PHY3205: ELECTRODYNAMICS

Effective Term
Semester A 2022/23

Part I Course Overview

Course Title
Electrodynamics

Subject Code
PHY - Physics
Course Number
3205

Academic Unit
Physics (PHY)

College/School
College of Science (SI)

Course Duration
One Semester

Credit Units
3

Level
B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
AP2191/PHY2191 Electricity and Magnetism
MA2158 Linear Algebra and Calculus

Precursors
AP3204/PHY3204 Waves and Optics

Equivalent Courses
AP3205 Electromagnetism

Exclusive Courses
Nil

Part II Course Details

Abstract

The course is designed for the senior undergraduate students in the BSc Applied Physics program. The course will provide students basic knowledge of electrodynamics at the introductory level so that they can proceed to advanced courses in the BSc Applied Physics program. Mathematical tools such as vector calculus will be reinforced throughout the course.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Recognize and explain the physics laws governing the behaviour of electromagnetic quantities.			x	
2	Solve introductory level electrodynamics problems using vector calculus.			x	
3	Analyze electromagnetic problems using special mathematical techniques for physics.			x	
4	Relate theory of electromagnetism to electromagnetic field subjects.			x	

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Teaching and Learning Activities (TLAs)

	TLAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures/Student Centred Activities/	Explain key concepts, build mathematic foundation and analytical skills, provide examples and solutions of advanced problems in electromagnetism and electrodynamics	1, 2, 3, 4	3 hours/week

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Assignments	1, 2, 3, 4	20	
2	Test	1, 2, 3, 4	20	

Continuous Assessment (%)
40

Examination (%)
60

Examination Duration (Hours)
2

Additional Information for ATs
For a student to pass the course, at least 30% of the maximum mark for the examination must be obtained

Assessment Rubrics (AR)

Assessment Task
1. Assignment

Criterion
Capable to show a good understanding of the taught materials from solving the given problems.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not given enough efforts or unable to grasp the basic concept.

Assessment Task
2. Test

Criterion
Ability to solve common electromagnetics and electrodynamics problems.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not given enough efforts or unable to grasp the basic concept.

Assessment Task
3. Examination

Criterion
Ability to grasp the concept of the taught materials and to solve common electromagnetics and electrodynamics problems.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not given enough efforts or unable to grasp the basic concept.

Part III Other Information

Keyword Syllabus
Maxwell’s Equations, Laws of Conservation, Electromagnetic Waves and Relativistic Electrodynamics.

- Maxwell’s Equations
  Development of the Maxwell’s equations, Gauss’s law for electricity and magnetism, Faraday’s law, and Ampère’s law and it’s correction for electrodynamics.
- Conservative Law
  Continuity equation, Poynting’s theorem, Maxwell’s stress tensor and Conservation of momentum.
- Electromagnetic Waves
  EM waves propagation in vacuum and in matters with complex permittivity.
- Guided Waves
  EM waves propagation in dielectric and metallic waveguides. waveguide modes, polarization, and dispersion.
- Scalar and vector potentials, Gauge transformations, Retarded potentials
- Electric dipole radiation, Magnetic dipole radiation, Radiation by arbitrary localized source
- Scattering by small particles, Optical theorem, Optical forces
- Einstein’s postulates, Geometry of relativity, Lorentz transformation, Spacetime structure
- Proper time and proper velocity, Relativistic energy and momentum, Relativistic kinematics, Relativistic dynamics
- Lorentz transformation of electromagnetic fields, Field tensor, Electrodynamics in tensor notations, Relativistic potentials

Reading List

Compulsory Readings

	Title
1	Nil

Additional Readings

	Title
1	David J Griffiths, “Introduction to electrodynamics”, Prentice Hall.
2	John David Jackson, “Classical electrodynamics”, Wiley.