# SI2390 Relativistic Quantum Physics 7.5 credits

## Relativistisk kvantfysik

This is a translation of the Swedish, legally binding, course syllabus.

If the course is discontinued, students may request to be examined during the following two academic years

## Establishment

Course syllabus for SI2390 valid from Autumn 2011

## Grading scale

A, B, C, D, E, FX, F

## Education cycle

Second cycle

## Main field of study

Physics

## Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

## Intended learning outcomes

After completion of the course you should be able to:

- apply the Poincaré group as well as classify particle representations.
- analyze the Klein-Gordon and the Dirac equations.
- solve the Weyl equation.
- know Maxwell's equations and classical Yang-Mills theory.
- quantize Klein-Gordon, Dirac, and Majorana fields as well as formulate the Lagrangian for these fields.
- use perturbation theory in simple quantum field theories.
- formulate the Lagrangian for quantum electrodynamics as well as analyze this.
- derive Feynman rules from simple quantum field theories as well as interpret Feynman diagrams.
- analyze elementary processes in quantum electrodynamics.
- compute radiative corrections to elementary processes in quantum electrodynamics.

## Course contents

**I. Relativistic quantum mechanics**

Tensor notation. Casimir operators. The Poincaré group. Irreducible representations of particles. The Klein-Gordon equation. The Dirac equation. The structure of Dirac particles. The Dirac equation: central potentials. The Weyl equation. Maxwell's equations and quantization of the electromagnetic field. Introduction to Yang-Mills theory.

**II. Introduction to quantum field theory**

Neutral and charged Klein-Gordon fields. The Dirac field. The Majorana field. Asymptotic fields: LSZ formulation. Perturbation theory. Introduction to quantum electrodynamics. Interacting fields and Feynman diagrams. Elementary processes of quantum electrodynamics. Introduction to radiative corrections.

## Specific prerequisites

Recommended prerequisites:
Quantum Physics.
Relativity Theory.
Analytical Mechanics and Classical Field Theory (recommended).

## Course literature

The course literature consists of one book (mainly):

- T. Ohlsson, **Relativistic Quantum Physics**, Cambridge (2011)

Further recommended reading:

- A.Z. Capri, **Relativistic Quantum Mechanics and Introduction to Quantum Field Theory**, World Scientific (2002)

- C. Doran and A. Lasenby, **Geometric Algebra for Physicists**, Cambridge (2003)
- W. Greiner, **Relativistic Quantum Mechanics - Wave Equations**, Springer (2000)
- F. Gross, **Relativistic Quantum Mechanics and Field Theory**, Wiley (1993)
- J. Mickelsson, T. Ohlsson, and H. Snellman, **Relativity Theory**, KTH (2005)
- M.E. Peskin and D.V. Schroeder, **Introduction to Quantum Field Theory**, Harper-Collins (1995)
- H.M. Pilkuhn, **Relativistic Quantum Mechanics**, Springer (2003)
- L.H. Ryder, **Quantum Field Theory**, 2nd ed., Cambridge (1996)
- F. Schwabl, **Advanced Quantum Mechanics**, Springer (1999)
- F.J. Ynduráin, **Relativistic Quantum Mechanics and Introduction to Field Theory**, Springer (1996)

## Examination

- INL1 - Assignments, 4.5 credits, grading scale: A, B, C, D, E, FX, F
- TEN1 - Examination, 3.0 credits, grading scale: P, F

Based on recommendation from KTH’s coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

## Other requirements for final grade

Hand in assignments (INL1; 4,5 university credits) and an oral exam (TEN1; 3 university credits).

## Ethical approach

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.
- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.