Electromagnetic Theory - Video course

COURSE OUTLINE

The course is a one semester first course on Electromagnetic Theory at B.Sc. level. This course would be a pre-requisite for the advanced level course at the M. Sc. Level.

The course begins with a review of vector calculus which is extensively used in the course. The course covers electrostatics, magnetostatics, electromagnetic induction and electromagnetic waves.

At the end of this course, a student is expected to be familiar with both the differential and integral forms of Maxwell's equations.

COURSE DETAIL

Sl.No.	Topic/s	No. of Lectures
1.	**Introduction to Vector Calculus:** Spherical and Cylindrical coordinates, gradient, divergence and curl, Laplacian operator. Volume and line integrals, surface integrals, Divergence and Stoke's theorem. Dirac delta function.	3
2.	**Electrostatics:** Coulomb's law; forces and fields; Electric Field and Potential ; Principle of Superposition; idea of a conservative field. Earnshaw's Theorem; electric dipoles, field of a dipole, couple and force on a dipole, energy of a dipole; Electric double layers. Gauss's law; solutions for simple symmetry, capacitances, field near charged conductor;Conductors in Electrostatic field; Laplace and Poisson equations; uniqueness theorem. Laplace's equation in rectangular coordinates, separation of variables. Laplace's equation in spherical coordinates, Legendre polynomials. Conducting sphere in E field.Method of images; point charge near conducting sphere, line charge near conducting cylinder. Isotropic dielectrics; polarisation charges	15

NP-TEL

NPTEL

http://nptel.iitm.ac.in

Physics

Pre-requisites:

Introductory course on Electricity and Magnetism at Halliday & Resnick level.

Additional Reading:

1. J. D. Jackson, "Classical Electrodynamics", 3rd Edition, Wiley (2007).
2. Ashok Das, " Lectures on Electromagnetism", Hindustan Publishing, (2004).

Hyperlinks:

1. http://ocw.mit.edu/OcwWeb/Physics/8-02Spring-2007.
2. http://www.cdeep.iitb.ac.in/nptel/Core Science/Engineering Physics 2/Course Objectives.html.

Coordinators:

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	(ρ_b;σ_b) Gauss's law; permittivity and susceptibility; properties of vectors D and E; Boundary conditions at dielectric surfaces; relationship between E and P; thin slab in field, Energy of the electrostatic field, stress in a dielectric.	
3.	**Magnetostatics:** Electric current, Lorentz force, motion of charged particle in electric and magnetic field. Force on and between current elements, definition of B and the Ampere's law; Gauss's law; field, force, torque and energy; magnetic scalar potential, solid angle of a loop; Ampere's law, examples; introduction to magnetic vector potential. Field of a small current loop; magnetic dipole, dipole in an external magnetic field, Biot-Savart's law. Magnetic media; magnetization, existence of diamagnetism and paramagnetism; permeability and magnetic susceptibility; properties of B and H; boundary conditions at surfaces; Methods of calculating B and H, magnetizable sphere in uniform field; electromagnets.	10
4.	**Faraday's law:** Emf, electromagnetic induction, Faraday's law for a circuit, interpretation of Faraday's emf; self-inductance, inductance of long solenoid, coaxial cylinders, parallel cylinders; mutual inductance; transformers; magnetic energy density.	4
5.	**Electromagnetic waves:** Equation of continuity, displacement current; Maxwell's equations; electromagnetic waves, velocity of light; plane waves in isotropic media; Energy density; Poynting's theorem; radiation pressure and momentum; insulating media; plasmas and the plasma frequency, evanescent waves. Characteristic impedance, reflection and transmission at an angle, total internal reflection. Conducting media; skin effect. Guided waves. Introduction to waveguides; TE modes; waveguide equation; cut-off frequency; characteristic impedance;cavity resonators; optical fibre, radiation by an accelerated particle, elements of antenna theory.	8

References:

1. D. J. Griffiths, “Introduction to Electrodynamics”,3rd Edition, Prentice Hall International (1999).
2. A. S.Mahajan and A, Rangwala, “Electricity and Magnetism”, Tata McGraw Hill (1988).
3. E. Purcell, “Electricity & Magnetism”, 2nd Edition, McGraw Hill (1985).
4. J. R. Reitz,F. J. Milford and R. W. Christie, “Foundations of Electromagnetic Theory”, Addison Wesley (2008).
5. W. Greiner, “Classical Electrodynamics”, Springer (1998).