COURSE OUTLINE

(1) GENERAL

SCHOOL	School of Science		
ACADEMIC UNIT	Physics		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	**10EK501**	**SEMESTER**	**8**
COURSE TITLE	**Correlated Quantum Systems**		

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/PHYS205/

(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*

In this course the student acquires the necessary knowledge for the understanding of the magnetic properties of matter (diamagnetism, ferromagnetism, antiferromagnetism), superconductivity, dielectric and optical properties of solids, mainly on the basis of microscopic principles and quantum mechanics.

With the completion of the course the student is able to:

Describe the phenomena of diamagnetism, ferromagnetism, antiferromagnetism, superconductivity, dielectric phenomena, and ferroelectricity.
Recognise the importance of strong correlations with respect to these phenomena.
Trace back the aforementioned phenomena to first principles of many-body quantum mechanics.

Calculate critical phase-transition temperatures in magnetic, superconducting and ferroelectric materials.
Explain the basic notions, principles and laws related to strong correlations.
Solve many-body problems with approximate methods.

Compose models that describe materials with strong correlations.
Evaluate the approximate solutions of models.

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…*
	…….

The course aims at the following general competences

Working independently
Production of free, creative and inductive thinking
Analytical and synthetic thinking
Critical thinking
Time management
Creativity
Meeting Deadlines and Keeping Schedules
Problem solving

(3) SYLLABUS

- Quantum theory of magnetism. The magnetic Hamiltonian and the electronic spin. Diamagnetism and paramagnetism.
- Second quantization formalism. Origin of the spontaneous magnetization and of the magnetic interactions.
- Models of magnetic systems. Types of magnetic order: ferromagnetism, antiferromagnetism. Magnons. Magnetization correlations and magnetic order transitions.
- Attractive electron interaction. Cooper pairs.
- Microscopic theory of superconductivity: BCS and Valatin-Bogoliubov theory. Isotopic effect.
- Order parameter correlations and superconducting order transitions. Landau-Ginzburg phase transition theory.

(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

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>Individual Study/ Study and Analysis of bibliography / Preparation</td><td>98</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>
</table>

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography

- C. Kittel, «Εισαγωγή στη Φυσική Στερεάς Κατάστασης», ΕΚΔΟΣΕΙΣ Α.Γ. ΠΝΕΥΜΑΤΙΚΟΣ, Αθήνα 1979. Code 6847
- (C. Kittel, "Introduction to Solid State Physics", translated to greek, Pnevmatikos Editions, Athens 1979)
- Ε. Ν. Οικονόμου, «Φυσική Στερεάς Κατάστασης, Τόμος ΙΙ», ΙΤΕ ΠΑΝ/ΚΕΣ ΕΚΔ. ΚΡΗΤΗΣ, Ηράκλειο 2003. Κωδ. «Εύδοξου» 299
- (E.N. Economou, "Solid State Physics, Vol. II", Crete University Editions, Heracleon 2003)
- H. Ibach & H. Lüth, «Φυσική Στερεάς Κατάστασης», ΕΚΔΟΣΕΙΣ ΠΕΛΑΓΙΑ ΖΗΤΗ, Θεσσαλονίκη 2011. Κωδ. «Εύδοξου» 12583778
- (H. Ibach & H. Lüth, "Solid State Physics", translated to greek, Pelagia Ziti Editions, Thessaloniki 2011)
- N. W. Ashcroft & N. D. Mermin, «Φυσική Στερεάς Κατάστασης», ΕΚΔΟΣΕΙΣ Α.Γ. ΠΝΕΥΜΑΤΙΚΟΣ, Αθήνα 2012. Κωδ. «Εύδοξου» 22768829
- (H. Ibach & H. Lüth, "Solid State Physics", translated to greek, Pnevmatikos Editions, Athens 2012)
- Γ. Ψαλτάκης, «Κβαντικά Συστήματα Πολλών Σωματιδίων», ΠΑΝΕΠΙΣΤΗΜΙΑΚΕΣ ΕΚΔΟΣΕΙΣ ΚΡΗΤΗΣ, 2008. Κωδ. «Εύδοξου» 293
- (G. Psaltakis, "Quantum many-body systems", University of Crete Publications, 2008)

- Related academic journals:

- Physical Review B
- Physical Review Letters
- Journal of Magnetism and Magnetic Materials
- Journal of Superconductivity.