**23EE21T1-ELECTROMAGNETIC FIELDS**

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| **Course Category:** | Engineering Science | **Credits:** | 3 |
| **Course Type:** | Theory | **Lecture-Tutorial-Practical:** | 3-0-0 |
| **Pre-requisite:** | Knowledge of vector analysis, co-ordinate system, vector calculus, differentiation of  scalars and vectors. | **Sessional Evaluation: External Exam Evaluation:**  **Total Marks:** | 30  70  100 |

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| **Course Objectives:** | Students undergoing this course are expected to learn : | | |
| 1. The concepts of vector algebra, vector calculus, various fundamental laws, self and mutual inductance. 2. The concepts of electrostatics, conductors, dielectrics, capacitance, magneto statics, magnetic fields, time varying fields, self and mutual inductances 3. Vector calculus, Coulomb’s law, Gauss’s law, Ohm’s law in point form, Biot- Savart’s law, Ampere’s circuital law, Maxwell’s third equation, self and mutual inductances, Faraday’s laws, Maxwell’s fourth equation, Poynting theorem to solve various numerical problems 4. The vector calculus, electrostatic fields, behavior of conductor in electric filed, Biot-Savart’s law and its applications. 5. The magnetic force, moving charges in a magnetic field, self-inductance of different cables, mutual inductance between different wires and time varying fields. | | |
| **Course Outcomes:** | After completing the course the student will be able to | | **Blooms levels** |
| CO1 | Remember the concepts of vector algebra, vector calculus, various  fundamental laws, self and mutual inductance. | **L1** |
| CO2 | Understand the concepts of electrostatics, conductors, dielectrics,  capacitance, magneto statics, magnetic fields, time varying fields, self and mutual inductances | **L2** |
| CO3 | Apply vector calculus, Coulomb’s law, Gauss’s law, Ohm’s law in point form, Biot-Savart’s law, Ampere’s circuital law, Maxwell’s third equation, self and mutual inductances, Faraday’s laws,  Maxwell’s fourth equation, Poynting theorem to solve various numerical problems | **L3** |
| CO4 | Analyze vector calculus, electrostatic fields, behavior of conductor in electric filed, Biot-Savart’s law and its applications | **L4** |
| CO5 | Analyze magnetic force, moving charges in a magnetic field, self- inductance of different cables, mutual inductance between different  wires and time varying fields. | **L4** |
| **Course Content:** | **UNIT – I**  **Vector Analysis:**  **Vector Algebra:** Scalars and Vectors, Unit vector, Vector addition and subtraction, Position and distance vectors, Vector multiplication, Components of a vector.  **Coordinate Systems:** Rectangular, Cylindrical and Spherical coordinate systems. **Vector Calculus:** Differential length, Area and Volume. Del operator, Gradient of a scalar, Divergence of a vector and Divergence theorem (definition only). Curl of a vector and Stoke’s theorem (definition only), Laplacian of a scalar  **Electrostatics:**  Coulomb’s law and Electric field intensity (EFI) – EFI due to Continuous charge distributions (line and surface charge), Electric flux density, Gauss’s law (Maxwell’s first equation, ∇. ⃗D→ = ρv), Applications of Gauss’s law, Electric Potential, Work done in moving a point charge in an electrostatic field (second Maxwell’s equation for  static electric fields, ∇ × ⃗E→ = 0), Potential gradient, Laplace’s and Poison’s equations. | | |

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| **Course Content:** | **UNIT – II**  **Conductors – Dielectrics and Capacitance:**  Behaviour of conductor in Electric field, 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, Behaviour of conductors in an electric field, Polarization, dielectric constant and strength, Continuity equation and relaxation time, Boundary conditions between conductor to dielectric, dielectric to dielectric and conductor to free space, Capacitance of parallel plate, coaxial and spherical capacitors, Energy stored and density in a static electric field, Coupled and decoupled capacitors.  **UNIT-III**  **Magneto statics, Ampere’s Law and Force in magnetic fields:**  Biot-Savart’s law and its applications viz. Straight current carrying filament, circular, square, rectangle and solenoid current carrying wire – Magnetic flux density and Maxwell’s second Equation (∇. ⃗B→ = 0), Ampere’s circuital law and its applications viz. MFI due to an infinite sheet, long filament, solenoid, toroidal current carrying conductor, point form of Ampere’s circuital law, Maxwell’s third equation (∇ × ⃗H⃗→ =  →J).  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, and moment.  **UNIT – IV**  **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.  **UNIT – V**  **Time Varying Fields:**  Faraday’s laws of electromagnetic induction, Maxwell’s fourth equation(∇ × ⃗E→ =  − ∂⃗B→), integral and point forms of Maxwell’s equations, statically and dynamically  ∂t  induced EMF, Displacement current, Modification of Maxwell’s equations for time varying fields, Poynting theorem and Poynting vector. |
| **Text Books & Reference Books:** | **TEXT BOOKS:**   1. “Elements of Electromagnetics” by Matthew N O Sadiku, Oxford Publications, 7th edition, 2018. 2. “Engineering Electromagnetics” by William H. Hayt & John. A. Buck Mc. Graw- Hill, 7th Editon.2006.   **REFERENCE BOOKS:**   1. Introduction to Electro Dynamics” by D J Griffiths, Prentice-Hall of India Pvt. Ltd, 2nd edition. 2. “Electromagnetic Field Theory” by Yaduvir Singh, Pearson India, 1st edition, 2011. 3.“Fundamentals of Engineering Electromagnetics” by Sunil Bhooshan, Oxford University Press, 2012.   4.Schaum's Outline of Electromagnetics by Joseph A. Edminister, Mahamood Navi, 4th Edition,2014. |

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| **e- Resources:** | 1. <https://archive.nptel.ac.in/courses/108/106/108106073/> 2. <https://nptel.ac.in/courses/117103065> 3. [http://iete-elan.ac.in](http://iete-elan.ac.in/) 4.<http://freevideolectures.com/university/iitm> |