UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Fisica e Chimica - Emilio Segrè
ACADEMIC YEAR	2023/2024
MASTER'S DEGREE (MSC)	PHYSICS
SUBJECT	THEORY OF FIELDS
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50340-Microfisico e della struttura della materia
CODE	07382
SCIENTIFIC SECTOR(S)	FIS/03
HEAD PROFESSOR(S)	PASSANTE ROBERTO Professore Associato Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	6
INDIVIDUAL STUDY (Hrs)	94
COURSE ACTIVITY (Hrs)	56
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	1
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**PASSANTE ROBERTO** Tuesday 15:00 17:00 Studio docente (stanza N. 208) - Dip. Fisica e Chimica, Via Archirafi 36 Thursday 15:00 17:00 Studio docente (stanza N. 208) - Dip. Fisica e Chimica, Via Archirafi 36

DOCENTE: Prof. ROBERTO PASSANTE

PREREQUISITES	Knowledge of nonrelativistic quantum mechanics, and relativistic wave equations (Klein-Gordon and Dirac).
LEARNING OUTCOMES	Knowledge and understanding: Knowledge of the fundamental concepts and main results of quantum field theory and quantum electrodynamics. Applying knowledge and understanding: Capability of using and applying the methods of quantum field theory and quantum electrodynamics, also in different fields of physics. Making judgements: Capability of a rigorous and critical analysis of the fundamental aspects of a specific problem of field theory. Communication skills: The student should be able to focus on and explain the essential elements of a specific problem related to field theory and its applications. Learning skills: The students should be able to study autonomously and gain a deep understanding of specialistic arguments of field theory and its applications.
ASSESSMENT METHODS	The final exam is an oral examination consisting in a presentation of a specific argument of quantum field theory, not developed during the course, that the student should prepare autonomously, and a discussion/questioning on arguments treated in the course. The assessment and the final mark will be given according the following criteria: a) Essential knowledge of the fundamental concepts of the course, sufficient understanding and capability of discussing/applying them (18-22); b) Good knowledge of the fundamental concepts of the course, good understanding and capability of discussing/applying them (23-26); c) Broad and deep knowledge of the fundamental concepts and subjects of the course, very good understanding and capability of discussing/applying them (27-29); d) Outstanding and thorough knowledge of the concepts and subjects of the course, excellent understanding and capability of discussing and applying them to different physical systems (30-30L).
EDUCATIONAL OBJECTIVES	The aim of the course is to give the student a good and deep knowledge of the basic aspects of quantum field theory, and its applications in quantum electrodynamics.
TEACHING METHODS	The course consists of lectures and exercises. The lectures aim to give a deep knowledge of quantum field theory and quantum electrodynamics. The subjects developed during the course are also applied to different specific systems relevant in field theory, in particular in quantum electrodynamics.
SUGGESTED BIBLIOGRAPHY	Testi Base (Basic Textbooks) F. Mandl, G. Shaw, Quantum Field Theory (second edition), Wiley, ISBN 978-0-471-49684-7 R.D. Klauber, Student Friendly Quantum Field Theory, Sandtrove Press, ISBN 978-0-9845139-3-2 Testi di approfondimento (Supplementary Textbooks) A. Rubbia, Phenomenology of Particle Physics, Cambridge University Press, ISBN 978-1-316-51934-9 M.D. Schwartz, Quantum Field Theory and the Standard Model, Cambridge University Press, ISBN 978-1-107-03473-0 M.E. Peskin, D.V. Schroeder, An Introduction to Quantum Field Theory, Addison-Wesley, ISBN 0-201-50397-2

SYLLABUS

Hrs	Frontal teaching
6	Lagrangian and Hamiltonian formulation of fields. Transition from the discrete to the continuum. Noether theorem for a field. Energy-momentum tensor. Introduction to the theory of continuous groups.
3	Systems of identical particles. Second quantization. Bosons and fermions. Spin-statistics theorem. Weyl and Majorana spinors.
4	Scattering theory and S matrix. Dyson expansion. Wick's theorem. Green's functions. Lippman-Schwinger equation.
6	Real and complex Klein-Gordon field in second quantization. The Dirac field in second quantization. Particles and antiparticles. Propagators. Feynman propagators of the Klein-Gordon and the Dirac field.
4	Covariant quantization of the electromagnetic field. Gupta-Bleuler formalism. Feynman Propagator of the electromagnetic field.
6	Quantum electrodynamics in the Lorentz gauge. Gauge invariance and electron-photon interaction. Feynman diagrams of quantum electrodynamics. Lowest-order Quantum-Electrodynamical processes.
3	Loop diagrams and radiative corrections. Self-energy, infrared and ultraviolet divergences. Regularization and renormalization.

Hrs	Practice
9	Exercises on: cross sections, scattering theory, propagators and Green's functions.
12	Exercises on Feynman diagrams and QED processes at the lowest order: creation and annihilation of particle-antiparticle pairs, Compton scattering, electron-electron scattering, Bhabha scattering, scattering from an external field.
3	Exercises on radiative corrections: electron self-energy, basic aspects of electron's mass and charge renormalization.