capacitance, and observe the effect of change in the dielectric medium	2
13	**Experiment-13** To observe Electric and Magnetic Fields of Round Solid Conductors and round hollow conductor	2
14	**Experiment-14** To simulate dipole	2
15	**Experiment-15** To simulation flux distribution in the core and winding of 1-phase transformer.	2
16	**Experiment-16** To find self and mutual inductance of 1-phase transformer.	2
Total Hours		**32**

Textbook :

1 Engineering Electromagnetics, W.H. Hayt and J A Buck, Tata McGraw Hill Publications, 2017

2 Principles of Electromagnetics, Matthew N.O. Sadiku, S.V. Kulkarni, Oxford University Press, 2015

3 Electromagnetic Field Theory, U.A. Bakshi and A.V. Bakshi, Technical Publication, 2007

References:

1 Electromagnetic Field Theory Fundamentals, Electromagnetic Field Theory Fundamentals, Bhag Singh Guru and Hüseyin R. Hiziroglu, Cambridge University Press, 2009

References:

2 Electromagnetic Field Theory for Engineers and Physicists, Electromagnetic Field Theory for Engineers and Physicists, Günther Lehner, Springer-Verlag Berlin Heidelberg, 2010

3 Fundamentals of Engineering Electromagnetics, Fundamentals of Engineering Electromagnetics, Rajeev Bansal, CRC Press, 2018

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery					
Remember / Knowledge	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Higher order Thinking / Creative**
10.00	20.00	25.00	25.00	20.00	0.00

Instructional Method:

1 The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, case studies etc

2 The internal evaluation will be done on the basis of continuous evaluation of students in the class-room

3 Practical examination will be conducted at the end of semester for evaluation of performance of students in lab

4 Students will use supplementary resources such as online videos

Supplementary Resources:

1 https://www.openfoam.com/documentation/tutorial-guide

2 https://www.femm.info/wiki/Documentation/

3 https://www.comsol.com/multiphysics/electromagnetics

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