ETY401 - Quantum Theory of Matter

COURSE OUTLINE

(1) GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	ETY401	**SEMESTER**	**4**
COURSE TITLE	Quantum Theory of Matter		

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

COURSE TYPE *general background, special background, specialized general knowledge, skills development*	General background
PREREQUISITE COURSES:	NO
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK
IS THE COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE WEBSITE (URL)	http://cmsl.materials.uoi.gr/lidorikis/courses.html

(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*

Knowledge: Learning and understanding the basic principles of modern quantum theory, with main emphasis on the properties of materials. The student will be able to distinguish between different phenomena and the effects/changes brought about by the quantum nature of matter.

Skills: Solving simple quantum problems such as e.g. electronic states, electronic structure of simple systems, eigenvalue problems, electronic transitions (absorption-emission), scattering problems, etc. Combination of two or more phenomena in one problem.

Competences: Understanding of complex devices and applications based on quantum phenomena (e.g. electronic microscopes, electronic nanodevices), comparing devices regarding the quantum phenomena that govern their operation, ability to attend advanced physics and chemistry courses such as quantum chemistry.

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, analyze and synthesize data and information, using the necessary technologies
- Production of new research ideas
- Autonomous work

(3) SYLLABUS

The Quantum Theory of Light: The experiments of Hertz-the light as an electromagnetic wave. Black body radiation. Rayleigh-Jeans Law. Derivation of the Plank formula for the black body. Quantization of light and photoelectric effect. Compton effect and X-rays. Particle-wave complementarity.

The Particle Nature of Matter: The atomistic nature of Matter. The constituents of atoms. The Bohr atom.

Material waves: The de Broglie wave. The experiment of Davisson-Germer. Waveforms and dispersion. Heisenberg's uncertainty principle. Wave-particle dualism.

Quantum mechanics in one dimension: The Born interpretation. The wave function of a free particle. Waveforms in the presence of forces. Particle in a box. Finite potential well. The harmonic quantum oscillator. Expectation values. Physical quantities and operators.

Tunneling Effects: Rectangular barrier, Barrier transmission, Applications.

Quantum Mechanics in Three Dimensions: Particle in three-dimensional box. Central forces and angular momentum. Quantization of space. The hydrogen atom.

Atomic Structure of Materials: Orbital magnetism and Zeeman's phenomenon. The rotating electron. Spin-orbit interaction and other magnetic effects. Exchange symmetry and exclusion principle.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	In class, lectures
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Communication with the students also through the course website
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*	

Activity	***Semester workload***
Lectures	39
In class recitation	13
Self-study for preparing	48

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*	for final examination	
	Course total	100
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.*	LANGUAGE OF EVALUATION: Greek METHOD OF EVALUATION: Written final exam: • Development and explanation of theory • Developing and resolving problems	

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- R.A. Serway, C.J. Moses, C.A. Moyer, "*Modern Physics*", Crete University Press, Heraklion Crete 2009. Isbn 960-524-059-9

- Stefanos Traxanas, "*Quantum Mechanics I*", Crete University Press, Heraklion Crete 2009. Isbn 960-524-206-0