Stampare su carta intestata del CdS

General information	
Academic subject	**Fundamental Interactions**
Degree course	PHYSICS (master degree)
Academic Year	*1st*
European Credit Transfer and Accumulation System (ECTS)	6
Language	English
Academic calendar (starting and ending date)	2nd semester: March-June
Attendance	compulsory

Professor/ Lecturer	
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Virtual headquarters	Teams code: dtlh4tx
Tutoring (time and day)	Monday, Thursday, 3-5 pm

Syllabus	
Learning Objectives	Understanding of the fundamental lows of the elementary interactions (excluding gravity) and of their consequences.
Course prerequisites	Non-relativistic Quantum Mechanics, Special Relativity, Quantum Field Theory I
Contents	Phenomenology of the strong and electroweak interactions: principles, descriptions and applications.
	Generalities: (Classical and quantum) scattering of electrons by a heavy nucleus. Scattering matrix and scattering cross section: Unitarity relations and consequences. Overview of total pp and ppbar cross sections. Decay rate of an unstable particle. **Strong Interaction Physics:** Multiparticle production at high energy, multiplicity, (pseudo)-rapidity. Naive parton model: Deep inelastic scattering of electrons and neutrinos. Evidence of neutral flavourless partons. Drell-Yan process. Factorization formulae. SU(2) and SU(3) groups in a nutshell. Gauge principle. Lagrangian density of Quantum ChromoDynamics. Vacuum charge screening vs antiscreening, strong coupling α_s and its running. Asymptotic freedom vs confinement in QCD. Advanced topics in strong interaction Physics: QCD in extreme conditions of temperature and baryon density, QCD phase diagram. **Electroweak Interaction Physics:** Gauge group of the Electroweak interactions. Description of the first lepton family and of its interactions. Spontaneous breaking of a physical system symmetry. SSB of a continuous global symmetry and Goldstone theorem. Higgs field and the EW symmetry breaking. Description of three lepton and quark fa Fermi theory recovered at low energy. Yukawa interaction terms. Fermion masses and mixing. Lagrangian density of the Standard EW model. Higgs boson properties. Computation of simple processes (h ->f bar f, Z0-> f bar f) and comparison with data. SM description of CP violation. Measurement of the CKM matrix elements. The lepton sector and the PMNS matrix. Advanced topics: Problems the SM is not able to face. Scenarios beyond the SM.

Books and bibliography	O. Nachtmann: Elementary particle Physics. Concepts and Phenomena. Springer 1990 G. Kane: Modern elementary particle physics. Cambridge University Press 2017 P. Langacker: The Standard Model and beyond. CRC Press 2017 Exercises: N. Cartiglia: Manuale di esercizi di fisica delle particelle, Levrotto &Bella 2015; H. Georgi: Lie algebras in Particle Physics. ABP 1999.
Additional materials	Written notes on selected topics in current research, as indicated in the list of contents.

Work schedule			
Total	Lectures	Hands on (Laboratory, working groups, seminars, field trips)	Out-of-class study hours/ Self-study hours
Hours			
	55	5	90
ECTS			
	FIS-01	ECTS: 6	
Teaching strategy	Classroom lectures at the blackboard. Guided exercises.		
Expected learning outcomes			
Knowledge and understanding on:	Deep understanding of the main aspects of the fundamental interactions, of their mutual correlations, of their ordering principles, of their experimental aspects and confirmations, of the unsolved problems and of the limitations of the present descriptions. The exercises during the course are important to achieve such an understanding.		
Applying knowledge and understanding on:	Acquisition of competences useful for the research work and, importantly, development of scientific learning, understanding, and reasoning methods useful for jobs outside the research system.		
Soft skills	***Making informed judgments and choices:*** Development of the individual critical skills, ingenuity, and capability of autonomously getting conclusions and opinions about the various aspects of the fundamental interactions and more in general. ***Communicating knowledge and understanding:*** Capability of communicating scientific concepts in direct, complete and precise way, avoiding any jargon and shortcomings. ***Capacities to continue learning:*** Capability of approaching problems in an open minded, critical and creative way.		

Assessment and feedback	
Methods of assessment	Oral examination

Evaluation criteria	• *Knowledge and understanding*
	  ○ Deep understanding of the fundamental laws and of their consequences.
	• *Applying knowledge and understanding*
	  ○ Capability to establish correlations between different phenomena. Capability to perform numerical evaluations.
	• *Autonomy of judgment*
	  ○ Critical approach to the various aspects of the fundamental interactions, awareness of the limitations of the present descriptions and of the open problems.
	• *Communicating knowledge and understanding*

	○ Precision and coherence in the language. • *Communication skills* ○ Capability to use a simple communication language. • *Capacities to continue learning* ○ Capability to autonomously deepen selected aspects of the fundamental interactions.
Criteria for assessment and attribution of the final mark	Overall knowledge of the fundamental interaction laws and of the details of their phenomenology. Precision and completeness in the discussion.
Additional information	