



UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Quantum Field Theory I

2021-1-F5801Q042

Aims

To give the basic conceptual and theoretical tools for studying the quantum theories of the fundamental interactions

Contents

Path integral formulation of relativistic quantum field theories

Detailed program

Identical particles, Fock space, creation and annihilation operators.

Poincaré transformations. Local field operators, S matrix, causality, spin-statistic theorem, discrete symmetries and CPT invariance.

Path integral quantization. Wick rotation and Euclidean field theories: scalar, spinor and vector fields. Faddeev-Popov prescription. Interacting theories and their perturbative expansion.

N-point connected correlation functions, proper vertices, generating functional, effective action. Loop wise expansion.

Gauge invariance, Quantum Electrodynamics (QED). Yang-Mills theories, BRST invariance, Quantum Chromodynamics (QCD).

Symmetries in the path integral formalism. Ward identities: charge conservation, energy-momentum tensor, chiral symmetry and associated currents.

Kallen-Lehmann and Lehmann-Symanzik-Zimmermann formulas.

Two and four point functions in $\lambda\phi^4$ theory at one and two loops, UV divergences, renormalization.

QED at one loop: photon self-energy and quark propagator, electron-photon vertex, $g-2$. UV divergences and their renormalization.

Prerequisites

Quantum mechanics and Theoretical physics I and II

Teaching form

Lessons and recitations at the blackboard.

During the Covid-19 emergency, lectures will be in video-conference off-line with some events in video-conference online.

Textbook and teaching resource

S. Weinberg, *The Quantum Theory of Fields*, vol. 1 e 2, Cambridge University Press

M. LeBellac, *Quantum and Statistical Field Theory*, Oxford Science Publications

F. Mandl and G. Shaw, *Quantum field theory*, Wiley

M.E. Peskin and D.V.Schroeder, *An Introduction To Quantum Field Theory*, Perseus

J. Zinn-Justin, *Quantum field theory and critical phenomena*, Oxford Science Publications

Semester

Second semester, eight hours per week

Assessment method

Oral exam concerning the topics discussed during the course. The first question is chosen by the student, the others by the examiner.

During the Covid-19 emergency exams will be in video conference only via the software *WebEx*.

Office hours

Students may come to my office any time, preferably Monday 12:30-14:30 . If needed, send an e-mail to fix an appointment.
