

PHYS-324

**Classical electrodynamics**

Penedones João Miguel

Cursus	Sem.	Type
Physics	BA5	Obl.

Language of teaching	English
Credits	4
Session	Winter
Semester	Fall
Exam	Written
Workload	120h
Weeks	14
<b>Hours</b>	<b>4 weekly</b>
Lecture	2 weekly
Exercises	2 weekly
<b>Number of positions</b>	

**Summary**

The goal of this course is the study of the physical 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, and electrodynamics, dipole radiation

**III 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.

**IV Electric and magnetic field in matter:** derivation of macroscopic electrodynamic equations, continuity boundary conditions, waves in a medium, reflection and refraction of waves.

**Learning Prerequisites****Recommended courses**

General physics, mechanics and mathematics

**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.

### Teaching methods

Lectures and problem solving sessions.

### Expected student activities

Attendance at lectures, problem solving.

### Assessment methods

Written exam.

### Resources

#### Bibliography

"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

- [Classical electrodynamics / John David Jackson](#)
- [Le cours de physique de Feynman / \[Richard\] Feynman, \[Robert\] Leighton, \[Matthew\] Sand](#)
- [Théorie des champs / L. Landau, E. Lifchitz](#)

#### Notes/Handbook

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#### Websites

- <http://itp.epfl.ch/page-60672-en.html>