COURSE OUTLINE

(1) GENERAL

SCHOOL	SCIENCE		
ACADEMIC UNIT	DEPARTMENT OF PHYSICS		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	201	**SEMESTER**	7
COURSE TITLE	ATOMIC PHYSICS & LASERS		

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**
	4	5
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Specialized general knowledge
PREREQUISITE COURSES:	Good knowledge of Quantum Mechanics I is recommended
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes
COURSE WEBSITE (URL)	http://ecourse.uoi.gr/course/view.php?id=591

(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 primary objective of the course is the in-depth understanding of the electronic structure of atoms and atomic processes under the influence of external disturbances. The course provides the necessary specialized knowledge in Quantum theory for the description of systems with many electrons as well as calculation techniques related to problems of atomic structure as well as dynamics when external fields are involved, especially laser fields.

After successful completion of the course, the student will be able to:

- expand and specialize his/her knowledge of Quantum theory through its application at the purely atomic level.
- understand the quantum mechanical description of multi-electron atoms.
- understand the quantum mechanical description of atoms under the influence of constant but also time-varying external fields, especially laser fields.
- carry out quantum mechanical calculations corresponding to realistic atomic processes.
- follow the time evolution of the physical problems related to the atomic theory.
- know the physics of the basic operating mechanisms of the laser.
- know the quality characteristics and the most popular applications of all types of lasers and based on these to be able to choose and evaluate their use.

- know the applications of laser fields in atomic physics.
- perceive and evaluate the range of applications of atomic processes in other branches of Physics, in related sciences, as well as in technology

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

-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

Principles of operation and description of the Laser. Gaussian beams and propagation. CW lasers, population rate equations. Pulsed Lasers, Q-switching, Mode-locking. Types of Lasers. Elements of Quantum Mechanics. One electron atomic systems. Interaction of one electron atomic systems with radiation, transitions, dipole approximation, selection rules, atomic spectra, lifetimes, spectral distributions. Fine and Hyperfine structure. One electron atoms in external fields, Zeeman and Stark effects. Two electron atomic systems, wavefunctions, notation, excited states. Many electrons atomic systems, Central Field Approximation, Thomas-Fermi model, Hartree-Fock method, LS coupling, Hund rules, Periodic Table, Alkali spectra, X-ray spectra. Special Topics of Atomic Physics, Photoionization, Rabi oscillations, interaction with strong laser fields.

(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*	• Use of ICT in teaching and communication with students. • The University's asynchronous distance learning **ecourse** system is used to provide notes, exercises and assignments. • Communication with students outside of class is mainly via email.
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*	

Activity	***Semester workload***
Lectures	26
Tutorials	13
Study and analysis of bibliography	55
Essay writing	20
Non-directed study	8
Exams	3
Course total	***125***

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.*	Written exams at the middle and the end of the semester which include multiple choice questionnaires and problem solving. Homework on problem solving per taught unit. Special topic assignment with required class presentation at the end of the course

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

1. Books and/or notes on Quantum Mechanics offered by the Department of Physics of the University of Ioannina to the students during their course enrolment.
2. " Atomic Physics and Lasers", Notes, E.P. Benis.
3. “Physics of Atoms and Molecules”, B.H. Bransden and C.J. Joachain, Longman Scientific and Technical, 1983.
4. “Κβαντική Φυσική”, Stephen Gasiorowicz, Εκδόσεις Κλειδάριθμος, 2015.
5. “Κβαντομηχανική ΙΙ”, Σ. Τραχανάς, Πανεπιστημιακές Εκδόσεις Κρήτης, 2009.
6. “Atoms Molecules and Photons”, W. Demtröder, Springer, 2010.
7. "Physics of Laser", Notes, E.P. Benis.
8. “Principles of Lasers”, O. Svelto, Plenum Press, 1998.
9. “Fundamentals of Photonics”, B.E.A. Saleh and M.C. Teich, Wiley-Interscience, 2007.