COURSE OUTLINE

(1) GENERAL

SCHOOL	School of Science		
ACADEMIC UNIT	Physics		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	**10YKO04**	**SEMESTER**	**4**
COURSE TITLE	**Physics IV (Modern 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)	6	7

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Special Background
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/PHYS183/*

(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 aims at introducing the fundamental principles of Modern Physics (quantum mechanics, atomic and subatomic physics) as well as in the perception of scientific methodology (theory-experiment) that led to the great discoveries in the field of physics. Upon completion of the course the student will be able to:

With the completion of the course the student is able to
•To know and apply relativistic definitions of quantities such as momentum and energy.
• To recognize and understand the experimental results that contradict the predictions of classical physics and highlight the particle nature of light and the wave nature of the particles.
• Understand the meaning of a wave function of a particle and its connection to the probability of finding it in space.
• Understand the solutions of Schrödinger's equation for simple one-dimensional problems and their consequences (such as quantum energy, tunneling effect).
• Use Heisenberg's Uncertainty Principle, mainly for estimates of size classes.
• Calculate typical quantities of atoms with one electron.
• Analyze the cumulative properties of multi-electron atoms.
• Describe qualitatively the structure of molecular bonds and spectra.
• Describe the characteristics of nuclear matter.
• Calculate typical quantities in nuclear reactions
•Understand the combined progress and synergy of experiment and theory that led to the Standard Model of Elementary Particles
• Understand and apply conservation laws to particle physics.
• Combine the above knowledge to draw qualitative and quantitative solutions/answers on complex physics problems.
• Evaluate the results of his/her calculations.

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
Teamwork
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
Teamwork
Production of new research ideas
Production of free, creative and inductive thinking

Analytical and synthetic thinking
Critical thinking
Taking initiative/responsibility
Creativity
Determination
Meeting Deadlines and Keeping Schedules
Flexibility / Adaptability
Problem solving

(3) SYLLABUS

• Relativistic energy and momentum of particles. Quantization of energy and momentum, invariant mass. Black body radiation. Photoelectric effect. Compton effect. Bremsstrahlung radiation. Creation - destruction of particle-antiparticle pair.

• De Broglie waves. Heisenberg's uncertainty principle. Two-slit experiment. Probability density. Wave function, Schrödinger equation, problems with infinite and finite potential wells.

• Bohr's model. The quantum mechanical atomic model. The hydrogen atom.

• Angular momentum and Spin. Magnetic Moments. Fine structure.

• The exclusion principle. Atomic spectra. Lasers and their applications.

• Molecular bonds. Metals and Semiconductors. Superconductivity. Nuclear properties. Nuclear Structure. Nuclear decays.

• Fission process. Fusion process. Elementary particles and interactions. Accelerators. Particle interaction with matter. Detectors.

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Face-to-face</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>Yes

Electronic communication with the students using ICT (Information and Communications Technology)
Computer-aided lectures, use of Overhead Projectors, eclass platform</td></tr>
<tr><td>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</td><td>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>52</td></tr>
<tr><td>Exercises</td><td>26</td></tr>
<tr><td>Seminars</td><td></td></tr>
<tr><td>Individual Study/ Study and Analysis of bibliography / Preparation</td><td>94</td></tr>
<tr><td>Writing reports/ essays/exams</td><td>3</td></tr>
<tr><td>Course Total</td><td>175</td></tr>
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</td></tr>
<tr><td>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.</td><td>Final written exam in Greek, with problem solving covering the entire course.

Oral examinations where appropriate.</td></tr>
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(5) ATTACHED BIBLIOGRAPHY

- Modern Physics, Beiser Arthur, ΕΚΔΟΣΕΙΣ Γ. ΔΑΡΔΑΝΟΣ-Κ. ΔΑΡΔΑΝΟΣ Ο.Ε (2001)
- University Physics, Part B, H. Young, R. Freedman, ΕΚΔΟΣΕΙΣ ΠΑΠΑΖΗΣΗ ΑΕΒΕ (2022)
- Physics for Scientists and Engineers Part B, Giancoli, ΕΚΔΟΣΕΙΣ ΤΖΙΟΛΑ & ΥΙΟΙ (2011)
- Fundamentals of physics, Part B, D. Hallidey, R. ResnicK, J. Walker, ΕΚΔΟΣΕΙΣ Γ. ΔΑΡΔΑΝΟΣ-Κ. ΔΑΡΔΑΝΟΣ Ο.Ε (2021)