Course Title	Course Code	Number of Study Hours				Year	Level	Prerequisites
		Theo.	Lab.	Credit	ECTS			
Classical Electrodynamics	PHYS602	3	-	3	9	1st	1st	-

Student's workload			
In-class activities	Contact Hours	Self-learning/study	Hours
Lectures	45	Preparation for classes	115
Laboratory	-	Case studies	-
Exams and quizzes	5	Working on lab experiment	-
Lab demo	-	HW/Assignments	42
		Study for exam	48
Total	50	Total	205
Total Learning Hours = 255		Equivalent ECTS points = Total LH/28 = 9	

BRIEF COURSE DESCRIPTION

- This course provides a rigorous foundation for advanced classical electrodynamics and some of its applications. It covers the physics and classical mathematics necessary to understand electromagnetic fields in materials and at surfaces and interfaces. Particular focus is given to time-dependent phenomena in which the calculation of the time-dependent scalar and vector potentials, and electric and magnetic fields, can be traced to the Green function formalism. The course develops a good knowledge on the Boundary–Value Problems in Electrostatics, Multipoles, Electrostatics of Macroscopic Media, Dielectric, Magnetostatics, Time-Varying Fields, Maxwell's Equations,

COURSE OBJECTIVES

The main objectives of this course are focused on the following:

1. Demonstrate knowledge of fundamental concepts of classical electrodynamics.
2. State and deal with the fundamental problems and theories of classical electrodynamics.
3. Develop physical intuition, mathematical reasoning, and problem-solving skills.
4. Apply the theory to discuss quantum phenomena quantitatively.
5. Solve a wide range of specific theoretical problems.

COURSE CONTENTS

- Introduction to Electrostatics: Coulomb's law, Electric field, Gauss's law, Differential form of Gauss's law, Scalar potential, Surface distributions of charges and dipoles, Poisson's and Laplace's equations, Green's theorem, Uniqueness theorem, Formal solution of boundary value problem, Green' functions, Electrostatic potential energy.
- Boundary–Value Problems in Electrostatics, I: Method of images, Point charge and a grounded conducting sphere, Point charge and a charged, insulated, conducting sphere, Point charge and a conducting sphere at fixed potential, conducting sphere in a uniform field, Method of inversion, Green's function for a sphere, Conducting sphere with hemispheres at different potentials, Orthogonal functions and expansions, Separation of variables in rectangular coordinates.
- Boundary-Value Problems in Electrostatics, II: Laplace's equation in spherical coordinates, Legendre polynomials, Boundary-value problems with azimuthal symmetry, Spherical harmonics, Addition theorem for spherical harmonics, Cylindrical coordinates, Bessel functions, Boundary-value problems in cylindrical coordinates, Expansion of Green's functions in spherical coordinates, Use of spherical Green's function expansion, Expansion of Green's functions in cylindrical coordinates.
- Multipoles, Electrostatics of Macroscopic Media, Dielectric: Multipole expansion, Multipole expansion of the energy of a charge distribution in an external field, Macroscopic electrostatics, Simple dielectrics and boundary conditions, Boundary–value problems with dielectrics, Molecular polarizability and electric susceptibility, Models for molecular polarizability, Electrostatic energy in dielectric media.
- Magnetostatics: Introduction and definitions, Biot and Savart law, Differential equations of Magnetostatics, Ampere's law, Vector potential, Magnetic induction of a circular loop of currents, Localized current distribution, magnetic moment, Force, and torque on localized currents in an external field, Macroscopic equations, Boundary conditions, uniformly magnetized sphere in an external field, Permanent magnets, Magnetic shielding.
- Time-Varying fields, Maxwell's Equations, Conservations Laws: Faraday's law of induction, Energy in the magnetic field, Maxwell's displacement current, Maxwell's equations, Vector and scalar potentials, wave equations, Gauge transformations, Green's function for the time dependent wave equation, Initial-value problem, Kirchhoff's integral representation, Poynting's theorem, Conservation laws, Macroscopic equations.

ASSESSMENT CRITERIA

- Mid-Term exams: 20 %
- Assignments, classroom activities: 30 %
- Final Exam: 50%

COURSE TEACHING STRATEGIES

- Lectures, Expository and Discovery, and Interactive Discussions.

TEXT BOOK	REFERENCE BOOKS
• J. D. Jackson, Classical electrodynamics, 3rd Edition, John Wiley and Sons, 1999.	• W. Greiner , Classical Electrodynamics, Springer-Verlag New York, Inc., 1998. • D. J. Griffith, Introduction to Electrodynamics, 4th Edition, Prentice Hall, 2013.