COURSE OUTLINE

(1) GENERAL

SCHOOL	School of Science		
ACADEMIC UNIT	Physics		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	**10EK403**	**SEMESTER**	**8**
COURSE TITLE	**Contemporary Quantum Mechanics & Applications**		

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)	4	6

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/PHYS253/

(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 first objective of the course is to introduce the concepts of density matrix, mixed states, multipartite systems, quantum entanglement, quantum information, qubits, quantum teleportation and quantum cryptography.

The second objective of the course is to provide an introduction to classical and quantum open systems, decoherence, non-unitary evolution, Kraus operators and Lindblad equations.

With the completion of the course the student:

- Becomes familiar with time-dependent perturbation theory.
- Becomes familiar with the use density matrix formalism to solve problems of multipartite quantum systems.
- Understands the basic concepts concerning quantum correlations such as entanglement, discord, mutual information, etc .
- Becomes familiar with the basic ingredients of quantum information theory.
- Becomes familiar with the theoretical basis of the recent developments in quantum technology (teleportation, quantum cryptography, etc.).
- Is able to solve problems of non-unitary evolution.
- Becomes familiar with decoherence and its impact on quantum interference.

By developing these skills, students will be able to:

- Solve problems related to radiation-matter interaction.
- Solve problems in open quantum systems and multipartite quantum systems.
- Follow the recent developments in quantum information and technology.
- Upgrade his conception of quantum mechanics.
- Understand the role of environment in quantum mechanical applications.

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…
…….

By successfully attending and completing the course the student will acquire the following skills:

• Ability to search, analyze and compose data and information, using the appropriate technological tools.
• Ability to work autonomously.
• Train free, creative and inductive thinking.
• Train analytical and synthetic thinking.
• Ability to solve problems.

(3) SYLLABUS

- Time-dependent perturbation theory, matter-radiation interaction, applications.
- Open quantum systems, density matrix.
- Quantum coherence-decoherence.
- Quantum entanglement, elements of measurement theory, EPR paradox, Bell inequalities.
- Elements of quantum information and quantum computers.
- Elements of quantum technology (quantum teleportation, quantum cryptography)
- Non-unitary evolution, Kraus operators.
- Quantum master equations, Lindblad equation.

(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>39</td></tr>
<tr><td>Exercises</td><td>13</td></tr>
<tr><td>Individual Study/ Study and Analysis of bibliography / Preparation</td><td>95</td></tr>
<tr><td>Writing reports/ essays</td><td>3</td></tr>
<tr><td>Course Total</td><td>150</td></tr>
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<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 exams in Greek
Open-ended questions, Problem solving</td></tr>
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(5) ATTACHED BIBLIOGRAPHY

Lectures notes of the tutors (in greek).