COURSE OUTLINE

(1) GENERAL

SCHOOL	School of Science		
ACADEMIC UNIT	Physics		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	**10ΕΛΕ01**	**SEMESTER**	**8**
COURSE TITLE	**Atomic and Molecular 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)	4	6

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	General 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/PHYS159/

(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 provides the student with an introduction to the quantum mechanics of atoms and molecules. It provides knowledge related to the interaction of the hydrogen atom with external magnetic fields and the spectral fine structure, multi-electron atoms in a magnetic field, multiple excitations. The hyper-fine structure and laser. It also provides insights into the quantum mechanical description of molecules in the aspects of the Born-Oppenheimer approach, the development of chemical bonds, the electronic, structural and vibration and rotation properties of molecules and molecular spectroscopy.

By successfully attending and completing the course, the student is able to:

- To interpret spectral fine structure, multi-electron atoms in a magnetic field, multiple excitations. and the hyper-fine structure.
- To use approximate quantum mechanical methods to solve the Schroedinger equation for the electrons and nuclei of simple molecules.
- Understand the nature of the chemical bonds of molecules and interpret the electronic, vibration and rotation energy structure.
- To interpret the experimental results of molecular spectroscopy.
- Formulate concepts and laws and propose solutions to molecular quantum mechanics problems.
- To compare the description of phenomena from different theories and evaluate their results for measured physical quantities.

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
Decision-making / Working independently
Production of new research ideas
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
New Technology skills / Creativity /Communication skills
Information management
Problem solving

(3) SYLLABUS

- Hydrogen atom. Electron spin and interaction with external magnetic field. Coupling with orbital momentum. Atomic spectra. Fine structure.

- Spectrum of He. Pauli's exclusion principle.

- Hartree theory. L–S and J–J coupling. Magnetic moments.

- Multi-electron atoms. Atomic spectra. Interaction with an external magnetic field. Multiple excitations. Hyper fine structure. LASER.

- Fundamental principles of molecular physics. Born-Oppenheimer approximation.

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- Linear Combination of Atomic Orbitals (LCAO). Valence bond theory. Energy structure and molecular spectra. Symmetries of molecules. Molecular orbitals. Huckel's approximation.

- Experimental methods in molecular spectroscopy .

(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>26</td></tr>
<tr><td>Exercises</td><td>26</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Individual Study/ Study and Analysis of bibliography / Preparation</td><td>98</td></tr>
<tr><td></td><td></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 examinations in Greek related to problem solving.
Oral examinations (where required) related to problem solving.
Mid-term written examination dealing with problem solving.

Solutions to the exam problems are accessible to students at the meeting where they are invited to see their papers.</td></tr>
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(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- Lecture Notes uploaded on the eclass site of the Course.
- P. Atkins and R. Friedman, Molecular Quantum Mechanics, Oxford University Press(2005))