SUBJECT TEACHING GUIDE

G2000 - Nuclear and Particle Physics

Double Degree in Physics and Mathematics
Degree in Physics

Academic year 2022-2023

1. IDENTIFYING DATA						
Degree	Double Degree in Physics and Mathematics Degree in Physics			Type and Year	Compulsory. Year 3 Compulsory. Year 3	
Faculty	Faculty of Sciences					
Discipline	Subject Area: Quantum Physics and the Structure of Matter Central Module					
Course unit title and code	G2000 - Nuclear and Particle Physics					
Number of ECTS credits allocated	6	Term		Semester based (2)		
Web						
Language of instruction	Spanish	English Friendly	No	Mode of delivery	Face-to-face	

Department	DPTO. FISICA MODERNA
Name of lecturer	ALICIA CALDERON TAZON
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Other lecturers	PABLO MARTINEZ RUIZ DEL ARBOL

3.1 LEARNING OUTCOMES

- - Know the elementary particles and the fundamental forces within the scheme of the Standard Model.
- Know the components and model of the nucleus.
- Understand the concept of disintegration, and its parameters.
- Be able to differentiate the different types of radiation, and its explanation at the nuclear level.
- Understand the concept of effective cross section.

4. OBJECTIVES
Acquire basic knowledge of atomic nuclei, nuclear processes, elementary particles and their interactions (in the scheme of the Standard Model), as well as the effects of the passage of ionizing radiation (alpha, beta, high-energy electromagnetic or hadronic) through matter and the methods of detecting these radiations. It is also intended to give an elementary idea of ??the possible applications related to Nuclear Physics and ionizing radiations.

6. COURSE ORGANIZATION	
CONTENTS	
1	Part I. Introduction Chapter 1. Basic Concepts. General introduction to nuclear and particle physics.
2	Part II: Nuclear Physics Chapter 2. Nuclear Phenomenology 2.1 Mass spectroscopy and binding energy. 2.2 Nuclear shapes and sizes. 2.3 Stable and unstable nuclei. 2.4 Semi-empirical mass formula. Drop pattern. 2.5 Radioactive decay: general properties. 2.6 Alpha, beta and gamma disintegration. 2.8 Nuclear fission. 2.9 Nuclear reactions. Chapter 3. Nuclear Models 3.1 Nucleon-nucleon interaction. nuclear potential. the deuteron. Independence of the charge and symmetry of the nuclear interaction. 3.2 Fermi gas model. 3.3 Layer model. Spin, parity and magnetic moment in the shell model. 3.4 Excited states in the shell model. 3.5 Non-spherical nuclei: collective model. Chapter 4. Nuclear Disintegration 4.1 General properties: decay constant, half-life and period. 4.2 Nuclear stability: alpha decay. 4.3 Beta decay. Fermi theory, electron momentum distribution. 4.4 Gamma decay: selection rules, transitions. 4.5 Internal conversion.

3	Part III: Particle Physics Chapter 5. Introduction to particle physics and the Standard Model. 5.1 Matter - Antimatter 5.2 Symmetries and conservation laws. 5.3 Feynman diagrams Chapter 6. Leptons, Quarks, and Hadrons 6.1 Multiplets of leptons and lepton numbers 6.2 Neutrinos. Oscillations, mixtures and masses 6.3 Evidence of quarks. Generations and quantum numbers 6.4 Hadrons: flavor independence and charge multiplets 6.5 Spectroscopy of the quark model Chapter 7. Weak interaction 7.1 Neutral and charged currents. W and Z. Symmetries of the weak interaction 7.2 Spin Structure of Weak Interactions 7.3 Weak interaction in hadrons. 7.4 Unification of electromagnetic and weak interactions Chapter 8. Strong interaction 8.1 Concept of Color. QCD 8.2 Bound states of heavy quarks 8.3 Coupling constant of the strong force and asymptotic freedom 8.4 Jets and gluons 8.5 Deep inelastic scattering experiments
4	Part IV: Interaction Radiation Matter, Nuclear Instrumentation Chapter 9. Interaction of Ionizing Radiation with Matter 9.1 Concepts of Range, Interaction Length, Attenuation. 9.2 Passage of Charged Particles in a Medium. Coulombian interaction. Dispersion and Ionization 9.3 Bethe-Bloch formula. Projectile and Medium Dependence. 9.4 Brehmsstralumg. Radiation Length and Critical Energy 9.5 Cherenkov effect 9.6 Gamm Rays: Photoelectric Effect, Compton Scattering, Pair Production, Attenuation 9.7 Hadron Interaction 9.8 Cascade Phenomena Chapter 10. Detectors and Instrumentation 10.1 Gas Detectors: Ionization Chamber, Proportional Counter, Geiger-Mueller Counter 10.2 Scintillation Counters and Photomultipliers 10.3 Solid State Counters 10.4 Accelerators. Collider Detectors

7. ASSESSMENT METHODS AND CRITERIA				
Description	Type	Final Eval.	Reassessn	%
Continuous assessment: throughout the course	Written exam	No	Yes	40,00
Final exam: all contents	Written exam	Yes	Yes	60,00
TOTAL				100,00

Observations

To pass the course, students must meet the requirements specified for the continuous and final evaluation, specified in the previous sections.

In case of being able to appear for the partial exams, the final mark will be the maximum between: 40% of the two partial exams + 60% of the ordinary exam or 100% of the ordinary exam.

In the case of not attending the midterms, you can go directly to the ordinary exam and this will count 100%.

Observations for part-time students

Evaluation will be done by the ordinary exam, that will count 100%.

8. BIBLIOGRAPHY AND TEACHING MATERIALS

BASIC

B. R. Martin: Nuclear and Particle Physics, segunda edición, Ed. John Wiley, NY 2009