Course Specification

(Postgraduate Programs)

Course Title:	Classical Electrodynamics
Course Code:	PHY 6121
Program:	Master of Science in Physics
Department:	Physics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University
Version:	3
Last Revision Date:	*26/09/2024*

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A. General information about the course:

1. Course Identification:

1. Credit hours: 4				
2. Course type				
A.	☐ University	☐ College	☒ Department	☐ Track
B.	☒ Required		☐ Elective	
3. Level/year at which this course is offered: Level 1/Year 1				

4. Course General 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, Conservations Laws.

5. Pre-requirements for this course (if any): None

6. Pre-requirements for this course (if any): None

7. Course Main Objective(s):

At the end of this course, students will be able to:

- Demonstrate knowledge of fundamental concepts of classical electrodynamics;
- State the fundamental problems and theories of classical electrodynamics;
- Find in classical electrodynamics a wholly new and counterintuitive way of thinking about the world;
- Develop physical intuition, mathematical reasoning, and problem solving skills;
- Deal with conceptually rich and technically difficult theoretical problems;
- Know how to use the theory to discuss quantum phenomena quantitatively;
- Have learned the techniques to solve, through discussion and reading, a wide range of specific theoretical problems, including their backgrounds and implications;

- **Have experienced the adept application of physics and mathematics to solve real life problems.**

2. Teaching Mode: (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	75	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**	**0**
3.	**Field**	**0**
4.	**Tutorial**	**30**
5.	**Others (specify)……**	**0**
	Total	**75**

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

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	**Outline the background and main features of the historical development of classical electrodynamics.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.2	**State the physical phenomena of classical electrodynamics.**	**K1, K3**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	**Define expressions for the energy both for the electrostatic and Magnetostatics fields, and derive Poyntings theorem from Maxwell's equations.**	**K1**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**			
2.1	**Explain and summarize the basic knowledge gained from studying classical electrodynamics course.**	**S1, S2**	• Lectures. • Class discussions. • Tutorials.	▪ Exams. ▪ Discussions. ▪ Participation.
2.2	**Develop the students ability to solve and analyze problems in physics related the topics covered by the course.**	**S2, S3**	• Problem classes and group tutorial. • Homework assignments as well as problems solutions.	▪ Exams. ▪ Discussions. ▪ Homework.
2.3	**Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.**	**S4**	• Lectures. • Class discussions. • Tutorials. • Encourage students to use electronic mail and internal network for submitting homework and assignments. • Use digital library.	▪ Exams. ▪ Participation and activities of students in the course community and blackboard. ▪ Homework.
3.0	**Values, autonomy, and responsibility**			
3.1	**Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.**	**V1, V2, V3**	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation. ▪ Homework. ▪ Mini-project(s).

C. Course Content:

No	List of Topics	Contact Hours
1.	**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.	12
2.	**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.	14
3.	**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 harmoics, Cylindrical coordinates, Bessel functions, Boundary-value problems in cylindrical coordinates, Expansion of Green's functions in spherical coordinates, Use of spherical Grren's function expansion, Expansion of Green's functions in cylindrical coordinates.	13
4.	**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 polarizabilty, Electrostatic energy in dielectric media.	12
5.	**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.	12
6.	**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.	12
	Total	**75**

D. Students Assessment Activities:

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	Class Activities (class quizzes, homework, solving problems, etc......)	weekly	20 %
2.	Midterm Exam 1	6th week	20 %
3.	Midterm Exam 2	12th week	20 %
4.	Final Exam	16th week	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	*-J.D. Jackson, Classical electrodynamics, 3rd Edition, John Wiley and Sons, 1998.*
Supportive References	*-W. Greiner , Classical Electrodynamics, Springer-Verlag New York, Inc., 1998.* *-D. J. Griffith, Introduction to Electrodynamics, 4th Edition, Prentice Hall, 2013*
Electronic Materials	https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx
Other Learning Materials	Multimedia associated with the textbook and the relevant websites.

2. Educational and Research Facilities and Equipment Required:

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	- Classrooms
Technology equipment (Projector, smart board, software)	- Classroom equipped with a whiteboard and a projector.
Other equipment (Depending on the nature of the specialty)	

F. Assessment of Course Quality:

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	- Students. - Second examiner.	Indirect (The student will complete evaluation forms at the end of semester. Final exam is

Assessment Areas/Issues	Assessor	Assessment Methods
		evaluated by the second examiner)
Effectiveness of students' assessment	- Instructors.	Direct (exams, HW, project, ...)
Quality of learning resources	- Faculty. - Students.	Indirect (surveys)
The extent to which CLOs have been achieved	- Instructors. - Program Leaders.	Direct (excel sheet)
Other		

Assessor (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval Data:

COUNCIL /COMMITTEE	Quality Unit-Physics Department
REFERENCE NO.	Department council No. 6
DATE	26/09/2024