Form: Course Syllabus	**Form Number**	EXC-01-02-02A
	Issue Number and Date	2/3/24/2022/2963 05/12/2022
	Number and Date of Revision or Modification	
	Deans Council Approval Decision Number	2/3/24/2023
	The Date of the Deans Council Approval Decision	23/01/2023
	Number of Pages	06

1.	**Course Title**	Classical Electrodynamics-3
2.	**Course Number**	0302982
3.	**Credit Hours (Theory, Practical)**	(3,0)
	Contact Hours (Theory, Practical)	(3,0)
4.	**Prerequisites/ Corequisites**	0332953
5.	**Program Title**	
6.	**Program Code**	Ph.D. in Physics
7.	**School/ Center**	Science
8.	**Department**	Physics
9.	**Course Level**	PhD
10.	**Year of Study and Semester (s)**	2017, Fall
11.	**Other Department(s) Involved in Teaching the Course**	
12.	**Main Learning Language**	
13.	**Learning Types**	☒Face to face learning ☐Blended ☐Fully online
14.	**Online Platforms(s)**	☐Moodle ☐Microsoft Teams
15.	**Issuing Date**	30/1/2018
16.	**Revision Date**	28/1/2025

17. Course Coordinator:

Name: Mohammad Hussein Contact hours: Sunday, Tuesday 13.30-14.30

Office number: 08 Phone number: 22023

Email: m.hussein@ju.edu.jo

18. Other Instructors:

Name:

Office number:

Phone number:

Email:

Contact hours:

Name:

Office number:

Phone number:

Email:

Contact hours:

19. Course Description:

The course PHY 982 represents the final segment of a three-part series focused on the classical theory of electrodynamics. Upon successful completion of PHY 982, students are well-prepared to progress to the next logical phase in their studies, which is the quantum theory of electrodynamics, specifically QED - PHY 0332958. This course is divided into two primary components: the study of magnetohydrodynamics and plasma physics, and the examination of how electromagnetic radiation scatters when interacting with various media. The curriculum is structured to ensure a balanced emphasis on grasping the fundamental aspects of electromagnetic theory while also developing expertise in highly advanced mathematical techniques. The course is designed for second-year graduate students who have successfully completed the second part of the EM series, Classical Electrodynamics-2 course, PHY 953.

20. Program Intended Learning Outcomes: (To be used in designing the matrix linking the intended learning outcomes of the course with the intended learning outcomes of the program)

1. To be able to demonstrate an advanced and comprehensive understanding of core physics concepts and specialized knowledge in a chosen field of research, contributing to the frontier of physics.
2. To be able to develop and execute independent, original research projects that address complex scientific problems, advancing theoretical and experimental physics.
3. To be able to apply advanced mathematical and computational techniques to analyze complex physical phenomena and critically evaluate scientific literature and experimental results.
4. To be able to effectively communicate complex physics concepts, research findings, and their significance through academic writing, presentations, and public outreach.

5. To be able to adhere to high ethical standards and professional responsibility in conducting research, including data integrity, ethical treatment of subjects, and the responsible use of resources.
6. To be able to demonstrate leadership and collaborative skills within multidisciplinary teams, contributing to the development of new scientific knowledge and promoting knowledge-sharing across disciplines.
7. To be able to cultivate the ability to adapt to new scientific advancements and continuously engage in professional development to contribute to innovation in the field of physics.
8. To be able to master experimental and computational techniques relevant to the research field, demonstrating competency in operating and developing specialized physics instrumentation and software.

21. Course Intended Learning Outcomes: (Upon completion of the course, the student will be able to achieve the following intended learning outcomes)

1. Derive the magnetohydrodynamic equations.
2. Determine the magnetic Reynolds number, and derive the magnetic diffusion equation.
3. Illustrate the magnetohydrodynamic flow between boundaries with crossed electric and magnetic fields.
4. Investigate the principle of the pinch effect.
5. Provide a complete derivation for the magnetohydrodynamic waves; Alfven waves.
6. Analyze in detail plasma oscillations and determine its limit; the Debye screening length.
7. Analyze the scattering of EM waves by systems whose dimensions are small compared with a wavelength: scattering in the long-wavelength limit.
8. Derive Rayleigh's law and the extinction coefficient.
9. Mie scattering from a dielectric sphere: calculate the total cross section in the long-wavelength limit.
10. Analyze the scattering of EM waves in the short-wavelength limit: compare the shadow scattering amplitude with the reflected amplitude, and derive the differential scattering cross section.
11. Investigate the scalar diffraction theory: derive Kirchhoff integrals and its operative approximations.
12. Obtain the vectorial Kirchhoff integral for EM fields to analyze the vector diffraction theory: Smythe-Kirchhoff integral.
13. The energy transfer to a harmonically bound charge: derivation of the classical and the quantum mechanical energy-loss formulae.
14. Investigate the density effect in energy loss and the emission of Cherenkov radiation.
15. Ginsburg-Frank radiation: an approximate calculation of the transition radiation.
16. Derive the differential cross section of fast particles scattered by atoms using Fermi-Thomas potential.
17. Derive Thomson cross section, and compare it with Rayleigh cross section.

18. Provide a complete calculation of the radiation cross section during atomic collisions; Bremsstrahlung. Based on the momentum transfer Q, the cross section is determined for the following physical circumstances:
    18.1 Classical Bremsstrahlung.
    18.2 Nonrelativistic Bremsstrahlung.
    18.3 Relativistic Bremsstrahlung.
    18.4 Relativistic Bremsstrahlung by a Lorentz transformation.

Course ILOs	The learning levels to be achieved					
	Remembering	**Understanding**	**Applying**	**Analysing**	**evaluating**	**Creating**
1		✓	✓	✓		
2		✓	✓	✓		
3		✓	✓	✓		
4		✓	✓	✓		
5		✓	✓	✓		
6		✓	✓	✓		
7		✓	✓	✓		
8		✓	✓	✓		
9		✓	✓	✓		
10		✓	✓	✓		
11		✓	✓	✓		
12		✓	✓	✓		
13		✓	✓	✓		
14		✓	✓	✓		
15		✓	✓	✓		
16		✓	✓	✓		

17		✓	✓	✓		
18		✓	✓	✓		

2٢. The matrix linking the intended learning outcomes of the course with the intended learning outcomes of the program:

Program ILOs / Course ILOs	ILO (1)	ILO (2)	ILO (3)	ILO (4)	ILO (5)	ILO (6)	ILO (7)	ILO (8)
1	✓	✓	✓	✓				
2	✓	✓	✓	✓				
3	✓	✓	✓	✓				
4	✓	✓	✓	✓				
5	✓	✓	✓	✓				
6	✓	✓	✓	✓				
7	✓	✓	✓	✓				
8	✓	✓	✓	✓				
9	✓	✓	✓	✓				
1	✓	✓	✓	✓				
11	✓	✓	✓	✓				
12	✓	✓	✓	✓				
13	✓	✓	✓	✓				
14	✓	✓	✓	✓				
15	✓	✓	✓	✓				
16	✓	✓	✓	✓				
17	✓	✓	✓	✓				
18	✓	✓	✓	✓				

2٣. Topic Outline and Schedule:

Week	Lecture	Topic	ILO/s Linked to the Topic	Learning Types (Face to Face/ Blended/ Fully Online)	Platform Used	Synchronous / Asynchronous Lecturing	Evaluation Methods	Learning Resources
1	1.1	Derive the magnetohydrodynamic equations.	1					
	1.2							
	1.3							
2	2.1	-Determine the magnetic Reynolds number, and derive the magnetic diffusion equation. -Illustrate the magnetohydrodynamic flow between boundaries with crossed electric and magnetic fields.	2,3					
	2.2							
	2.3							
3	3.1	Investigate the principle of the pinch effect.	4					
	3.2							
	3.3							
4	4.1	Provide a complete derivation for the magnetohydrodynamic waves; Alfven waves.	5					
	4.2							
	4.3							
5	5.1	Analyze in detail plasma oscillations and determine its limit; the Debye screening length.	6					
	5.2							
	5.3							
6	6.1	Analyze the scattering of EM waves by systems whose dimensions are small compared with a wavelength: scattering in the long-wavelength limit.	7					
	6.2							
	6.3							
7	7.1	-Derive Rayleigh's law and the extinction coefficient. -Mie scattering from a dielectric sphere: calculate the total cross section in the long-wavelength limit.	8,9					
	7.2							
	7.3							
8	8.1	Analyze the scattering of EM waves in the short-wavelength limit: compare the shadow scattering amplitude with the reflected	10					
	8.2							
	8.3							

		amplitude, and derive the differential scattering cross section.						
9	9.1	-Investigate the scalar diffraction theory: derive Kirchhoff integrals and its operative approximations. -Obtain the vectorial Kirchhoff integral for EM fields to analyze the vector diffraction theory: Smythe-Kirchhoff integral.	11, 12					
	9.2							
	9.3							
10	10.1	The energy transfer to a harmonically bound charge: derivation of the classical and the quantum mechanical energy-loss formulae.	13					
	10.2							
	10.3							
11	11.1	-Investigate the density effect in energy loss and the emission of Cherenkov radiation. -Ginsburg-Frank radiation: an approximate calculation of the transition radiation.	14, 15					
	11.2							
	11.3							
12	12.1	Derive the differential cross section of fast particles scattered by atoms using Fermi-Thomas potential.	16					
	12.2							
	12.3							
13	13.1	Derive Thomson cross section, and compare it with Rayleigh cross section.	17					
	13.2							
	13.3							
14	14.1	Provide a complete calculation of the radiation cross section during atomic collisions; Bremsstrahlung. Based on the momentum transfer Q, the cross section is determined for the following physical circumstances: 18.1 Classical Bremsstrahlung. 18.2 Nonrelativistic Bremsstrahlung.	18.1, 18.2					
	14.2							
	14.3							
15	15.1	Provide a complete calculation of the radiation cross section during atomic collisions; Bremsstrahlung. Based on the momentum transfer Q, the cross section is determined for the following physical circumstances: 18.3 Relativistic Bremsstrahlung. 18.4 Relativistic Bremsstrahlung by a Lorentz transformation.	18.3, 18.4					
	15.2							
	15.3							

2٤. Evaluation Methods:

Opportunities to demonstrate achievement of the ILOs are provided through the following assessment methods and requirements:

Evaluation Activity	Mark	Topic(s)	ILO/s Linked to the Evaluation activity	Period (Week)	Platform
First Exam	25		1,2,3,4,5,6	7	On campus
Second Exam	35		7,8,9,10,11,12,13,14,15,16,17	13	On campus
Final Exam	40		1,2,3,4,5,6,7,8,9,10,11,12,13,14, 15, 16,17,18	15	On campus

2٥. Course Requirements:

(e.g.: students should have a computer, internet connection, webcam, account on a specific software/platform…etc.):

N/A

2٦. Course Policies:

A- Attendance policies: According to JU by-laws.

B- Absences from exams and submitting assignments on time: According to JU by-laws.

C- Health and safety procedures: N/A

D- Honesty policy regarding cheating, plagiarism, misbehavior: According to JU by-laws.

E- Grading policy: According to JU by-laws.

F- Available university services that support achievement in the course: N/A

2٧. References:

A- Required book(s), assigned reading and audio-visuals:

Text:
1. Classical Electrodynamics, by J. D. Jackson, 3^{rd} edition, John Wiley & Sons 1999, ISBN 0-471-30932-X.
2. Classical Electrodynamics, by K. Milton & J. Schwinger, 2^{nd} edition, CRC Press 2024, ISBN: 978-0-367-50207-2.

B- Recommended books, materials, and media:

References: Suggested titles include, but are not limited to:
-Modern Electrodynamics, by A. Zangwill, 1^{st} edition, Cambridge University Press 2013, ISBN 978-1-108-47322-4.
-Principles of Electrodynamics, by Melvin Schwartz, 1^{st} edition, Dover Publications 1987, ISBN 10:0-486-65493-1.
-Classical Electromagnetism in a Nutshell, by A. Garg, 1^{st} edition, Princeton University Press 2012, ISBN-13: 978-0-691-13018-7.

2٨. Additional information:

Name of the Instructor or the Course Coordinator: Mohammad Hussein
Signature:

Date: 28/1/2025

Name of the Head of Quality Assurance Committee/ Department
……………………………………………………
Signature: ………………………………
Date: ……………………

Name of the Head of Department
……………………………………………………
Signature: ………………………………
Date: ……………………

Name of the Head of Quality Assurance Committee/ School or Center
……………………………………………………
Signature: ………………………………
Date: ……………………

Name of the Dean or the Director
……………………………………………………
Signature: ………………………………
Date: ……………………