COURSE OUTLINE

(1) GENERAL

SCHOOL	School of Science		
ACADEMIC UNIT	Physics		
LEVEL OF STUDIES	Undergraduate (postgraduate course offered to undergraduate students)		
COURSE CODE	**10EK411**	**SEMESTER**	**7**
COURSE TITLE	**MATHEMATICAL 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	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/PHYS230/

(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 the use of approximate mathematical methods for solving complex physical problems as well as advanced techniques for solving wave type partial differential equations for a range of boundary conditions. By successfully attending and completing the course, the student will be able to: • Use orthogonal polynomials as a basis for solving the Laplace, diffusion, Helmholtz and Poisson equations for various boundary conditions. • Use advanced integration techniques in the complex plane. • Calculate a variety of mathematical transforms and their inverses (Fourier, Laplace, Hilbert, Mellin) and be able to use them in solving physical problems. • To be able to find the asymptotic expansions of special functions defined through integral relations and to understand their connection to physical problems. • Calculate Green's functions for a series of wave-type equations. • To use the technique of Green's functions to solve problems of non-relativistic and relativistic Quantum Mechanics. • To solve Fredholm and Volterra type integral equations focusing on their application to scattering problems in Quantum Mechanics.

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. • Working independently. • Analytical and synthetic thinking. • Critical thinking. • Problem solving.	

(3) SYLLABUS

- Special functions and orthogonal polynomials. Expansion in eigenfunctions. Laplace, diffusion, Helmholtz, Poisson equations (4 hours).
- Hilbert transform. Dispersion relations. Advanced complex integration techniques and their applications (12 hours).
- Saddle point and stationary phase approximations. Asymptotic expansions (10 hours).
- Green's functions: Construction of Green's functions for the Helmholtz, Poisson, Laplace equations and for the wave equation (8 hours).
- Problems in Cartesian, spherical and cylindrical coordinates with homogeneous and inhomogeneous boundary conditions. Expansion in orthogonal polynomials. The importance of propagator and Green's function in quantum mechanics (8 hours).
- Integral equations: Fredholm and Volterra equations. Relation to Green's equations. Exact solution techniques through expansion in orthogonal polynomials and through integral transformations (Fourier, Laplace, Mellin, Hankel). Solving through iterative approaches (10 hours).

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Face-to-face (Distance learning in special circumstances)</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.
Computer-aided lectures, e-class 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>52</td></tr>
<tr><td>Individual Study/ Study and Analysis of bibliography / Preparation</td><td>48</td></tr>
<tr><td>Exercises at home</td><td>50</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 exams in the Greek language (or English) combined, if necessary, with an oral exam</td></tr>
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(5) ATTACHED BIBLIOGRAPHY

Suggested bibliography:

- Mathematics of Classical and Quantum Physics, F. W. Byron & R. W. Fuller (Dover)
- Methods of Theoretical Physics, P. M. Morse & A. H. Feshbach (Mc Graw Hill)
- Methods of Mathematical Physics, R. Courant & D. Hilbert (Wiley)
- Elements of Green's Functions and Propagation, G. Barton (Oxford Science Publications)
- Mathematical Physics: A modern introduction to its foundations, S. Hassani (Springer)

Instructor's notes and plenty of notes online