INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

ELECTROMAGNETIC FIELDS								
III Semester: EEE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
AEED07	**Core**	3	0	0	3	40	60	100
Contact Classes: 48	**Tutorial Classes: -**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Electrical Circuits								

I. COURSE OVERVIEW:
This course will equip the students with good understanding of underlying principles and laws in electromagnetic fields and waves. The concepts of vector algebra, principles and basic laws of electrostatics, characteristics and properties of conductors and dielectrics, behavior of static magnetic field and application of Ampere's law, determination of force in magnetic field and magnetic potential, concept of time varying fields and propagation of electro-magnetic waves.

II. COURSE OBJECTIVES:
The students will try to learn:

I. The behavior of charge under rest with static electric field in terms of electric field intensity, electric displacement and electric potential
II. The charge distribution in conductors, dielectrics and condensers.
III. The sources to develop constant and variable magnetic field to study effect of these fields in terms of magnetic field intensity, magnetic displacement, and magnetic potential
IV. The nature of electromagnetic wave propagation in free space, conductors, and dielectric materials

III. COURSE OUTCOMES:
CO1 Make use of Vector Calculus, Coulomb's Law and Gauss Law for obtaining electric field intensity, Potential and behavior of electrostatic field
CO2 Calculate the capacitance of different physical configuration based on the behavior of the conductors and dielectric materials
CO3 Demonstrate Biot-Savart law and Ampere circuital law for derivation of magnetic field intensity due to different current carrying conductors.
CO4 Predict the force due to moving charge/current in the static magnetic field, thereby obtaining the inductance for different configurations of wires and energy stored in the coil
CO5 Apply the Faraday's law of Electromagnetic induction and Maxwell Equations to produce a wave equation for the free- space, insulators and conductors for propagation of electromagnetic waves

III. COURSE CONTENT:
MODULE-I: ELECTROSTATICS (10)
Introduction to Cartesian, cylindrical and spherical co-ordinates. Conversion of one type of co-ordinates to another; Electrostatic fields: Coulomb's law, electric field intensity due to line and surface charges, work done in moving a point charge in an electrostatic field, electric potential, properties of potential function, potential gradient, Gauss's law, application of Gauss's law, Maxwell's first law, Laplace's and Poisson's equations, solution of Laplace's equation in one variable.

MODULE-II: CONDUCTORS AND DIELECTRICS (08)
Dipole moment, potential and electric field intensity due to an electric dipole, torque on an electric dipole in an electric field, behavior of conductors in an electric field, electric field inside a dielectric material, polarization, conductor and dielectric, dielectric boundary conditions, capacitance of parallel plate and spherical and coaxial capacitors with composite dielectrics, energy stored and energy density in a static electric field, current density,

conduction and convection current densities, Ohm's law in point form, equation of continuity.

MODULE-III: MAGNETOSTATIC (10)

Biot-Savart's law, magnetic field intensity, magnetic field intensity due to a straight current carrying filament, magnetic field intensity due to circular, square and solenoid current carrying wire, relation between magnetic flux, magnetic flux density and magnetic field intensity, Maxwell's second equation, div(B)=0. Magnetic field intensity due to an infinite sheet of current and a long current carrying filament, point form of Ampere's circuital law, Maxwell's third equation, Curl (H)=Jc, field due to a circular loop, rectangular and square loops

MODULE-IV: FORCE IN MAGNETIC FIELD AND MAGNETIC POTENTIAL (10)

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 and dipole moment, a differential current loop as a magnetic dipole, torque on a current loop placed in a magnetic field; Vector magnetic potential and its properties, vector magnetic potential due to simple configurations, Poisson's equations, self and mutual inductance, Neumann's formula, determination of self-inductance of a solenoid, toroid and determination of mutual inductance between a straight long wire and a square loop of wire in the same plane, energy stored and density in a magnetic field, characteristics and applications of permanent magnets.

MODULE-V: TIME VARYING FIELDS AND FINITE ELEMENT METHOD (09)

Faraday's laws of electromagnetic induction, integral and point forms, Maxwell's fourth equation, curl (E)=$\partial B/\partial t$, statically and dynamically induced EMFs, modification of Maxwell's equations for time varying fields, displacement current. Derivation of Wave Equation, Uniform Plane Waves, Maxwell's equation in phasor form, Wave equation in Phasor form, Plane waves in free space and in a homogenous material. Wave equation for a conducting medium, Plane waves in loss dielectrics, Propagation in good conductors, Skin effect. Poynting theorem

IV. TEXT BOOKS:

1. K.B. MadhuSahu, " Eelectromagnetic Fields", Scitech Ltd., 2nd edition, 2014.
2. David J Griffiths, "Introduction to Electrodynamics" Pearson Education Ltd., 4th edition, 2014.
3. Sunil Bhooshan, "Fundamentals of Engineering Electromagnetics", Oxford University Press, 1st edition, 2012.
4. E Kuffel, W S Zaengl, J Kuffel, "High Voltage Engineering Fundamentals", Newnes, 2nd edition, 2000.

V. REFERENCE BOOKS:

1. Matthew N O Sadiku, S V Kulkarni, "Principles of Electromagnetics", Oxford University Press, 6th edition, 2015.
2. AS Mahajan , AA Rangwala "Electricity And Magnetism", McGraw Hill Publications, 1st edition, 2000.
3. MS Naidu, V Kamaraju "High Voltage Engineering", McGraw Hill Publications, 3rd edition, 2013.
4. William H Hayt, John A Buck, "Problems and Solutions in Electromagnetics", McGraw Hill Publications, 1st edition, 2010.

VI. ELECRONIC RESOURCES:

1. https://www.calvin.edu/~pribeiro/courses/engr315/EMFT_Book.pdf
2. https://www.web.mit.edu/viz/EM/visualizations/coursenotes/modules/guide02.pdf
3. https://www.nptel.ac.in/courses/108106073/
4. https://www.iare.ac.in

VIII. MATERIALS ONLINE:

1. Course template
2. Tutorial question bank
3. Tech talk topics
4. Open end experiments
5. Definitions and terminology
6. Assignments

7. Model question paper - I
8. Model question paper - II
9. Lecture notes
10. E-learning readiness videos (ELRV)
11. Power point presentation