# ELECTROMAGNETIC FIELD THEORY

| **Course Code** | 20BS1401 | **Year** | II | **Semester(s)** | II |
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| **Course Category** | Basic Sciences | **Branch** | EEE | **Course Type** | Theory |
| **Credits** | 3 | **L-T-P** | 3-0-0 | **Prerequisites** | - |
| **Continuous Internal Evaluation:** | 30 | **Semester End Evaluation:** | 70 | **Total Marks:** | 100 |

| **Course Outcomes** | |
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| **Upon successful completion of the course, the student will be able to** | |
| CO1 | **Understand** the concepts on Electrostatics, Magnetostatics and Time varying fields.(L2) |
| CO2 | **Apply** basic laws and theorems to determine the electrostatic fields. (L3) |
| CO3 | **Analyze** different parameters of static electric fields. (L4) |
| CO4 | **Apply** basic Laws to determine the various parameters of Magnetostatic and Time varying fields. (L3) |
| CO5 | **Analyze** various parameters of Magnetostatic fields and Time varying fields. (L4) |
| CO6 | **Submit a report** in Electrostatic, Magnetostatic fields and Time varying fields**.** |

| **Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3:High, 2: Medium, 1:Low)** | | | | | | | | | | | | | | |
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| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | | | | | | | | | | | | | | |
| CO2 | 3 | | | | | | | | | | | | 2 | |
| CO3 | | 2 | | | | | | | | | | | 2 | |
| CO4 | 3 | | | | | | | | | | | | 2 | |
| CO5 | | 3 | | | | | | | | | | | 2 | |
| CO6 | | | | | | | | | 3 | 3 | | | 2 | |

| **SYLLABUS** | | |
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| **Unit No.** | **Contents** | **Mapped CO** |
| I | **Static Electric Field – I**<br>Coulomb‘s law, Electric field intensity, Electrical field due to point charges, Line Charges (Derivations Only) – Infinite, Finite and Circular Ring, Surface charges (Derivations Only) – Infinite sheet and Circular Disk.<br>Electric Flux Density, Gauss law and applications of Gauss’s Law to Point Charges, Infinite Line Charge, Infinite Sheet of Charge, Co-axial cable, Spherical shell and Uniformly charged sphere. Divergence and Divergence theorem. Maxwell’s first law, div( D )=$\rho_v$<br>Energy expended in moving a charge in an electric field, Absolute Electric potential, Potential difference, Calculation of potential | **CO1, CO2, CO3,CO6** |

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| | difference for point charges, Potential Gradient. | |
| II | **Static Electric Field – II**<br>Poisson's and Laplace's equations, Solution of Laplace equations in one variable<br>Electric dipole, Dipole moment, potential and electric field due to an electric dipole, Torque on an Electric dipole in an electric field. Electrostatic Energy and Energy density.<br>Current and current density, Ohms Law in Point form, Continuity of current equation.<br>Electric field inside dielectric material - concept of Polarization, Boundary conditions between conductor dielectric and two dielectric materials.<br>Capacitance, Capacitance of parallel plate, Spherical, Co-axial capacitors and parallel plates with Composite Dielectric. | **CO1, CO2, CO3,CO6** |
| III | **Static Magnetic Fields**<br>Biot – Savart's Law, Magnetic Field Intensity (MFI), MFI due to straight current carrying filament, circular, square and solenoid current carrying loops. Magnetic flux and flux density, Maxwell's second Equation, div(B)=0.<br>Ampere circuital Law, Applications of Ampere's circuital law to infinite sheet of current and a long current carrying filament. Point form of Ampere's circuital law, Maxwell's third equation, Curl (H)=J. | **CO1, CO4, CO5, CO6** |
| IV | **Magnetic Forces and Inductance**<br>Force on a moving charge, Lorentz force equation, Force on a differential current element, Force between differential current elements, Magnetic boundary conditions, Magnetic dipole and dipole moment, a differential current loop as a magnetic dipole, Torque on a current loop placed in a magnetic field<br>Inductances and mutual inductances, determination of self-inductance of a solenoid and toroid 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. | **CO1, CO4, CO5, CO6** |
| V | **Time Varying Fields**<br>Faraday's laws of electromagnetic induction – its integral and point forms, Maxwell's fourth equation, Curl (E)=-$\partial$B/$\partial$t, statically and dynamically induced EMF – simple problems, modification of Maxwell's equations for time varying fields, displacement current, Poynting theorem and Poynting vector. | **CO1, CO4, CO5, CO6** |

| **Learning Resources** |
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| **Text Books** |
| 1. Mathew N. O. Sadiku "Principles of Electromagnetics," Oxford University Press, 6th Edition 2015<br>2. William H. Hayt, Jr. John A. Buck, M Jaleel Akhtar "Engineering Electromagnetics", McGraw-Hill, 9th Edition, 2020 |
| **Reference Books** |
| 1. Ashutosh Pramanik, "Electromagnetism - Theory and Applications", Prentice Hall India, 2nd edition, New Delhi, 2008.<br>2. Ashutosh Pramanik, "Electromagnetism - Problems with solution", Prentice Hall India, 2nd Edition, 2012.<br>3. John D Kraus, Daniel Fleisch "Electromagnetics with Applications", McGraw Hill, 5th |

Edition, 2017.

4. Nathan Ida, “Engineering Electromagnetics, Springer 2nd Edition, 2005.

**e- Resources & other digital material**

1. https://nptel.ac.in/courses/108/106/108106073/#
2. https://ocw.mit.edu/resources/res-6-001-electromagnetic-fields-and-energy-spring-2008/