UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO

DIPARTIMENTO INTERUNIVERSITARIO DI FISICA

| General information | | |
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| Academic subject | **STANDARD MODEL** | |
| Degree course | Physics | |
| Academic Year | Second Master degree | |
| European Credit Transfer and Accumulation System (ECTS) | | 6 |
| Language | English | |
| Academic calendar (starting and ending date) | 1st Semester (September – December 2022) | |
| Attendance | Not compulsory | |

| Professor/ Lecturer | |
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| Name and Surname | Fulvia De Fazio |
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| Telephone | 0805443209 |
| Department and address | Room R01 – Dipartimento Interateneo di Fisica – Campus Universitario – Via E. Orabona, 4 Bari |
| Virtual headquarters | MS Teams Virtual Classroom |
| Tutoring (time and day) | Tuesday, from 3:00 to 5:00 pm or on appointment also in other days |

| *Syllabus* | |
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| **Learning Objectives** | The goal of the teaching is to provide<br>- the fundamental knowledge on the Standard Model of strong and electroweak interactions;<br>- the tools to compute the Feynman rules in any gauge theory<br>- the methodology for renormalization and the techniques related to the renormalization group.<br>The course also aims at providing an overview of the most modern developments in the field of theoretical Physics of elementary particles. |
| **Course prerequisites** | Quantum Mechanics, Mathematical methods for Physics. |
| **Contents** | 1.Basics of Gauge invariance<br>Reminders of basic elements of group theory;<br>Gauge principle; Yang-Mills Theories.<br>2. Classical fields, symmetries and their breaking.<br>The action, equations of motion;<br>Symmetries, conservation laws, Noether's theorem.<br>3. Feynman rules<br>S matrix and Green functions; Feynman functional integral formalism; Derivation of Feynman rules<br>4. Renormalization and renormalization group<br>Regularization; Classification of divergences; Sistematics of renormalization;<br>Renormalization group equations; Beta function in QED and QCD.<br>5. Quantum Chromodynamics<br>QCD Lagrangian density; The Fadeev-Popov Lagrangian; BRST symmetry; Operator Product Expansion; Anomalies<br>6. Standard Model<br>The gauge group of electroweak interaction; The Higgs field and spontaneous symmetry breaking<br>The mass matrix; the Cabibbo-Kobayashi -Maskawa matrix; CP violation<br>7. Effective theories<br>_ Flavour Physics and effective hamiltonians |
| **Books and bibliography** | O. Nachtmann: Elementary Particle Physics. Concepts and Phenomena. Springer 1990<br>T. Muta: Foundations of Quantum Chromodynamics World Scienti_c 2nd Ed. 1997<br>M. Peskin and R. Schroeder: Introduction to Quantum Field Theory<br>A.J. Buras: Gauge Theory of Weak Decays.Cambridge University Press 2020. |
| **Additional materials** | |

| Work schedule | | | |
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| Total | Lectures | Hands on (Laboratory, working groups, seminars, field trips) | Out-of-class study hours/ Self-study hours |
| **Hours** | | | |
| 140 | 48 | 12 | 85 |
| **ECTS** | | | |
| 6 | 6 | | |

| Teaching strategy | |
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| | As a rule, lectures and exercises at the blackboard.<br>Online mode, if necessary. |
| **Expected learning outcomes** | |
| **Knowledge and understanding on:** | The course aims at providing the students with the modern ideas about the elementary constituents of the matter and their fundamental interactions. Basic principles of Quantum Field Theory will be adressed. The fundamental theoretical grounding will be provided, together with selected modern advanced developments and perspectives. |
| **Applying knowledge and understanding on:** | Tools for problem solving will be developed. A consistent part of the course will be devoted to solving exercises |
| **Soft skills** | • *Making informed judgments and choices*<br>The student will acquire the autonomous capability to afford problems in field theories.<br>• *Communicating knowledge and understanding*<br>The proper and modern language of elementary particle Physics will be learnt.<br>• *Capacities to continue learning*<br>The student will acquire the basic tools as well as the most modern approaches to study processes involving elementary particles. |

| Assessment and feedback | |
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| Methods of assessment | Final Exam is an oral test on all the topics covered during the course.<br>To pass the exam, students will have to demonstrate that they have well understood the contents of the course.<br>Preliminary signing up on ESSE3 is compulsory. |
| Evaluation criteria | • *Knowledge and understanding:*<br>Students will have to demonstrate knowledge and understanding of the fundamentals of Theoretical Physics of Fundamental Interactions<br><br>• *Applied knowledge and understanding:*<br>Students will have to demonstrate their ability to solve problems in Theoretical Physics of Fundamental Interactions<br>• *Autonomy of judgment:*<br>Students must show that they have acquired autonomy and critical reasoning skills on the topics covered in the teaching.<br>• *Communication skills:*<br>Students should be able to present the concepts learned during the course using clear, appropriate and scientifically rigorous language.<br>• *Ability to learn:*<br>Students must be able to independently examine and deepen problems of Theoretical Physics of fundamental interactions.<br>• *Capacities to continue learning*<br>Students must be able to independently examine and deepen problems of Theoretical Physics of fundamental interactions. |
| Criteria for assessment and attribution of the final mark | The grade, out of thirty, will reflect the degree of knowledge of the course contents.<br>The exam is passed when the grade is larger than or equal to 18.<br>Full understanding of the subject, exposure clarity, language accuracy guarantees the |

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| | maximum mark, 30 cum laude. |
| **Additional information** | |
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