EE 444: Electromagnetic Fields Theory (EE)

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(3 – 1 – 0)
Theory Marks =100
Sessional Marks = 50
Time = 3 hours

1. **Vector Analysis:**

Review of dot and cross products, gradient, divergence and curl. Divergence and Stock's theorem, Cartesian, Cylindrical and Spherical co-ordinates system. Transformation between co-ordinates, General curvilinear co-ordinates. Value of gradient divergence and curl in general co-ordinates and to obtain there from their values in cylindrical and spherical co-ordinates.

2. The Static Electric Field:

Coulomb's Law, Electric Field strength, Field due to point charges, a line charge and a sheet of charge, field due to continuous volume charge, electric flux density, Gauss's law in integral form, Gauss's law in differential form (Maxwell's first equation in electrostatics), applications of the Gauss's law.

Electrostatic potential difference and potential, potential and potential difference expressed as a line integral, potential field of a point charge, potential field of a system of charges, conservative property, potential gradient, the dipole, energy density in the electrostatic field.

3. The static magnetic field:

The Biot-Savart's law (the magnetic field of filamentary currents), the magnetic field of distributed surface and volume currents, ampere's circuital law in integral and differential form (Maxwell's curl equation for steady magnetic field).

The scalar and vector magnetic potentials, Maxwell's Divergence equation for B, steady magnetic field laws, forces in magnetic field, force on a current element, force between two current elements, force and torque in a current loop.

4. The Electromagnetic field:

Faraday's law in integral and differential form (Maxwell's first curl equation for electro-magnetic field). The Lorentz force equation.
The concept of displacement current and modified ampere's law (Maxwell's 2^{nd} curl equation for electro- magnetic field), the continuity equation, power flow in an electromagnetic field, the boynting vector.
Sinusoidally time varying fields, Maxwell's equation for Sinusoidally time varying fields, Power and energy considerations for Sinusoidally time varying fields.
The retarded potentials, polarization of vector fields, review of Maxwell's equations.

5. **Materials and fields (review type only):**

Current and current density, the continuity equation, conductor in fields.
Dielectrics in fields: Polarization, flux density, electric susceptibility, relative permittivity, boundary conditions in perfect dielectrics, magnetic materials, magnetization, permeability, boundary conditions.

6. **Applied Electromagnetic I :**

Poisson's and Laplace's equations, solution of one-dimensional cases, general solution of Laplace's equation, method of images.

7. Applied Electromagnetic II:

Electromagnetic waves, the Helm Holtz Equation, wave motion in free space, wave motion in perfect lossy dielectrics, propagation in good conductors, skin effect. Reflection of uniform plane waves- co-efficient of reflection and refraction, characteristic impedance, Radiation of electromagnetic waves- half wave antenna.

8. Transmission line equations and parameters:

Some examples of transmission lines.

Books:

1. Hayt: Engineering Electromagnetics.
2. N. N. Rao: Basic Electromagnetics with applications.
3. Corson and Lofrain: Introduction to Electromagnetic Fields and waves.
4. Bradshaw and Byatt: Introductory Engineering Field Theory.
5. Nussbaum: Electromagnetic theory for engineers and scientists.