COURSE OUTLINE

(1) GENERAL

SCHOOL	School of Science				
ACADEMIC UNIT	Physics				
LEVEL OF STUDIES	Undergraduate				
COURSE CODE	10E/VE04	AE04 SEMESTER 8			
COURSE TITLE	GROUP THEORY AND 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	4		6
COURSE TYPE general background, special background, specialised general knowledge, skills development	General Knowledge				
PREREQUISITE COURSES:	No				
LANGUAGE OF INSTRUCTION and	Greek				
EXAMINATIONS:					
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes (in the English language for Erasmus students)				
COURSE WEBSITE (URL)	https://eclass.uoa.gr/courses/PHYS299				

(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 the opportunity to become familiar with basic concepts and theorems of the mathematical Group Theory, as well as to learn methods for systematically solving problems related to the impact of symmetry transforms to the phenomenological properties of physical systems. By successfully attending and completing the course, the student will be able to:

- Understand the origin of conservation laws in Physics.
- Understand in depth properties of operators and their connection to physical observables (angular momentum, spin).
- Use Group theoretical tools to extract spectral properties (eigenvalues, eigenstates) of Hamiltonian operators of quantum systems with specific symmetries.
- Use Group Theory to describe the modes of mechanical systems in symmetric set-ups.
- Use Group Theory to derive selection rules, implied by underlying symmetries, for possible transitions in quantum mechanical systems.

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	Project planning and management
information, with the use of the necessary technology	Respect for difference and multiculturalism
Adapting to new situations	Respect for the natural environment
Decision-making	Showing social, professional and ethical responsibility and
Working independently	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:

- Search for, analysis and synthesis of data and information, with the use of the necessary technology.
- Working independently.
- Analytical and synthetic thinking.
- Critical thinking.
- Problem solving.

(3) SYLLABUS

- Groups: definition, categories and examples. Multiplication table. Construction of groups. Mapping between groups. Conjugacy classes. Subgroups. Permutation groups. Point symmetry groups.
- Representations of finite groups. Orthogonality theorems. Character tables. Reducible and irreducible representations. Reduction of representations. Examples from physics. Partial diagonalization in eigenvalue problems using symmetry. Degeneracy. Degeneracy lifting induced by a perturbation.
- Topological groups and Lie groups. Continuous rotation groups and their representations. The O(2), SO(3), O(3), SU(2) groups. Examples from atomic physics. SU(N) groups with N>2. Young diagrams. Isospin. Nucleon-nucleon scattering.
- Irreducible tensor operators. Selection rules in optical transitions. Projection operators. Construction of symmetrized eigenfunctions in electronic structure and molecular vibration problems. Crystal harmonics. The group of lattice translations. Bloch theorem.
- Time reversal symmetry. Kramers degeneracy. Non-unitary groups and their applications in magnetism.

DELIVERY Face-to-face, Distance learning, etc.	Face-to-face (Distance learning in special circumstances)			
USE OF INFORMATION AND	Yes			
COMMUNICATIONS TECHNOLOGY Use of ICT in teaching, laboratory education, communication with students	Electronic communication with the students using ICT. Computer-aided lectures, e-class platform.			
TEACHING METHODS	Activity	Semester workload		
The manner and methods of teaching are	Lectures	52		
aescribea in detail. Lectures, seminars, laboratory practice.	Individual Study/ Study and	95		
fieldwork, study and analysis of bibliography,	Analysis of bibliography /			
tutorials, placements, clinical practice, art	Preparation			
workshop, interactive teaching, educational visits project essay writing artistic creativity	Exams	3		
etc.				
The student's study hours for each learning	Course Total	150		
activity are given as well as the hours of non-				
directed study according to the principles of the ECTS				
STUDENT PERFORMANCE				
EVALUATION				
Description of the evaluation procedure	Written final exam in Greek.			
Language of evaluation, methods of evaluation,				
summative or conclusive, multiple choice				
ended questions, problem solving, written work,				
essay/report, oral examination, public				
presentation, laboratory work, clinical				
Specifically defined avaluation criteria are				
given, and if and where they are accessible to				
students.				

Suggested bibliography:

- I. Vergados, Group Theory, volumes A' and B', E. Kalamaras Editions, 1991 (in Greek)
- M.S. Dresselhaus, Applications of Group Theory to the Physics of Solids, MIT 2002
- F.W. Byron and R.W. Fuller, Mathematics of Classical and Quantum Physics, Dover, 1992

Instructors' notes and plenty of notes online.