



Course unit English denomination	Standard Model and Flavor
Teacher in charge (if defined)	Alessandro Gaz ¹ , Gabriele Simi ¹ , and Mia Tosi ¹ ¹ <i>Physics Department, University of Padova</i>
Teaching Hours	24
Number of ECTS credits allocated	3
Course period	February-May 2025
Course delivery method	☒ In presence ☐ Remotely Blended
Language of instruction	English
Mandatory attendance	☒ Yes (50%) ☐ No
Course unit contents	3.1 Precision Electroweak Physics The first part (10h) 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: mass, width, spin, coupling • Global Electroweak Fit 3.2 CKM Matrix and Dark Matter The second part (12h) of the course will cover: • The Motivation for studying the CKM Matrix, the CKM mechanism and what is CP violation • Role of B meson oscillations as a tool to observe CP



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- The measurement of B and D mesons mixing
- How to measure CKM Angles (α , β , γ),
- How to measure CKM Sides V_{ub} and V_{cb}
- Rare B decays as constraints on new physics
- How to search for dark matter at colliders

3.3 Advanced Topics

The third part (8h) of the course will cover:

- Experimental techniques to perform amplitude analysis of resonant decays
- Time dependent amplitude analyses
- How to search for exotic (multi-quark) states
- Flavor tagging at B factories and LHC
- CP violation in kaons and rare K decays

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 to search 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.	
Teaching methods	The course is organized in three sets of lectures, where different topics are treated and described. Several publications in the most important peer review 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 (in applicable)	The exam will consist in a presentation on an experimental topic among those covered or suggested during the course.
Suggested readings	Slides and the most relevant publications
Additional information	