COURSE OUTLINE

(1) GENERAL

SCHOOL	School of Science			
ACADEMIC UNIT	Physics			
LEVEL OF STUDIES	Undergraduate (postgraduate course offered to undergraduate students)			
COURSE CODE	**10EK511**	**SEMESTER**	**8**	
COURSE TITLE	**PHYSICS OF THE EARTH'S SOLID CRUST**			
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*	Specialized 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/PHYS172			

(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 aim of the course is to provide the general principles for understanding the complex phenomena that take place in the Solid Crust of the Earth. The fields of deformation, mechanical stress, temperature as well as the electromagnetic field of the Earth's Solid Crust are examined. The governing equations are given, and various models are developed for understanding the processes in the Earth's Solid Crust. The tectonic processes that are due to the stresses of the Earth's Solid Crust and cause earthquakes are presented. An introduction is made to the methods of analysis such as electrical and electromagnetic methods. The VAN short-term earthquake prediction method is presented as well as the physics of the corresponding Seismic Electric Signals. With the completion of the course the student is able to:

- To understand the fields (mechanical stress, mechanical deformation, temperature, electromagnetic) that exist in the Solid Crust of the Earth as well as the equations that govern their spatiotemporal evolution.
- Be able to solve the elasticity equations for the spatio-temporal evolution of the strain field and derive the body (seismic) waves traveling in the Earth's Solid Crust.
- To be able to calculate fluctuations and phase and group velocities for surface seismic waves.
- To be able to calculate the propagation of thermal fluctuations from the surface to the Solid Crust of the Earth and to understand the Kelvin model for the first scientific calculation of the age of the Earth.
- To be able to calculate the transmission of electromagnetic signals in the Solid Crust of the Earth.
- To be able to recognize Seismic Electric Signals (SES) in the recordings of the electric field of the Earth and extract information from them on the epicentral distance and the magnitude of the impending earthquake.

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:

- 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

1. Introduction to elasticity theory (12 hours)
Mechanical stress and strain. The elastic region as a necessary limit of thermodynamic equilibrium. Lamé measures. Equations of elasticity. The body waves P and S as solutions of these equations with the corresponding scalar and vector potentials.

2. Introduction to Physics of the Rocks (4 hours)
Introduction to Physics of the Earth. Grüneisen theory. Harmonicity-anharmonicity. Melting. Porous materials. Heterogeneity and transfer phenomena. Effect of fluid infiltration on the elastic parameters of rocks.

3. Strength, imperfections and breakage of crystalline materials and rocks (4 hours)
Effect of point and line defects on the strength of crystalline materials and fracture processes, theoretical models. Mechanical properties of materials of the Earth. Critical phenomena and dynamic instability during the fracture preparation process. Theoretical models relating mechanical processes preceding rock fracture to the emission of wide-frequency electromagnetic signals.

4.Seismic waves and structure of the Earth's Solid Crust (12 hours)
Seismic waves. Structure of the Earth's Solid Crust. Thermal and pressure gradients in Earth's interior. Earthquakes and tectonics of lithospheric plates, faults. Body waves. Surface waves. Seismic wave velocities. Constitution of the Earth.

5. The temperature field in the Solid Crust of the Earth (4 hours)
Fourier theory. The first scientific calculation for the age of the Earth (Lord Kelvin 1862).

6. The electromagnetic field in the Solid Crust of the Earth (8 hours)
Electromagnetic properties of the materials of the Earth's Solid Crust. Dispersion relations. The semi-static approximation of Maxwell's equations for their application to the Earth's Solid Crust. Transmission of Electromagnetic disturbances in the Earth's Solid Crust: Diffusion-Propagation.

7. Electric and electromagnetic prospecting methods.
Electrical methods (DC resistivity method). Magnetotelluric method (MT method).

8**. Introduction to the Physics of preseismic electric signals (4 hours)**
The VAN method of short-term earthquake prediction. Physical properties of Seismic Electric Signals (SES).

(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

Electronic communication with the students using ICT. Computer-aided lectures, 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>52</td></tr>
<tr><td>Individual Study/ Study and Analysis of bibliography / Preparation</td><td>48</td></tr>
<tr><td>Projects</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 Greek</td></tr>
</table>

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- A. Tselentis, General Seismology Vol. A, Liberal Books (2006) 839 pages.
- Y. Gueguen and V. Palciauskas, Introduction to the Physics of Rocks, Princeton University Press (1994) 392 pages.
- P. Varotsos and K. Alexopoulos, Thermodynamics of Point Defects and their relation with the bulk properties, Eds. S. Amelinckx, R. Gevers, and J. Nihoul, North Holland (1986) 474 pages.
- M. N. Nabighian (Ed.), Electromagnetic Methods in Applied Geophysics: Volume 1, Theory, Society of Exploration Geophysicists (1988) 531 pages.
- P. Varotsos, The Physics of Seismic Electric Signals, TerraPub, Tokyo (2005) 338 pages.
- P. A. Varotsos, N.V. Sarlis, N.V. and E.S. Skordas, Natural Time Analysis: The new view of time. Precursory Seismic Electric Signals, Earthquakes and other Complex Time-Series, Springer-Verlag, Berlin Heidelberg (2011) 476 pages.

- Related academic journals (Indicative list):

- Physical Review B, Physical Review E, Physical Review Letters (APS).
- Europhysics Letters, EPL (IOP).
- Geophysical Research Letters, Journal of Geophysical Research (AGU).
- Physica A, Tectonophysics, Journal of Geodynamics (ELSEVIER).
- Entropy, Applied Sciences, Geoscieces (MDPI).
- Geophysics Journal International (OXFORD ACADEMIC).