COURSE OUTLINE

(1) GENERAL

SCHOOL	School of Science		
ACADEMIC UNIT	Physics		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	**10EKA04**	**SEMESTER**	**6**
COURSE TITLE	**Introduction to Nuclear and Particle Physics**		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures (theory and exercises)	5	7
Labooratory	1	

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Specialised Knowledge
PREREQUISITE COURSES:	No
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes, in the English language for Erasmus students
COURSE WEBSITE (URL)	https://eclass.uoa.gr/courses/PHYS122/

(2) LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

The course is the first systematic introduction to the fundamental aspects of Nuclear and Particle. It provides the students with the knowledge of the basic building blocks of matter and the fundamental symmetries involved in the strong nuclear interactions that is essential of both scientific subjects.

With the successful attendance and completion of the course, the student is in position to:

- Describe the Fermionic and Bosonic character of matter based on the Strandard Model.
- Understand the fundamental interactions among particles of matter.
- Determine the stability or disintegration of nuclear matter based on conservation principles and fundamental symmetries.
- Know the basic characteristics of nuclear structure and the radiation associated to its change.
- Explain the existence of various subatomic particles based on the Standard Model and describe their interactions with Feynman diagrams.
- Assess if a process is conserved or not based on fundamental symmetries and conservation laws.
- Calculate the stability of nuclei against potential decays based on the liquid-drop model and the energy balance of nuclear reactions.
- Evaluate nuclear radiation characteristics.
- Explain fundamental subatomic phenomena in basic and applied level.
- Evaluate theoretical models in comparison with experimental data.
- Organize the approach to questions and problems in a methodical and organized manner.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology
Adapting to new situations
Decision-making
Working independently
Team work
Working in an international environment
Working in an interdisciplinary environment
Production of new research ideas
Project planning and management
Respect for difference and multiculturalism
Respect for the natural environment
Showing social, professional and ethical responsibility and sensitivity to gender issues
Criticism and self-criticism
Production of free, creative and inductive thinking
……
Others…
…….

The course aims at the following general competences

Search for, analysis and synthesis of data and information, with the use of the necessary technology
Adapting to new situations / Decision-making
Working independently / Team work
Working in an international environment
Working in an interdisciplinary environment
Respect for the natural environment
Criticism and self-criticism / Production of free, creative and inductive thinking
Analytical and synthetic thinking / Critical thinking
Time management / Planning /Taking initiative/responsibility
Creativity / Determination/ Communication skills
Information management / Self control skills / Meeting Deadlines and Keeping Schedules
Flexibility / Adaptability / Problem solving

(3) SYLLABUS

- Characteristic scales and units, the standard model, quarks & leptons, conservation principles, relativistic kinematics.
- The field concept, interactions via boson exchange, Yukawa theory, Feynman diagrams, virtual particles, antiparticles, electromagnetic and weak interactions and their unification.
- Chromodynamics, strong interactions, symmetries (parity, charge conjugation, time reversal), static quark model, hadron classification.
- Properties of nuclei, valley of β-stability, semi-empirical formula, mirror nuclei.
- Charge distribution, scattering of electrons from nuclei, radioactivity, α-decay, tunneling effect.
- Nuclear potentials, deuterium, mean field theory, independent particle model, L-S coupling, nuclear shell model.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Yes Electronic communication with the students using ICT (Information and Communications Technology) Computer-aided lectures, use of video Projectors, specialized instrumentation (eg radiation detectors) eclass platform, instructors websites, use of online databases
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	Final written exams in Greek Open-ended questions, Problem solving Oral examination

Activity	Semester workload
Lectures - exercises	65
Laboratory	13
Seminars	15
Individual Study/ Study and Analysis of bibliography / Preparation	77
Educational Visits	5
Course Total	**175**

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography

- W.N. Cottingham & D.A. Greenwood (μετάφραση) Κ. Σαρηγιάννης, Εισαγωγή στην Πυρηνική Φυσική, Εκδόσεις Γ. Δαρδανός Κ. Δαρδανός ΟΕ, 2002.
- D. Perkins (μετάφραση) Κ. Σαρηγιάννης, Εισαγωγή στη Φυσική Υψηλών Ενεργειών, Εκδόσεις Γ. Δαρδανός Κ. Δαρδανός ΟΕ, 1998.
- S.S.M. Wong, Introductory Nuclear Physics (electronic resource), (2nd ed.), Heal-link Wiley UBCM ebooks, ISBN:9783527617906, 1998.
- B.R. Martin, Nuclear and Particle Physics (electronic resource), (1st ed.), Heal-link Wiley UBCM ebooks, ISBN:9783527617906, 2006.
- K. Krane, (επιμέλεια) Μ. Κόκκορης, Θ. Μερτζιμέκης, Ν. Πατρώνης, Σ. Στούλος, Εισαγωγή στην Πυρηνική Φυσική, Εκδόσεις Γ. Δαρδανός Κ. Δαρδανός ΟΕ, 2021.

- Related academic journals:

- Nature
- Scientific Reports
- Science
- Physical Review Letters
- Physical Review C
- Physical Review D
- Journal of High Energy Physics
- Journal of Instrumentation
- Nuclear Instruments and Methods in Physics Research A
- Nuclear Instruments and Methods in Physics Research B
- European Physics Journal A
- Journal of Physics G
- Physics Letters B
- Nuclear Physics A
- Nuclear Physics B
- arXiv.org Preprints
- Procedia
- IAEA Technical Reports