Department of Physics, IIT Kanpur

PHY552 (Classical electrodynamics) 3-1-0-0-11

02/01/2026

Objectives:

- Aim of this course is to discuss basic and some advanced concepts of electrodynamics and to highlight their implications on our understanding of the natural phenomena.
- During the course we shall revisit the fundamental principles of electrostatics and magnetostatics while also discussing some standard problems demonstrating the power and usefulness of new mathematical tools developed during the course. We shall also discuss time-dependent behavior of electric and magnetic fields and their inter-relations.
- Lecture delivery will be of interactive nature and participation from the students is encouraged and required.

Prerequisites:

There are no official prerequisites for the course, however the students are strongly advised to revise their concepts from earlier electricity and magnetism courses (equivalent to PHY113) done at BSc/BS level. BS/BT students must have finished PHY113 prior to registering for this course. If found otherwise, their registration may be cancelled during the course.

Course Contents:

1. Basic Laws of Electrodynamics: Maxwell's equations, scalar and vector potentials
2. Boundary Value Problems: Dirichlet and Neumann Boundary Conditions
3. Formal Solution of the Poisson Equation Using the Green Function
4. Method of Images, Construction of the Green Function from Images
5. Laplace Equation as Boundary Value Problem in electrostatics, applications
6. Electric Multipole Expansion
7. Electric polarization
8. Boundary value problems in magnetostatics
9. Multipole Magnetic Moments
10. Generalized Ampere's Law in Material Media
11. Energy and Momentum Conservation: Poynting Theorem

12. Electromagnetic waves in vacuum and in dielectric media
13. Polarization
14. Stokes parameters, Fresnel equation
15. Electromagnetic wave in conducting media
16. Multipole radiation: Electric dipole and quadrupole radiation, magnetic dipole radiation, antenna
17. Long Wavelength dipole scattering, general formulation and applications
18. Introduction to waveguides and resonant cavities.

Sequence of topics covered may deviate from the above ordering.

Course organization - Schedule

Instructor	:	Aditya H. Kelkar	(akelkar@iitk.ac.in)
TA's	:	Sourav Karan	(souraviitk20@iitk.ac.in)
		Pranay Mohta	(pmohta@iitk.ac.in)
		Sunit Das	(sunitd@iitk.ac.in)

Day & time	:	(L)	:	T, W, Th (8:00 – 9:00 AM)
		(T)	:	F (8:00 – 9:00 AM)
Venue			:	LHC (L-05)

First course lecture is scheduled on 06/01/2026 (Tuesday)

Course organization – Evaluation

Total marks = 100%

a) Class Quizzes (Surprise or announced)	:	20% (20-30 mins each)
b) Mid Sem exam	:	30% (2 hrs)
c) End Sem exam	:	50% Marks (3 hrs)

d) Regular assignments may be given for practice. The assignments will not be graded.

The evaluation policy may change during the course subject to student feedback and feasibility of formative assessment.

Course Policies:

- Minimum 90% attendance is mandatory for all the students. Attendance will be taken randomly. Entry in the lecture room will be **stopped at 8:10 AM**.
- Students failing to maintain ~ 90% attendance (other than for medical emergency) or not attending quizzes and mid semester exam, **may not be allowed** to appear in the end sem exam and will be deregistered from the course.
- Giving end Sem exam is **mandatory** to secure a **passing grade** in the course.
- Tentatively **>30% marks** are needed to secure a passing grade in the course.
- Some information/resource material will be hosted on **"https://hello.iitk.ac.in/"** portal and the information will be sent to the students via email. The portal will be primarily used to **upload student marks** for each evaluation component. The portal is not to be used for discussion/chat.
- If feasible, "Gradescope" will be used for grading and evaluation.
- Use of **unfair means** in any component of evaluation will be penalized with an **F grade** in the course. A repeat offence will be reported to the **SSAC**.
- No make-up will be offered for class quizzes.

Books & References:

1. Introduction to electrodynamics – D. J. Griffiths
2. Classical electrodynamics – J. D. Jackson
3. Feynman lectures on Physics – Vol. 2

   Additional references:
4. Electricity and Magnetism – Purcell (Berkeley physics course)
5. Electrodynamics of continuous media – Landau and Lifshitz
6. Modern electrodynamics – A. Zangwill