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
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	Number of Pages	06

1.	**Course Title**	Classical Electrodynamics-2
2.	**Course Number**	0332953
3.	**Credit Hours (Theory, Practical)**	(3,0)
	Contact Hours (Theory, Practical)	(3,0)
4.	**Prerequisites/ Corequisites**	
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)**	2018, Spring
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**	30/5/2018
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
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18. Other Instructors:

Name:

Office number:

Phone number:

Email:

Contact hours:

Name:

Office number:

Phone number:

Email:

Contact hours:

19. Course Description:

This course aims to provide a comprehensive analysis of the electromagnetic radiation produced by localized oscillating systems and accelerating point charges, including both free and bound charges. 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 first-year graduate students who have successfully completed the Classical Electrodynamics-1 course, PHY 0362753.

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. Solve for the vector potential in the Lorenz gauge, assuring the causal behavior of the fields.
2. Set up three spatial regions of interest for the fields of localized oscillating sources.
3. Provide a complete derivation for the power radiated by electric dipole sources.
4. Provide a complete derivation for the power radiated by magnetic dipole sources.
5. Provide a complete derivation for the angular distribution of the power radiated by electric quadrupole sources, and the total power as well.
6. Calculate the angular distribution for the power radiated by short center-fed linear antenna.
7. Establish the multipole expansion of the EM fields using the vector spherical harmonic as a basis.
8. Determine the vector multipole expansion of EM fields.
9. Derive the general formulae for both electric and magnetic multipole coefficients.
10. Use the multipole expansion to calculate the power radiated by a center-fed linear antenna.
11. Review the key aspects of the kinematics and dynamics of the special theory.
12. Investigate the covariance of electrodynamics.
13. Derive thoroughly the Lienard-Wiechert fields for a point charge.
14. Derive Larmor's formula for an accelerated charge, and its relativistic generalization; Lienard’s formula.
15. Analyze the angular distribution of radiation emitted by an accelerated charge.
16. Derive Thomson cross section, and compare it with Rayleigh cross section.
17. Derive Abraham-Lorentz equation for the radiation reaction effects.
18. Determine the level shift and the line width for a radiation oscillator.
19. Investigate the density effect in energy loss and the emission of Cherenkov radiation.

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		✓	✓	✓		
19		✓	✓	✓		

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	✓	✓	✓	✓				
19	✓	✓	✓	✓				

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	-Solve for the vector potential in the Lorenz gauge, assuring the causal behavior of the fields.	1,2					
	1.2							
	1.3							

		-Set up three spatial regions of interest for the fields of localized oscillating sources.						
2	2.1	-Provide a complete derivation for the power radiated by electric dipole sources. -Provide a complete derivation for the power radiated by magnetic dipole sources.	3,4					
	2.2							
	2.3							
3	3.1	Provide a complete derivation for the angular distribution of the power radiated by electric quadrupole sources, and the total power as well.	5					
	3.2							
	3.3							
4	4.1	Calculate the angular distribution for the power radiated by short center-fed linear antenna.	6					
	4.2							
	4.3							
5	5.1	Establish the multipole expansion of the EM fields using the vector spherical harmonic as a basis.	7					
	5.2							
	5.3							
6	6.1	-Determine the vector multipole expansion of EM fields. -Derive the general formulae for both electric and magnetic multipole coefficients.	8,9					
	6.2							
	6.3							
7	7.1	Use the multipole expansion to calculate the power radiated by a center-fed linear antenna.	10					
	7.2							
	7.3							
8	8.1	-Review the key aspects of the kinematics and dynamics of the special theory. -Investigate the covariance of electrodynamics.	11, 12					
	8.2							
	8.3							
9	9.1	Derive thoroughly the Lienard-Wiechert fields for a point charge.	13					
	9.2							
	9.3							
10	10.1	Derive Larmor's formula for an accelerated charge, and its relativistic generalization; Lienard's formula.	14					
	10.2							
	10.3							
11	11.1	Analyze the angular distribution of radiation emitted by an accelerated charge.	15					
	11.2							
	11.3							
12	12.1	Derive Thomson cross section, and compare it with Rayleigh cross section.	16					
	12.2							
	12.3							
13	13.1	Derive Abraham-Lorentz equation for the radiation reaction effects.	17					
	13.2							
	13.3							
14	14.1		18					

	14.2	Determine the level shift and the line width for						
	14.3	a radiation oscillator.						
15	15.1		19					
	15.2	Investigate the density effect in energy loss and						
	15.3	the emission of Cherenkov radiation.						

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	30		1,2,3,4,5,6,7,8,9,10	8	On campus
Second Exam	30		11,12,13,14,15,16	13	On campus
Final Exam	40		1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16, 17,18,19	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, 3rd edition, John Wiley & Sons 1999, ISBN 0-471-30932-X.
2. Classical Electrodynamics, by K. Milton & J. Schwinger, 2nd 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, 1st edition, Cambridge University Press 2013, ISBN 978-1-108-47322-4.
-Principles of Electrodynamics, by Melvin Schwartz, 1st edition, Dover Publications 1987, ISBN 10:0-486-65493-1.
-Classical Electromagnetism in a Nutshell, by A. Garg, 1st 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: ……............