SHIV NADAR UNIVERSITY

UNDERGRADUATE COURSE PROPOSAL

I. COURSE TITLE: Classical Electrodynamics

II. COURSE CODE: PHY303

III. COURSE CREDITS (L:T:P): 3:1:0

IV. TOTAL CONTACT HOURS/ WEEK (L:T:P): 3:1:0

V. NO. OF BATCHES: 1

VI. COURSE TYPE (MAJOR/UWE/CCC): MAJOR/UWE

VII. PREREQUISITE/S (IF ANY): PHY103, PHY104, OR PHY101, PHY102 & PHY207

VIII. COURSE COORDINATOR(S)/INSTRUCTOR(S): Dr. Santosh Kumar

IX. SCHOOL/ DEPARTMENT: Natural Sciences/ Physics

X. DISCIPLINES TO WHICH THE COURSE MAY BE OF INTEREST: Mathematics, Engineering (some branches)

XI. COURSE CONTENT:

This is an advanced course in electrodynamics. Among other things, it covers techniques for solving partial differential equations encountered in solving Maxwell's equations, emphasizing the universal nature of these tools and their connection to underlying symmetries in the problem. It also covers the introductory relativistic electromagnetism.

Electrostatics

Review: Coulomb's and Gauss's laws, Electric field and scalar potential

Boundary value problem solving techniques: Separation of Variables (review), Green's function method

Multipole Expansion: Multipole expansion of electric potential using spherical harmonics, Multipole moments, Multipole expansion of the energy of a charge distribution in an external field

Electrostatics in Macroscopic Media, Dielectrics: Electric polarization, Electric displacement, Electric susceptibility, Boundary value problems: Point charge in a semi-infinite dielectric, Dielectric sphere in an electric field

Magnetostatics

Review: Biot-Savart and Ampere's laws, Magnetic field and vector potential

Magnetostatics in Macroscopic Media: Boundary value problems: Uniformly magnetized sphere, Magnetized sphere in an external field

Maxwell's Electromagnetism, Conservation Laws

Review: Maxwell's equations

Plane electromagnetic waves and wave propagation: Plane waves in a nonconducting medium, Poynting vector, Linear and Circular polarization, Stokes parameters, Electromagnetic waves in matter: Reflection and refraction at a plane interface between dielectrics, Electromagnetic waves in conductors: Reflection at a conducting surface, Frequency dependence of permittivity, Absorption, Dispersion

Waveguides: TE, TM and TEM waves, Rectangular wave guide, Coaxial transmission line

Potentials and Fields: Gauge transformations, Lorentz gauge and Coulomb gauge, Retarded and Advanced potentials, Fields of a moving point charge

Radiation: Electric dipole radiation, Magnetic dipole radiation, Power radiated by a point charge

Relativistic Electromagnetism

Preliminary ideas: Lorentz transformations, Four vectors and four tensors, Relativistic momentum and energy, Mathematical properties of space-time in special relativity

Electromagnetism: Electromagnetic field tensor, Maxwell's equations in covariant notation, Transformation of Electromagnetic fields, Lagrangian and Hamiltonian for a relativistic charged particle in external electromagnetic fields

XII. RECOMMENDED BOOK(S):

- *Classical Electrodynamics (Third Edition)*, J. D. Jackson
- *Classical Electrodynamics*, Walter Greiner
- *Introduction to Electrodynamics (Fourth Edition)*, D. J. Griffiths
- *Modern Electrodynamics*, A. Zangwill
- *Electricity and Magnetism*, Edward Mills Purcell

XIII. ASSESSMENT SCHEME

Quizzes (2):	30% (15% each)
Mid-Sem Examination:	30%
End-Sem Examination:	30%
Project/Assignment:	10%

Attendance Policy: As per the standard university policy.