Kingdom of Saudi Arabia
Al-Imam Muhammad Ibn Saud Islamic University
Faculty of Sciences
Department of Physics

PHY 321 - Electromagnetic Theory

Course Code	Course Num.	Course Name	Credit Hours	Lec	Lab	Tut	Prerequisites
PHY	321	Electromagnetic Theory	3	3	0	1	PHY 220 – MAT 203

Learning Objectives

- Provide an understanding of the physical laws derived from the fundamental concepts of electricity and magnetism
- Apply the physical laws to solve simple problems in electro-magnetic theory.
- Develop the ability to analyze and interpret problems dealing with electromagnetic fields.
- Solve electromagnetic wave problems using Maxwell's equations for simple systems of charge and current distributions with boundary conditions.
- Apply vector calculus to understand the behavior of static electric fields in standard configurations.

Syllabus (52 Hours)

Vector Analysis (04 H) : Vector Algebra, Coordinate Systems and Transformation – Cartesian, Cylindrical and spherical coordinates, constant-coordinate surfaces, Vector Calculus – Differential length, area and volume, Line, surface and volume integrals, Del operator, Gradient of a scalar, Divergence of a vector, Divergence Theorem, Curl of a vector, Stoke's Theorem, Laplacian of a scalar, Classification of vector fields.

Electrostatics: Electrostatic Fields (06 H) – Coulomb's Law and field intensity, Electric fields due to continuous charge distributions, Electric flux density, Gauss's Law, Applications of Gauss's Law, Electric Potential, Relationship between E and V, Electric dipole, Energy density in Electrostatic fields.

Electric fields in material space (10 H) – Properties of materials, Convection and conduction currents, Conductors, Polarization in Dielectrics, Dielectric constant and strength, Linear, isotropic and homogeneous dielectrics, Continuity equation, relaxation time, Boundary conditions. Electrostatic Boundary value problems–Poisson's and Laplace's Equations, Uniqueness Theorem, Resistance and capacitance [Parallel-plate, coaxial, spherical capacitors].

Magnetostatics and Maxwell's equations (time varying field) (16 H):
Magnetostatic fields Lorentz Force Law – Biot-Savart's Law, Ampere's circuital law, Applications of Ampere's circuital law, Magnetic flux density, Magnetic scalar and vector potentials. Magnetic forces, Materials and devices – Forces due to magnetic fields, Magnetic torque and moment, Magnetic dipole, Magnetization in materials, Classification of Magnetic Materials, Magnetic boundary conditions, Inductors and inductances, Magnetic energy, Magnetic circuits. Faraday's Law, Displacement current, Time-harmonic fields, Maxwell's equations for static fields and time varying fields, Word statement.

Electromagnetic wave propagation (16 H) : Electromagnetic waves- Waves in 1D, ,Wave propagation in lossy dielectrics- Wave equations from Maxwell's equations, propagation constant, intrinsic impedance of the medium, complex permittivity, loss tangent, Plane waves in lossless dielectrics, Plane waves in free space – uniform plane wave, TEM wave, Plane waves in good conductors – skin effect, Poynting's Theorem, Reflection of a plane wave at normal incidence – standing waves, Reflection of a plane wave at oblique incidence – parallel and perpendicular polarization. Numerical Methods in Electromagnetics (Concepts) .

Text Book:

1. Elements of Electromagnetics by Matthew N.O. Sadiku, [Publisher: Oxford University Press Edition 2004]

Reference Books:

1- Introduction to Electromagnetic Fields by Clayton R.Paul, Keith W.Whites, Syed A.Nasar ,3rd Edition[Publisher: McGraw Hill Series].
2- Guru Hiziroglu, *Electromagnetic Field Theory Fundamentals* , Thomson ,2003.
3- Engineering Electromagnetics by William H.Hayt, JR and John A. Buck, 7th Edition [ISBN:007-124449-2, Publisher: McGraw-Hill , International Edition 2006]
4- Cheng, *Field and Wave Electromagnetics,* Pearson Education ,2005.
5- Joseph A. Edminister, *Electromagnetics*, Schaum series - McGraw Hill ,1993.