COURSE OUTLINE **PHYSICS 621 (**Section 101) **Fall 2025**

Class Schedule:

Class: Classical Electrodynamics
Day and Time: Thursday and 6:00-8:50 pm
Room: Faculty Memorial Hall 116
Delivery Mode: Face-to-Face (Delivery of instruction is structured around in-person classroom meeting times. Instruction is delivered in person and students are expected to attend class).

General Information

This course is a graduate-level introduction to classical electrodynamics, intended for students who have already completed a senior-level undergraduate course in electromagnetism. The primary goal is to develop sufficient knowledge and proficiency in classical electrodynamics—from Coulomb's law through Maxwell's equations—to apply these concepts in research. As a graduate-level course, emphasis is placed on understanding the physical significance of the formulas rather than rote memorization. A solid background in mathematics, including vector calculus, differential equations, Fourier analysis, and linear algebra, is required. In this course, we will work through a few practice problems every time to enhance and develop problem-solving skill.

Learning Outcome

A shift from rote memorization to deep understanding of physics: This course emphasizes conceptual mastery over memorization. Students will learn to derive, analyze, and apply the principle of classical electrodynamics with mathematical rigor and physics insight.

1. Fundamental Understanding

1-1. Explain the theoretical foundations of classical electrodynamics, from Coulomb's law to Maxwell's equations, with mathematical rigor.
1-2. Demonstrate a clear conceptual and mathematical understanding of fundamental principles, including the physical meaning and derivations of the key equations.

2. Problem Solving and Analysis

2-1. Apply advanced mathematical techniques — such as vector calculus, Fourier analysis, Green's functions, and differential equations — to analyze and solve complex problems in electrodynamics.
2-2. Critically evaluate problem-solving strategies and validate solutions for consistency with physical principles.

3. Applications

3-1. Apply the laws of electrodynamics to individual research problems in physics, astrophysics, or related fields.
3-2. Develop the ability to independently advance research by integrating theoretical concepts with analytical and computational methods.

Instructor Information

Instructor: Satoshi Inoue
Center for Solar-Terrestrial Research (CSTR), New Jersey Institute of Technology (NJIT)
Major: Plasma Physics, Solar Physics, Magnetohydrodynamics (MHD), MHD simulation.
Office: 423C (Tiernan Hall)
Office Hour: Monday (1:30-3:30 pm) in person or virtual.
Phone: 973-642-4059
E-Mail: Satoshi.Inoue@njit.edu
URL: http://inosato78.wixsite.com/inosatopage

1)<u>Textbook</u> Jackson, J. D., “Classical Electrodynamics”, 3rd edition, J. Wiely is primarily used. David J. (Griffiths, “Introduction to Electrodynamics” 4th Edition will be also used in conjunction with Jackson book.) I strongly recommend the students to have Griffiths book.

2) <u>Lecture Quiz;</u> The Quiz is given at the beginning of the class.

3) <u>Homework</u>; Homework will be assigned weekly.

4) **<u>Attendance;</u>** I will not be taking an attendance.

5)<u>Midterm and Final Exam;</u> The Midterm exam will be asked from Chapters 1-3, and the Final exam will be asked from Chapters 4– 6 (Depending on the situation, the Final exam will be asked from the whole area, Chapters 1-6). **Review the slides, separately distributed problems, and quiz**.

Final Letter Grades: Here are the approximate weights to be used for calculating the composite score:

- **70%** for the midterm and final exams (35% for each)
- **15% f**or quiz given at the begging or during the class.
- **10%** for homework work
- **5%** for the final report

The cutoff percentages for various letter grades will be:

Percentage	Letter Grade
> 80%	A
75 - 80	B+
70 – 75	B
65 - 70	C+
55 - 65	C
< 55	F

<u>Final grades are not negotiable: A score of 79.99% is a B+, not an A.</u>

TOPIC	TEXT STUDIES	NOTES
Week 1 (9/4/25)	Chapter1	Coulomb’s law, Electric Field, Gauss’s law. Scalar Potential
Week 2 (9/11/25)	Chapter 1	Scalar Potential, Capacitance
Week 3 (9/18/25)	Chapter 1	Properties of Poisson Equation, Green function
Week 4 (9/25/25)	Chapter 2	Conductor, Method of image
Week 5 (10/2/25)	Chapter 2	Method of image, orthogonal functions and expansions.
Week 6 (10/9/25)	Chapter 2-3	Boundary value problems I.
Week 7 (10/16/25)	Chapter 3	Boundary value problems II.
Week 8 (10/23/25) Midterm Exam (Chapters 1-3)		Coulomb’s law – Boundary value Problems (Lecture note 1-4)

Week 9 (10/30/25)	Chapter 4	Multipoles, Dielectric.
Week 10 (11/6/25)	Chapter 5	Magnetic field, Biot-Savart Law, Electric current density, Ampere's law
Week 11 (11/13/25)	Chapter 5	Vector potential, Lorentz force, Multipole expansion,
Week 12 (11/20/25)	Chapter 5	Magnetized object,
Week 13 (11/**25**/25)	Chapter 5	Friday's law, Inductance
Week 14 (12/4/25)	Chapter 5-6	Inductance, Maxwell equations
Week 14 (12/11/25)	Chapter 6	Maxwell equations