Classical Electrodynamics

Code: 66704 **Credits:** 12

Character: Optative **Hours by week:** 6

Type: Theoretical **Hours**

Theory: 6 **Practice:** 0

General Objective:

To provide to the students the fundamental knowledge in classical electrodynamics, offering a comprehensive and updated overview of this subject. This program and the training on this subject, help as a guide for the qualifying exam for prospective PhD students. This lecture can be taken by master´s studentes but it´s not compulsory for them. The level of this lecture is high, so prospective master´s students are advise to balance their lecture load in order to fulfill the syllabus of this lecture properly.

Specific Objectives

This course has the objective to deepen the basic concepts of the classical electrodynamics, previously known by the student at undergraduate level. This will permit the student to strengthen the knowledge for a high level specialized training or for the use of this subject in their particular research project. It is aimed that the student clearly understands the unified nature of the electric and magnetic phenomena from the microscopic and macroscopic point both physically and at an advanced mathematical level. The purpose of the subject is to expose the student to the typical techniques for resolve problems of electro and magnet static with Jackson's book level. The course also has the

objective to go in depth electrodynamics knowledge especially about radiative process and electrodynamics covariant schemes.

Thematic Contents

Unit 1 Maxwell equations in vacuum

1.1 Electrostatics and magnetstatics.

1.2 General Solution to Laplace's and Poisson equations with boundary conditions. Green's function. Multipolar development in electrostatics and magnetostactics.

1.3 Faraday's Law and Ampere-Maxwell law.

Unit 2 Conservation Laws.

2.1 Energy balance (Poynting's Theorem).

2.2 Moment Balances.

2.3 Tensor algebra**.**

2.4 Angular moment balance.

Unit 3 Response of dielectric material

3.1 Maxwell equations in material media. Concept of average field.

3.2 Microscopic equation. The concept of dielectric tensor.

3.3 Temporal dispersion and analytical properties of dielectric response.

3.4 Drude's model and plasma model for dielectric response.

3.5 Conservation Laws in material media.

Unit 4 Electromagnetic waves.

4.1 Wave equation for electromagnetic fields.

4.2 Planes Waves polarization.

4.3 Non-monochromatic waves on metals and surface plasmons.

4.4 Waves in dielectrics and conductors.

4.5 Reflection and refraction of electromagnetic waves. Phase velocities and group velocity.

4.6 Spreading of a pulse in a dispersive media.

Unit 5 Radiation

5.1 Equation wave with sources for electromagnetic potentials .

5.2 Invariance standard.

5.3 Solution of the wave equation with point and extended sources.

5.4 Retarded potentials.

5.5 Lienard-Wiechert potentials and electromagnetic fields of point charges.

5.6 Synchrotron radiation.

5.7 Spectral and angular distribution of radiation.

5.8 Radiation of a classic Atenna.

5.9 Multipolar development of radiation fields.

Unit 6 Covariant method of electrodynamics.

6.1 Invariance and covariance of electrodynamics.

6.2 Lorentz transformation of the sources potentials and fields.

6.3 Maxwell's equation in covariant form.

6.4 Continuity equation and wave equation for electromagnetic quadrupoles.

6.5 Lagrangian and Hamiltonian method for relativistic particles on electromagnetic fields.

Complement Bibliography

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- Vanderlinde J., *Classical electromagnetic theory 2nd. edition*,Kluwer, New York, 2004.
- Barut A. O., *Electrodynamics and classical theory of fields and particles*, Dover, New York,
1980.
- Greiner W., *Classical Electrodynamics*, Springer-Verlag,1998.
- Bredov, M. y Otros, *Electrodinámica clásica*, Editorial Mir, Moscú,1986.
- J. Schwinger y Otros, *Classical electrodynamics*,Perseus Reading Massachusetts, 1998.
- Panofsky. W. K. H. y Phillips, M., *Classical electricity and magnetism, 2nd. edition*, Addison- Wesley, 1972.
- Good, R. H. y Nelson, T. J., *Classical theory of electric and magnetic fields*, Academic Press,
New York, 1971.
-Thide, B., *Electromagnetic field theory, Upsilon Books*, http://www.plasma.uu.se/CED/Book,
2001.