

Module Outline

1. GENERAL

SCHOOL	OF SCIENCE AND TECHNOLOGY		
PROGRAMME	Studies in Natural Sciences		
LEVEL OF STUDIES	Level 6 of the Hellenic and European Qualifications Framework		
MODULE CODE	FYE40	YEAR	4th
MODULE TITLE	FYE40: Quantum Physics		
INDEPENDENT TEACHING ACTIVITIES <i>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</i>		HOURS	CREDITS
Weekly workload: (12-13 hours) x 32 weeks		392	14 ECTS
MODULE TYPE <i>Compulsory/Elective/ Mandatory Optional</i>	Compulsory		
MODULE DESCRIPTION <i>general background, special background, specialised, general knowledge, skills development</i>	Special background (Scientific Area)		
PREREQUISITE MODULES	FYE34		
LANGUAGE OF INSTRUCTION and EXAMINATIONS	Greek		
IS THE MODULE OFFERED TO ERASMUS STUDENTS	No		
MODULE WEBSITE (URL)	The Module has its own space in the digital learning environment of HOU (https://study.eap.gr/login/index.php , https://study.eap.gr/course/view.php?id=142) with controlled access (using a code) for students and Teaching Staff.		

2. LEARNING OUTCOMES

Learning outcomes

The learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the Module 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*

LEARNING OUTCOMES

Knowledge:

Upon successful completion of the Module, students are expected to:

- Demonstrate knowledge of the fundamental principles and the mathematical formalism of Quantum Physics and understand their physical significance.
- Understand the theoretical description of bound states and simple scattering processes.
- Be familiar with the quantum-mechanical description of the hydrogen atom and the role of spin in atomic structure.
- Know basic approximation methods for non-exactly solvable problems in Quantum Physics.
- Understand the principal models describing nuclear structure and behavior.
- Be familiar with the fundamental principles of Elementary Particle Physics (physical properties, symmetries, classification, and fundamental interactions).

- Understand the relationship between theoretical predictions and experimental data, and be able to comprehend modern research results published in scientific journals.

Skills:

Upon successful completion of the Module, students are expected to:

- Apply the mathematical formalism of quantum mechanics to systematically and rigorously analyze and solve problems involving bound states and simple scattering processes.
- Use appropriate theoretical models (including relevant conservation laws and relativistic kinematics) to characterize and quantitatively analyze the properties and behavior of nuclei and subatomic particles, both in decay processes and in their interactions.
- Compare and critically evaluate theoretical results against experimental data, identifying the validity limits of the applied models.
- Study and interpret selected scientific articles in related research areas.

Competences:

Upon successful completion of the Module, students are expected to:

- Systematically manage complex problems, apply theoretical concepts in depth, and develop autonomy in solving advanced-level exercises, as demonstrated through the completion of six (6) compulsory written assignments, each consisting of eight (8) comprehensive problems covering the entire syllabus.
- Demonstrate critical judgment in selecting and applying appropriate theoretical approaches.
- Evaluate the physical significance of mathematical results and formulate well-documented conclusions.
- Take responsibility for the organization and timely completion of extended academic assignments.
- Possess the necessary theoretical and methodological background to pursue postgraduate studies or to work in research or professional environments requiring autonomy, critical thinking, and evidence-based reasoning.

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 Module 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

The general skills that the students will acquire are:

- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Working independently
- Production of free, creative and inductive thinking

3. SYLLABUS

Purpose of Module

The aim of the Course Module is to provide an in-depth introduction to the theoretical description and understanding of microscopic physical systems, ranging from quantum systems with one or more degrees of freedom to the structure of atomic nuclei and elementary particles. The course seeks to develop a solid theoretical foundation in Quantum Mechanics, to promote understanding of fundamental nuclear phenomena, and to introduce the principles governing Elementary Particle Physics. At the same time, it aims to cultivate analytical and critical thinking through the mathematical formulation of physical laws and the connection between theoretical predictions and experimental observations.

Subjects covered

1. Quantum Mechanics
2. Introduction to Nuclear Physics
3. Introduction to the Physics of Elementary Particles

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY <i>Face-to-face, Distance learning, etc.</i>	- Distance teaching and learning with six (6) Group Counseling Meetings (GCMs) and at least four (4) Supporting Group Counseling Meetings (SGCMs) of 4-hour duration during the academic semester on weekends. - Personal communication and feedback (advisory role of Adjunct Faculty).														
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY <i>Use of ICT in teaching, laboratory education, communication with students</i>	<u>During GCMs and teaching the following are used:</u> - Remote meetings tools (webex, Teams), - Presentation software (PowerPoint, educational video - animations etc.), - Specialized software/databases for the subjects under study (NCBI PubMed, NCBI Blast, EndNote etc.). In addition, students use office automation tools, web browsers and e-reader for digital books. <u>Communication with the students is supported by:</u> - The digital platform of HOU (https://study.eap.gr/login/index.php) (course information, educational material posts, announcements, messages, examination results, user groups, discussion forums etc.). - e-mail														
TEACHING METHODS <i>The manner and methods of teaching are described in detail.</i> <i>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.</i> <i>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</i>	<table border="1"> <thead> <tr> <th>Activity</th><th>Year Workload</th></tr> </thead> <tbody> <tr> <td>6 GCMs and 4 SGCMs (x 4 hours)</td><td>40</td></tr> <tr> <td>6 Written Assignments (x 16 hours)</td><td>96</td></tr> <tr> <td>Individual Study time (7-8 hours x 32 weeks)</td><td>238</td></tr> <tr> <td>Self-evaluation activities</td><td>9</td></tr> <tr> <td>Final examination</td><td>9</td></tr> <tr> <td>Total Workload</td><td>392</td></tr> </tbody> </table>	Activity	Year Workload	6 GCMs and 4 SGCMs (x 4 hours)	40	6 Written Assignments (x 16 hours)	96	Individual Study time (7-8 hours x 32 weeks)	238	Self-evaluation activities	9	Final examination	9	Total Workload	392
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STUDENT PERFORMANCE EVALUATION <i>Description of the evaluation procedure</i> <i>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</i> <i>Specifically-defined evaluation criteria are given, and if and where they are accessible to students.</i>	Students' evaluation – Grade assessment of a Module: a. Six (6) Semester Assignments (A) which contribute equally to the final grade with a value of 5% each and 30% of the final grade as a total. <i>The scoring of educational activities and assignments is activated only if the student succeeds an overall score equal to or above the base (≥ 5) in the final or repeat exams.</i> b. Final or repeat exams (E) contributing to the final grade of the module by 70% (35% from the exam of part A and 35% from the exam of part B). The Final Grade of the module, within scale 1-10 (10 is the excellent), is calculated as follows: Final Grade= (Ax0.3) + (Ex0.7) Language of evaluation: Greek														

5. ATTACHED BIBLIOGRAPHY

- Bibliography given to the students:

- 1) *An Introduction to Quantum Mechanics*, Stefanos Trachanas, Willey (2017), translated from Greek originally published from Crete University Press (2016).
- 2) *An Introduction to Nuclear Physics*, W.N. Cottingham & D. A. Greenwood, Cambridge University Press (1995).
- 3) *Introduction to Nuclear Physics*, Panagiotis A. Asimakopoulos, published in Greek by HOU (2004)
- 4) *Introduction to Elementary Particle Physics (Quantum Physics, vol. C)*, Ioannis D. Vergados, published in Greek by HOU (2003).

Additional and alternative teaching materials (webcasts), as well as slides from the Group Counseling Meetings are in the website of the course and in the digital reader (locklizard) of HOU:

<https://apothesis.eap.gr/>

<https://study.eap.gr/>

- Other suggested bibliography:

- 1) *Introduction to Quantum Mechanics*, Kyriakos Tamvakis, in Greek by Leader Books (2013).
- 2) *Exactly Solvable Quantum Mechanical Potentials*, Stefanos Trachanas, Στέφανος Τραχανάς, in Greek by Crete University Press (2014).
- 3) *Introductory Nuclear Physics*, Kenneth Krane, Willey (1988).

- Related academic journals:

Physical Review Letters (PRL)

Physical Review A (atomic and quantum physics)

Physical Review C (nuclear physics)

Physical Review D (particle physics, cosmology, etc)

Nature Physics

European Physical Journal A (nuclear physics)

European Physical Journal C (particle physics)

Physics Letters B (Particle Physics, Nuclear Physics and Cosmology)

Journal of High Energy Physics (JHEP) (particle physics)

Nuclear Physics A (nuclear physics)

Nuclear Physics B (particle physics, cosmology, etc)

Progress in Particle and Nuclear Physics