Course unit English denomination	Standard Model and Flavour Physics
SS	FIS01, FIS04
Teacher in charge	Gabriele Simi Mia Tosi Alessandro Gaz Patrizia Azzi
Teaching Hours	24
Number of ECTS credits allocated	3
Course period	March - June 2026
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (50% minimum of presence) ☐ No
Course unit contents	1) Precision Electroweak Physics (8h) This part of the course will cover: - Measurement at the Z pole (LEP 1 and SLD): Z mass and width, eff, branching fractions - Asymmetries: forward-backward, left-right, polarization - W mass (and width) at Lep II, Tevatron and LHC - Top mass (Tevatron and LHC): methods and issues - Higgs discovery and measurements of its properties: mass, width, spin, coupling - Global Electroweak Fits 2) CKM Matrix and New Physics (7h) This part of the course will cover: - The CKM mechanism CP violation, the role of B meson oscillations - The measurement of B and D mesons mixing - How to measure CKM Angles (β, γ), - How to measure CKM Sides Vub and Vcb, LFU violation - Rare B decays as constraints on new physics and search for dark matter

	at colliders 3) Advanced Topics (5h) This part of the course will cover: - Experimental techniques to perform amplitude analysis of resonant decays - Time dependent amplitude analyses - How to search for exotic (multiquark) states - CP violation in kaons and rare K decays 4) Future Colliders (4h) This part of the course will be devoted to the possible post-LHC physics program, which includes e+e- colliders, high energy hadron colliders (including heavy ion collisions), electron-hadron/ion colliders, muon-muon colliders. The students will see the relevant physical measurements that can be performed at the different machines, considering the various types of colliding particles (protons, electrons, muons, ions, etc.) and the different energy ranges, such as those of the current designs under discussion. The course will discuss the various physics challenges and the final performances of each type of machine. Some details on the detectors will be provided
Learning goals	In the first part of the course, the student will learn how to perform precision electroweak measurements at the energy frontier how to use them to perform the global electroweak fit (Z,W,H,t). The main EW measurements will be described, highlighting the experimental strategies and challenges. The most recent results in terms of EW measurements will be discussed. In the second part, the student will learn how to describe the flavor sector of the SM in terms of the CKM matrix, how to build the unitarity triangle, and how to measure its angles and sides. Furthermore, the student will learn how to use the B meson rare decays as a tool to search for new physics at the intensity frontier. Finally, the student will learn the main techniques for searching for dark matter at colliders. In the third part of the course, the student will learn some advanced topics relevant to modern particle physics, including how to use the amplitude analysis method to search for exotic states and to measure CP violation. The student will also learn how to use advanced tools such as the b- and charm flavor taggers. An overview of CP violation in the kaon system will also be given. In the fourth part of the course, students will learn to use the fundamental

	concepts learned throughout the course (physical observables, phenomenology, measurement methods, systematic evaluation...) to critically understand the differences of the various machines proposed for the future and which physics can be performed better on which machine. The goal is to understand the advantages and limitations of different choices of machines for various physics benchmarks that we want to achieve: precision electroweak measurements, properties of the Higgs boson, including the measurement of self-coupling, direct searches for new physics
Teaching methods	The course is organized into four sets of lectures, where different topics are treated and described. Several publications from the most important peer-reviewed journals are presented or suggested for further studies
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	Sub-nuclear physics course, basic principles of theoretical physics
Examination methods (if applicable)	The exam will consist of an oral presentation on an experimental topic among those covered or suggested during the course.
Suggested readings	Slides and the most relevant publications
Additional information	