Electrodynamics

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SEMESTER I (January - May 2019)

OBJECTIVES:
The course objective is to provide students with basic ideas and methods of classical electrodynamics and enable them to be capable of applying these basics to physical systems in order to explain and predict the behaviour of such systems.

COURSE CONTENTS:
The course will begin with a revision of ideas from electrodynamics involving potentials and fields. This involves the consideration of the scalar and vector potentials in electrodynamics, gauge transformations, conservation laws, etc. After recollecting the above which has been seen to some extent in earlier courses, the course goes over to relativistic electrodynamics. Here we shall start with special relativity and look into the covariant formulation of electrodynamics. In the last part of the course we will study retarded potentials and topics related to the radiation of moving charges and radiation in collisions.

PLANNED TOPICS:

Introduction: From statics to dynamics:
Estimated time: 6 weeks (can vary depending on the speed of the class)
Maxwell's equations in integral and differential form, Static Potentials - Laplace and Poisson's equations, Green's function method, Dirichlet and Neumann boundary conditions, Potentials in Electrodynamics, Gauge transformations, Energy in electric and magnetic fields, Poynting's theorem, conservations laws, electric and magnetic fields in matter

Relativistic Electrodynamics:
Estimated time: 5 weeks
Lorentz transformations and relativistic kinematics, Covariant formulation of electrodynamics, antisymmetric field strength tensor, Lagrangian and Hamiltonian for a relativistic charged particle in external electromagnetic fields, motion of charged particles in electric and magnetic fields, Lagrangian description of electromagnetic fields, action function of the electromagnetic field, continuity equation in the 4-dimensional form, stress tensors

Fields of moving charges and topics in radiation:
Estimated time: 4 weeks
Retarded potentials and fields, Liénard Wiechert potentials and fields for a point charge, electric and magnetic dipole radiation, Power radiated by an accelerated charge: Larmor's formula, angular distribution of radiation emitted by an accelerated charge, radiation emitted during collisions, Bremsstrahlung in collisions and decay processes

Extra topics such as energy loss, Cherenkov radiation etc (if time permits)

Evaluation:
Homeworks will be given regularly, but will not be graded.
Partial exams:
15% February 8, 2019
15% March 8, 2019
20% April 5, 2019
20% May 4, 2019
FINAL EXAM : 30%

Main reference books:
1. *Classical Electrodynamics*, **J. D. Jackson, Wiley 1998**
2. *The Classical Theory of Fields: Volume 2 (Course of Theoretical Physics Series)*, **L. D. Landau and E. M. Lifshitz, Butterworth-Heinemann 1980**
3. *Classical Electromagnetic Radiation, Third Edition*, **M. A. Heald and J. B. Marion, Dover Publications 2012**

Additional Books:
1. *Introduction to Electrodynamics (4th Edition)*, **David J. Griffiths, Addison-Wesley 2012**
2. *Classical Electromagnetic Theory*, **Jack Vanderlinde, Springer 2004**
3. *Electrodynamics (Chicago Lectures in Physics)*, **Fulvio Melia, University Of Chicago Press 2001**
4. *Electrodynamics*, **Harald J. W. Muller-Kirsten, World Scientific 2011**
5. *Classical Electrodynamics*, **Walter Greiner and D. A. Bromley, Springer 2009**
6. *Electrodynamics and Classical Theory of Fields and Particles*, **A. O. Barut, Dover 1980**
7. *Classical Field Theory*, **Florian Scheck, Springer 2012**