| Essential Course Information | |
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| Course title | Particle Physics |
| Degree Course title | PHYSICS |
| ECTS | 6 |
| Compulsory attendance | YES |
| Course teaching language | ENGLISH |

| Teacher | TBD | |
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| ECTS Details | Disciplinary area | SSD | ECTS |
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| | Characterizing | FIS/04 | 6 |

| Time management and teaching activity type | Period | Year | Lesson type |
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| | 2nd semester | Ist | Lessons (32h)<br>Practical session (30h) |

| Time management | Total hours | In-class study hours | Out-of-class study hours |
|---|---|---|---|
| | 150 | 62 | 88 |

| Course calendar | Starting date | Ending date |
|---|---|---|
| | March 2021 | June 2021 |

| Syllabus | |
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| Prerequisites | The course has a phenomenological basis. The topics will be addressed starting from short references to theory to focus more on the experimental aspects, on the interpretation of the data and on the comparison with the theory.<br><br>It is therefore essential to get basic knowledge of the theoretical part and some specific topics, such as, for example, QED and Feynman diagrams, developed within the course of Theoretical Physics. It is also essential to have learned the notions of the course of Institutions of Nuclear and Subnuclear Physics. |
| Expected learning outcomes (according to Dublin Descriptors) | The learning outcomes expected at the end of the course for knowledge and understanding are:<br><br>- Knowledge of the phenomenology of elementary particles and of the main experimental methods on which it is based.<br>- Basic knowledge of fundamental interactions, the classification of particles and their properties, with reference to the Standard Model (leptons, quarks, gluons and W / Z bosons).<br><br>- Ability to satisfactorily refer about the main aspects of the wide phenomenology of elementary processes within the Standard Model. |

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| Course contents summary | |
| **Detailed syllabus** | Classification of elementary particles and references of the static model of quarks.<br><br>Low-energy hadron-hadron collisions: resonances, Breit-Wigner formula, low-energy confirmations of the static model of quarks.<br><br>High energy interaction and Dynamic model for quarks: Depp Inelastic Scattering (DIS), inelastic lepton-nucleon cross section, form factors and partons in nucleons, scaling and Callan-Gross formula, CC neutrino nucleon cross section, dependence of the structure functions on Q2, summary of DIS results. phenomenology of proton-proton collisions, hadron-hadron cross sections.<br><br>Review of theory and phenomenology of weak interactions.<br><br>Electron-positron interaction: results at low energy, the LEP collider and the detectors at LEP, cross sections e+e− → $\gamma$ → μ+μ−, e+e− → $\gamma$/Z0 → μ+μ−, e+e− → $\gamma$/Z0 → q antiq, the R ration, FB asimmetry, sen2 $\theta$ w, mass and width of Z0, number of light neutrino families, other results at LEP1, cross sections e+e− → f+f−, W+W−, Z0 Z0 at LEP2, measurement of mw and mt, other results at LEP2, hints of the search for Higgs boson at LEP.<br><br>QCD: gluons and color factors, color-color scattering, quark-gluon coupling factor, mesonic and barionic bound states, model for multihadron production and phenomenology of jets, coupling constant alpha s, running of alpha s, hints for jet physics at CDF.<br><br>The Standard Model: fundamental constituents and interactions, divergences for the weak and em interactions, hints for gauge theories, formal treatment of the Standard model, the Higgs mechanism, the model for leptons, the model for quarks, fermion masses, renormalization and QED screening, connections between QED and QCD.<br><br>CP violation and particle oscillations: neutral mesons K, direct and indirect CP violation, Cabibbo-Kobayashi-Maskawa matrix, unitarity triangle, neutral mesons B, CP violation in the B sector, neutrino oscillations in vacuum, oscillations between 3 flavors and CP violation, mass hierarchy, hints of experiments for neutrino oscillations.<br><br>Search for Higgs boson at Tevatron and LHC: LHC collider and |

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| | detectors for LHC, the Higgs couplings and decay modes, production cross sections, data analysis for Higgs searches, latest results.<br><br>Beyond the Standard Model: the problem of naturalness and fine tuning, introduction to the supersimmetry, experimental signatures of supersymmetric particles, hints for extra-dimensions, the dark matter, methods for dark matter detection. |
| Books | *S. Braibant et al., "Particles and fundamental interactions", Springer*<br><br>*D. H. Perkins: "Introduction to High Energy Physics", 4th edition, Cambridge University Press* |
| Notes | |
| Teaching methods | Classroom lessons supported by video projector and with the help of networked PCs. Practical sessions with the execution of exercises are foreseen to verify the application of the notions and a deep understanding of them . |
| Assessment of final mark | Oral examination |
| Evaluation criteria | The student<br>**Knows** the basic concepts of Standard Model Physics<br>**Knows** the experimental observables for physics measurements<br>**Knows** the experimental methods to look for new physics<br>**knows how** to benefit from the theoretical notions for practical applications for the experimental particle physics. |
| Other | |
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