Course Specification

(Postgraduate Programs)

Course Title: Electrodynamics
Course Code: PHYS613
Program: Master of Science in Physics
Department: Physics
College: College of Sciences
Institution: Majmaah University
Version: 1
Last Revision Date: 12/2024

Table of Contents

A. General information about the course:

1. Course Identification

1. Credit hours: (3)					
2. Course type					
A.	☐University	☐College	☒Department	☐Track	☐Others
B.	☒Required		☐Elective		
3. Level/year at which this course is offered: (1st/1)					
4. Course general Description:					
Classical electrodynamics is essential from both the fundamental and applied viewpoints. This course aims to provide students with an introduction to the principles and behaviours of dynamical electric and magnetic systems, as well as a theoretical foundation in classical field theory. The course will cover classical electromagnetism in both microscopic and macroscopic forms, electromagnetic fields and forces between charged particles, and applications to electrostatic, magnetostatic, electrodynamic, and radiation problems.					
5. Pre-requirements for this course (if any):					
none					
6. Co-requisites for this course (if any):					
none					
7. Course Main Objective(s):					
• Use a range of mathematical techniques for solving challenging problems in electrodynamics. • Create and interpret visual representations of electromagnetic fields and potentials. • Gain physical insight from mathematical expressions of energy, momentum, and charge conservation. • Apply boundary conditions to solve reflection and transmission problems involving dielectric and conducting materials. • Express scalar and vector potentials in different gauges, and use them to compute time-dependent electromagnetic fields Modern technology to understand Physics and physical phenomena is critical, e.g. 1. Experimental or Theoretical Modeling					

2. Equipment and Computer Interfacing to Collect and Process Data
3. Computer Simulations and Graphics
4. Research/Reference/Presentation, Reporting, and Displaying Information
5. Use of digital libraries like the Saudi Digital Library (SDL)

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	45	100%
2	E-learning		
3	Hybrid • Traditional classroom • E-learning		
4	Distance learning		

3. Contact Hours (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	45
2.	**Laboratory/Studio**	
3.	**Field**	
4.	**Tutorial**	
Total		**45**

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Code of PLOs aligned with program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	Understand the origin of Maxwell's equations in magnetic and dielectric media.	K1	Lectures-Class discussions	Exams-Writing reports
1.2	Understand transport of energy and the Poynting vector	K1	Lectures-Class discussions	Exams-Writing reports
1.3	Understand transport of momentum, Maxwell stress	K3	Lectures-Class discussions	Exams-Writing reports

	tensor, and radiation pressure.			
1.4	Write down Maxwell's equations in linear, isotropic, homogeneous media	K3	Lectures-Class discussions	Exams-Writing reports
2.0	**Skills**			
2.1	Derive continuity conditions on electromagnetic fields at boundaries	S2	Solving Problems-Class Discussions-Presentations	EXAMS Assignment Quizzes-Observation
2.2	Obtain scalar and vector potential equations in the presence of sources. Understand gauge invariance of Maxwell's equations.	S2	Solving Problems-Class Discussions-Presentations	EXAMS Assignment Quizzes-Observation
2.3	Derive electromagnetic wave solutions and propagation in dielectric and other media.	S4	Solving Problems-Class Discussions-Presentations	EXAMS Assignment Quizzes-Observation
2.4	decoupling of scalar and vector potential equations in the Lorentz gauge and corresponding solutions	S4	Solving Problems-Class Discussions-Presentations	EXAMS Assignment Quizzes-Observation
3.0	**Values, autonomy, and responsibility**			
3.1	Use information technology and modern computer tools to locate and retrieve scientific information relevant to Electrodynamics.	V1	Presentations-Small group supervisions	Small projects Presentations Survey
3.2	Work effectively in groups as well as individuals	V2	Presentations-Small group supervisions	Small projects Presentations Survey

C. Course Content

No	List of Topics	Contact Hours
1.	Electrodynamics: Electromotive force, Electromagnetic induction, Maxwell's equations, Maxwell's equations in matter, Boundary conditions, Conservation Laws: Charge and energy, the continuity equations, Poynting's theorem, Maxwell's stress tensor, conservation of momentum	12
2.	Potentials and Fields: Scalar and vector potentials, Gauge transformations, Coulomb Gauge and Lorentz Gauge, Lienard-Wiechert Potentials, The Fields of a Moving Point Charge, Radiation: Dipole	21

	Radiation, Electric Dipole Radiation, Magnetic Dipole Radiation, Power radiated by a point charge, The mechanism responsible for radiation reaction.	
3.	Electrodynamics and relativity: The Special Theory of Relativity, The Lorentz Transformations, Relativistic Energy and momentum, Relativistic Kinematics, Magnetism as a Relativistic Phenomena, How the Fields transform, Electrodynamics in Tensor Notation, Relativistic Potentials,	12
Total		**45**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	Homework (Assignment , Problem solving),	Each unit	10%
2.	Mid-term-1 Examination	week 7	15%
3.	Quiz	6, 11)	10%
4.	Mid-term-2 Examination	week 12	15%
5.	Small Project	one per semester	10%
6.	Final Examination	at end of Semester	40%

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	Introduction to Electrodynamics (4th edition), David J. Griffiths, Pearson Education, 2015
Supportive References	Classical Electrodynamics (3rd edition), John David Jackson, Wiley, 1998
Electronic Materials	Saudi Digital Library (SDL) • https://www.wikipedia.org/ • Web of Knowledge • Physics Today (web version) • MIT Courseware
Other Learning Materials	Class presentation • Desire to learn (Black Board) Equipment manuals/handout • Software manuals/ user guide

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	Classroom (must be the same for the same subject) Seminar room • Computer lab for (e-Quiz)

Technology equipment (projector, smart board, software)	Black Board software / login • MS software suite • Origin Graphic software • Smart board with maintains feedback • White board
Other equipment (depending on the nature of the specialty)	Black Board software / login • MS software suite • Origin Graphic software • Smart board with maintains feedback • White board

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Student	Indirect
Effectiveness of Students assessment	Instructor	Direct
Quality of learning resources	Department Examination Committee	Direct
The extent to which CLOs have been achieved	Program Leaders	Indirect

Assessors (Students, Faculty, Program Leaders, Peer Reviewers, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	Physics Department
REFERENCE NO.	16
DATE	30/12/2024