Course Title	Course Code	Number of Study Hours				Year	Level	Prerequisites
		Theo.	Lab.	Credit	ECTS			
Quantum Field Theory	**PHYS660**	**3**	**-**	**3**	**9**	**1st/ 2nd**	**2nd/ 3rd**	**-**

Student's workload			
In-class activities	**Contact Hours**	**Self-learning/study**	**Hours**
Lectures	**45**	**Preparation for classes**	**120**
Laboratory	**-**	**Case studies**	**-**
Exams and quizzes	**5**	**Working on lab experiment**	**-**
Lab demo	**-**	**HW/Assignments**	**32**
		Study for exam	**38**
Total	**50**	**Total**	**190**
Total Learning Hours = 240		**Equivalent ECTS points = Total LH/28 = 9**	

BRIEF COURSE DESCRIPTION

- This course is designed to give the basic concepts and techniques of quantum field theory, with applications to elementary particle physics, Quantum Electrodynamics (QED), with special emphasis to Quantum Chromodynamics (QCD).

COURSE OBJECTIVES

The main objectives of this course are focused on the following:

1. Outline the basic concepts and techniques of quantum field theory
2. Discuss the applications to elementary particle physics, Quantum Electrodynamics (QED), with special emphasis to Quantum Chromodynamics (QCD).
3. Apply the Lagrangian formulation for the canonical quantization of free fields.
4. Apply the perturbation theory for interacting fields and Feynman diagram methods for Quantum Electrodynamics.
5. Investigate path integral methods in quantum field theory.
6. Identify the quantization of gauge theories and forms an essential tool for the understanding and development of the 'standard model' of particle physics.

COURSE CONTENTS

- The Klein-Gordon Field
- The Necessity of the Field Viewpoint
- Elements of Classical Field Theory (Lagrangian Field Theory; Hamiltonian Field Theory; Noether's Theorem)
- The Klein-Gordon Field as Harmonic Oscillators
- The Klein-Gordon Field in Space-Time
- Causality; The Klein-Gordon
- Propagator; Particle Creation by a Classical Source
- The Dirac Field
- Lorentz Invariance in Wave Equations
- The Dirac Equation
- Free-Particle Solutions of the Dirac Equation (Spin Sums)
- Dirac Matrices and Dirac Field Bilinears
- Quantization of the Dirac Field (Spin and Statistics; The Dirac Propagator)
- Discrete Symmetries of the Dirac Theory (Parity; Time Reversal; Charge Conjugation)
- Interacting Fields and Feynman Diagrams
- Perturbation Theory
- Perturbation Expansion of Correlation Functions
- Wick's Theorem
- Feynman Diagrams
- Cross Sections and the S-Matrix
- Computing S-Matrix Elements from Feynman Diagrams
- Feynman Rules for Fermions
- Feynman Rules for Quantum Electrodynamics
- Functional Method
- Path Integrals in Quantum Mechanics
- Functional Quantization of Scalar Fields (Correlation Functions; Feynman Rules; Functional Derivatives and the Generating Functional)
- Introduction to renormalization
- Renormalized Perturbation Theory
- Renormalization of Quantum Electrodynamic

ASSESSMENT CRITERIA

- Mid-Term exam and Quizzes: 30 %
- Assignments and classroom activities: 20 %
- Final Exam: 50%

COURSE TEACHING STRATEGIES

- Lectures, active learning: research articles, web of science, previous thesis.

TEXT BOOK	REFERENCE BOOKS
• M. E. Peskin and D. V. Schroeder, An Introductionto Quantum Field Theory, (West view Press 1995).	• F. Mandl, G. Shaw, Quantum Field Theory " (2nd Edition), (Wiley, 2010) • C. Itzykson and J-BZuber, Quantum Field Theory, (McGraw-Hill, 1980). • M. Srednicki, Quantum Field Theory, (Cambridge, 2007). • M. Magguore, A Modern Introduction to Quantum Field Theory, Oxford, 2005