Università degli Studi della Basilicata

DIPARTIMENTO DI MATEMATICA, INFORMATICA ED ECONOMIA

COURSE: Theoretical Physics			
ACADEMIC YEAR: 2019 / 2020			
TYPE OF EDUCATIONAL ACTIVITY: Characterizing			
TEACHER: D. Cocolicchio			
e-mail:		website:	
phone:		mobile (optional):	
Language of Instruction: Italian			
ECTS: 6	n. of hours: 48	Campus: Potenza DIPARTIMENTO DI MATEMATICA, INFORMATICA ED ECONOMIA Corso di Laurea Magistrale in Matematica	Semester: II

EDUCATIONAL GOALS AND EXPECTED LEARNING OUTCOMES

Course Outline and Contents: This course provides a broad introduction and numerous applications in the field of quantum-relativistic physics.

Learning Outcomes: This course aims to introduce the fundamental concepts of quantum relativistic physics, focusing on the most recent discoveries.

PREREQUISITES

This course has been meant for students with a good knowledge of general and modern physics.

SYLLABUS

The course consists of three main parts:

- From Analytical Mechanics to Classical Field Theory
- Mathematical Formulations of Relativistic Quantum Mechanics
  - The problem of computing Quantum Corrections to Classical Theory
  - The canonical and path integral formalism through simple examples
  - Basics of Quantum Field Theory
  - Covariant Second Quantization of the Electro-Dynamics (QED)
  - Quantum Corrections, Feynman Diagrams and the Renormalization Theory
  - Non-Abelian Gauge Theories and the Standard Model
  - Introduction to quantum many-body theory
  - Systems of identical particles. Bose-Einstein and Fermi-Dirac quantum statistical distributions
- Physical Applications of Group Theory
  - Fundamental Particles and associated Unitary Irreducible Representations of the Poincarè Group
  - Relativistic Wave Equations: Klein-Gordon, Dirac, Pauli, Proca and Maxwell

TEACHING METHODS

Teaching Methods and Tools: Class lessons are highlighted by means of a computer assisted approach, with examples in MatLab and MATHEMATICA.

EVALUATION METHODS

Assessment Methods: Oral examination is usually supplemented with a discussion of a homework report.

TEXTBOOKS AND ON-LINE EDUCATIONAL MATERIAL

Although, this course is largely based on lecture notes, nevertheless, the following textbooks may be a useful completion.

- G. Costa, G.L. Fogli, *Lorentz group and particles states*, in "Kinematics and symmetry", Text-book on Elementary Particle Physics, ed. M. Nikolic' (1979) Chap. V, pp. 58-165.
- G. Costa, G.L. Fogli, *Internal symmetries*, in "Kinematics and symmetries", Text-book on Elementary Particle Physics, ed. M. Nikolic' (1979) Chap. VI, pp. 167-294.
- G. Costa, G.L. Fogli, *Symmetries and Group Theory in Particle Physics. An Introduction to Space-time and Internal Symmetries*, Lecture Notes in Physics Volume 823 (Springer-Verlag, Berlin Heidelberg, 2012)
- L. Maiani, O. Benhar, *Relativistic Quantum Mechanics: An Introduction to Relativistic Quantum Fields, (CRC, 2016)*
- M. Maggiore, A *modern Introduction to Quantum Field Theory*, (Oxford University Press, 2005)
- R. D'Auria, M. Trigiante, From Special Relativity to Feynman Diagrams, (Springer 2012)
- A. 0. Barut, *"Electrodynamics and Classical Theory of Fields and Particles"* (Dover Publications, New York, 1980)
- B. Thidé, *"Electromagnetic Field Theory",* (Dover Publications, New York, 2010[2Ed])
- D. Griffiths, *"Introduction to Elementary Particles"* (Wiley, New York, 2008[2Ed])
- M. Srednicki, Quantum Field Theory, Cambridge University Press, 2007
- M.D. Scadron, "*Advanced Quantum Theory*" , (Springer, Berlin, 1991[2Ed])
- J.D. Biorken, S. Drell, *"Relativistic Quantum Mechanics",* (McGraw-Hill , 1964)
- J.D. Biorken, S. Drell*, "Relativistic Quantum Fields",* (McGraw-Hill , 1965)
- P. Ramond, *"Field Theory: A modern Primer" (Benjamin, 1981)*
- C. Itzykson, J.-B. Zuber, *"Quantum Field Theory"* (McGraw-Hill Book, 1980)
- L. H. Ryder, *"Quantum Field Theory"* (Cambridge University Press, Cambridge, 1985)
- M.Peskin, D. Schroeder, *"An Introduction to Quantum Field Theory"* (Perseus Books, 1995)
- F. Mandl, G. Shaw, *"Quantum Field Theory"*, Revised edition (Wiley-Interscience, Chichester, 1993)
- T-P. Cheng, L-F. Li, *"Gauge Theory of Elementary Particle Physics"* (Oxford Univ. Press, 1984)
- L. D. Landau, E. M. Lifshitz, "*The Classical Theory of Fields"*, (Pergamon Press, New York, 1975[4Ed])
- M. Le Bellac, *"Quantum and Statistical Field Theory"* (Oxford U.P., Oxford, 1992).
- S. Weinberg, *"Teoria quantistica dei campi", vol. I* (Zanichelli, 2000)
- S. Weinberg, *"The quantum theory of fields", vol. II, III* (Cambridge Univ. Press, 1996, 2000)
- W. Greiner, *"Theoretical Physics", vol. 3, 4, 5* (Springer-Verlag, 1992, 1993, 1998)
- L. S. Brown, *"Quantum Field Theory"* (Cambridge University Press, Cambridge, 1992)
- B. S. DeWitt, "*Dynamical Theory of Groups and Fields"* (Gordon and Breach, New York, 1965)
- J. Collins, *"Renormalization"* (Cambridge U.P., Cambridge, 1984)
- R. Gilmore, *Lie groups, Lie algebra, and some of their applications*, (Wiley Interscience, 1974)
- B. DeWitt, *Relativity, Groups and Topology* (Les Houches 1963), Gordon and Breach (1964)
- S. Sternberg, *Group Theory and Physics*, (Cambridge University Press, 1999).
- M. Hamermesh, *Group Theory and its Application to Physical Problems* (Dover, 1989)
- J. F. Cornwell, *Group Theory in Physics.* Vol. 1 & Vol. 2, (Academic, 1984)
- H. Georgi, *Lie Algebras in Particle Physics*. From Isospin to Unified Theories, (Frontiers of Physics, 1982)
- A. O. Barut and R. Raczka, *Theory of Group Representations and Applications*, (Polish Scientific Publishers, 1977).

INTERACTION WITH STUDENTS

EXAMINATION SESSIONS (FORECAST)[1]

Month	Year	Day
March	2020	11
June	2020	17
July	2020	15
September	2020	16
October	2020	21
November	2020	25
December	2020	9

SEMINARS BY EXTERNAL EXPERTS YES ☐ NO ☒

FURTHER INFORMATION

[1] Subject to possible changes: check the web site for updates.