Teaching guide

Subject identification

Subject	21033 - Nuclear and Particle Physics
Credits	2.4 de presencials (60 hours) 3.6 de no presencials (90 hours) 6 de totals (150 hours).
Group	Group 1, 2S, GFIS (Campus Extens)
Teaching period	Second semester
Teaching language	English

Professors

Lecturers	Horari d'atenció als alumnes					
	Starting time	Finishing time	Day	Start date	Finish date	Office
Rashid Nazmitdinov - rashid.nazmitdinov@uib.es	You need to book a date with the professor in order to attend a tutorial.					
Antonio Puente Ferrá toni.puente@uib.es	15:30	16:30	Tuesday	14/09/2016	31/07/2017	F309.2

Contextualisation

Nuclear and Particle Physics course aims to be an introduction to the description of elementary particles and their interactions. From these, the structure of the bound states is explained and its properties are characterized. Phenomenology and properties of atomic nuclei are introduced later analyzing how neutrons and protons give rise to the nuclei of different chemical elements.

Requirements

For understanding of theoretical aspects of the subject it is essential to have acquired adequate knowledge of the proper tools of quantum mechanics for interacting systems. It is highly recommended to have already studied the subject of atomic and molecular physics, where the student has been introduced in the properties of bound atomic states and the interaction of atoms with the radiation.

Essential requirements

Having passed the subjects of the third course on Quantum Physics and Quantum Mechanics.

Recommendable

Atomic and Molecular Physics.

Skills

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Within the generic skills the basic (B) and transversal (T) ones are distinguished, both included in the proposal degree of studies in Physics.

Specific

* E1: Being able to evaluate clearly the orders of magnitude, to develop a clear perception of situations that are physically different, but show analogies, thus allowing the use of known solutions to new problems.
* E2: Understand the essentials of a process / situation and establish a corresponding working model; the graduate should be able to perform the required approximations in order to reduce the problem to a manageable level; thinking critically to construct physical models.
* E3: Having a good understanding of the most important physical theories and their logical and mathematical structure, giving an experimental support and the physical phenomenon that can be described within these theories..
* E4 Being able to describe the physical world using mathematics, understand and know how to use mathematical models and approximations.
* E5: Being able to compare critically results of calculations based on a physical model with experimental observations.

Generic

* B1: Demonstrate knowledge and understanding in the area of physics that is a part of the general secondary education basis, at a level that it is supported by advanced textbooks and includes some aspects of the forefront Physics knowledge..
* B2: Know how to apply their knowledge to their work or vocation in a professional manner and have competences demonstrated typically through the preparation and defense of arguments at the solution of physical problems.
* B3: Having the ability to gather and interpret relevant data (usually within the area of physics) to make judgments that include reflection on relevant social, scientific or ethical themes..
* T1: Capacity for analysis and synthesis..

Basic

* You may consult the basic competencies students will have to achieve by the end of the degree at the following address: http://www.uib.eu/study/grau/Basic-Competences-In-Bachelors-Degree-Studies/

Content

The course contents will be spit in chapters that form the theoretical aspects of the subject. Associated with each theme, a collection of problems will be presented that, in its resolution, will demonstrate the practical application of the discussed techniques.

Theme content

1. Elementary particles

   Quarks and leptons families. Gauge bosons. Klein-Gordon equation. Dirac equation. Stability and half-life time.

2. Fundamental interactions

   Interaction with exchange of particles. Feynman diagrams and coupling constants. Electromagnetic, weak and strong processes. Range of interactions. Rates and cross sections.

3. The Standard Model

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Bound states of quarks: hadrons. Conservation laws, dynamic invariance and intrinsic quantum numbers. Isospin formalism. Predictions of the Standard Model at low energies. Excited states: hadronic resonances.

4. Weak processes
   Diagrams for lepton-W, lepton-Z processes. Quark-W and quark-Z diagrams. Mixing matrix. Decay and hadronization of strange hadrons. The Higgs boson.

5. Strong interaction
   Color charges. Confinement and asymptotic freedom.

6. Atomic nuclei
   General properties of the nucleus. Binding energies. Valley of stability. Processes and chains of disintegration.

7. Deuteron
   Parameterizations of interaction between nucleons. Deuteron properties.

8. Nuclear structure
   Phenomenological models. Pairing interaction. Spherical and deformed shell models.

9. Experimental techniques and applications
   Alpha-, beta- and gamma-spectroscopy. Estimation of sample activity.

Teaching methodology

The theoretical contents of the subject will be exposed in lectures. The student will fix the knowledge and develop the associated skills through attendance to lectures, personal study and practical work of problem solving. The problems posed in each chapter will be resolved after the exposition of theoretical content, whether through class tutorials, individually or in small groups. During the second half of the course students will be asked to attend laboratory and prepare an individual report.
The languages used for displaying the contents will be English and Spanish. However, students may use any of them, both orally and in writing. The statements of the tests will be given in Spanish.

Workload

The acquisition of knowledge, skills and abilities require different types of classroom and individual work. The time dedicated to each of these modes is presented in the following table.

In-class work activities

Modality	Name	Typ. Grp.	Description	Hours
Theory classes	Theory	Large group (G)	Purpose: To acquire an overview of the contents of the subject in order to assimilate the basic concepts and facilitate the acquisition of all competences of the matter. Methodology: Lectures.	30
Practical classes	Exposition of works	Large group (G)	Purpose: To develop the skills of analysis, synthesis and communication of results.	3

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Modality	Name	Typ. Grp.	Description	Hours
			Methodology: Short-term exposure of a proposed work individually or in small groups.	
Practical classes	Problems	Large group (G)	Purpose: Development of the competences by applying specific techniques, presented during the lectures, for problem solving. Methodology: Resolution and discussion of problems.	6
Laboratory classes	Laboratory experiments	Medium group (M)	Purpose: Getting acquainted with some experimental techniques. Methodology: Conducting laboratory practices. Preparation of an individual report.	6
ECTS tutorials	Tutorials	Medium group (M)	Purpose: To practice the application of techniques for solving of practical problems. Methodology: Guided problem solving and group discussion.	12
Assessment	Examination	Large group (G)	Purpose: To evaluate the evolution of student learning, especially in terms of understanding the contents of the subject. Methodology: Written exam based mainly on problem solving.	3

At the beginning of the semester a schedule of the subject will be made available to students through the UIBdigital platform. The schedule shall at least include the dates when the continuing assessment tests will be conducted and the hand-in dates for the assignments. In addition, the lecturer shall inform students as to whether the subject work plan will be carried out through the schedule or through another way included in the Campus Extens platform.

Distance education work activities

Modality	Name	Description	Hours
Individual self-study	Preparation of work	Purpose: Personal development of the report, corresponding to a proposed issue. The work must reflect the correct acquisition of the material, particularly regarding critical spirit of the methodology and approaches used, as well as adequate mathematical development. Methodology: Preparation of an individual report.	10
Group or individual self-study	Problem resolution	Purpose: Set the necessary knowledge by practicing personally solution of practical problems. Methodology: Solution of problems given in textbooks and in proposed list of problems.	20
Group or individual self-study	Study	Purpose: To acquire an overview of the contents of the subject to assimilate the basic concepts and facilitate the acquisition of all competences of the matter. Methodology: Individual study or group work.	60

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Specific risks and protective measures

During laboratory practices radioactive samples will be handled. Such samples, although low activity and being suitably encapsulated, should be handled with the appropriate protective measures exposed to that effect at the entrance to the laboratory.

Student learning assessment

The continuous assessment system will be used throughout the course. The assessment will be based on 1) objective evidence in the form of exams, mainly oriented to problem solving, 2) performance and discussion in classes of problems of exercises and 3) preparation and presentation of work and reports.

Exposition of works

Modality	Practical classes
Technique	Oral tests **(non-retrievable)**
Description	Purpose: To develop the skills of analysis, synthesis and communication of results. Methodology: Short-term exposure of a proposed work individually or in small groups.
Assessment criteria	Correctness of analysis, synthesis capacity and clarity in the presentation will be assessed.

Final grade percentage: 5%

Laboratory experiments

Modality	Laboratory classes
Technique	Student internship dissertation **(retrievable)**
Description	Purpose: Getting acquainted with some experimental techniques. Methodology: Conducting laboratory practices. Preparation of an individual report.
Assessment criteria	Correctness of analysis, synthesis capacity and clarity in the preparation and presentation of the data will be assessed.

Final grade percentage: 10%

Examination

Modality	Assessment
Technique	Objective tests **(retrievable)**
Description	Purpose: To evaluate the evolution of student learning, especially in terms of understanding the contents of the subject. Methodology: Written exam based mainly on problem solving.
Assessment criteria	There will be a partial test (P1) and a final exam (F) consisting of two parts: first partial recovery (P1) and (P2) for the remainder of thecourse content. All tests are mainly based on problem solving. The percentages of each test will be: P1-40%, P2-40%.

Final grade percentage: 80%

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Preparation of work

Modality	Individual self-study
Technique	Papers and projects **(non-retrievable)**
Description	Purpose: Personal development of the report, corresponding to a proposed issue. The work must reflect the correct acquisition of the material, particularly regarding critical spirit of the methodology and approaches used, as well as adequate mathematical development. Methodology: Preparation of an individual report.
Assessment criteria	Clear statement of the problem, objectives and applied techniques. Analysis and mathematical development. Discussion of the results.

Final grade percentage: 5%

Resources, bibliography and additional documentation

Basic bibliography

Particle Physics, B. R. Martin y G. Shaw (Wiley)
Introductory Nuclear Phsyics, S.S.M. Wong (Clarendon)
Fisica Nuclear y de Particulas: Problemas resueltos, María Shaw Martos y Amalia Wlliart Torres (Uned)
Shapes and shells in Nuclear Structure, S.G. Nilsson y I. Ragnarsson (Cambridge university press)

Complementary bibliography

Quantum theory of angular momentum, D.A. Varshalovich, A.N. Moskalev y V.K. Khersonskii (World Scientific)
Particles and Nuclei, B. Povh et al. (Springer)
Introductory Nuclear Physics, K. S. Krane (Wiley)
Techniques for nuclear and particle physics experiments. Leo, W.R. (Springer-Verlag)

Other resources

http://pdg.lbl.gov/
http://www.nndc.bnl.gov/nudat2/
List of problems.

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