PHYS-324

Classical electrodynamics

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Cursus	Sem.	Type
Physics	BA5	Obl.

Language of teaching	English
Credits	7
Session	Winter
Semester	Fall
Exam	Written
Workload	210h
Weeks	14
Hours	**6 weekly**
Courses	3 weekly
Exercises	3 weekly
Number of positions	

Summary

The goal of this course is the study of the physical and conceptual consequences of Maxwell equations.

Content

I Maxwell equations: the laws of electrodynamics, differential and integral form of Maxwell equations, scalar and vector potential, gauge transformations, solutions of Maxwell equations using Green functions, Neumann and Dirichlet boundary conditions, vacuum solutions and solutions in the presence of charges and currents, retarded potentials, Liénard-Wiechert potentials, radiation emission by moving charges.
II Multipole expansion: electrostatics, magnetostatics, electrodynamics, dipole radiation.
III Electric and magnetic field in matter: derivation of macroscopic electrodynamic equations, continuity boundary conditions, waves in a medium, reflection and refraction of waves.
IV Special Relativity: Maxwell equations and the birth of relativity, Galilean and Lorentz transformations, four-vectors and tensor calculus, covariant form of Maxwell equations, relativistic particle dynamics.

Keywords

Maxwell equations, electromagnetic field, multipole expansion, special relativity, Lorentz transformations.

Learning Prerequisites

Recommended courses

General physics and mathematics courses of the physics bachelor cycle.

Important concepts to start the course

Differential and integral calculus. Newtonian mechanics. Electro and magnetostatics.

Learning Outcomes

By the end of the course, the student must be able to:

- Describe Maxwell equations and its physical consequences
- Formalize physical problems into mathematical equations.
- Solve problems analytically and/or numerically
- Formulate the basic consequences of special relativity
- Synthesize specific electrodynamic phenomena into precise mathematical language
- Describe physical phenomena in the language of fields and particles

- Derive specific consequences of Maxwell equations
- Explain the meaning of each term in Maxwell equations

Transversal skills

- Use a work methodology appropriate to the task.
- Continue to work through difficulties or initial failure to find optimal solutions.
- Demonstrate the capacity for critical thinking

Teaching methods

Lectures and problem solving sessions.

Expected student activities

Attendance at lectures, study of the lectures at home and problem solving during exercise sessions and at home.

Assessment methods

Final written exam

Supervision

Office hours	Yes
Assistant.e.s	Yes

Resources

Bibliography

"Modern electrodynamics", Andrew Zangwill, Cambridge University Press 2013. ISBN-13: 978-0521896979
"Classical electrodynamics / John David Jackson". Year:1999. ISBN:978-0-471-30932-1
"Le cours de physique de Feynman / [Richard] Feynman, [Robert] Leighton, [Matthew] Sands". Year:1995. ISBN:2-10-004504-0
"Théorie des champs / L. Landau, E. Lifchitz; [traduit du russe par Sergueï Medvédev]". Year:1999. ISBN:5-03-000641-9

Ressources en bibliothèque

- Find the references at the Library

Références suggérées par la bibliothèque

- The Classical Theory of Fields / Landau & Lifchitz
- The Feynman lectures on physics

Notes/Handbook

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Moodle Link

- https://go.epfl.ch/PHYS-324