Bachelor in Physics
(Academic Year 2024-25)

Physics of the Earth		Code	800512	Year	3rd	Sem.	2nd
Module	Applied Physics	**Topic**	Mandatory Applied Physics	**Character**	Optional		

	Total	Theory	Exercises	Lab
ECTS Credits	6	4.2	1.8	
Semester hours	45	31	9.5	4.5

Learning Objectives (according to the Degree's Verification Document)

- Apply the principles of Physics to the study of the Earth.
- Know the fundamental physical processes of the Earth and apply mathematical methods for their understanding and analysis.
- Know the basic techniques to study the physical properties, structure and dynamics of the Earth.
- Know the methods for resources exploration and evaluating and mitigating natural risks.
- Recognize the influence of the physical properties of the Earth in all physical observations and experiments (LHC, satellites, etc.)

Brief description of contents

Structure of the Earth; radioactivity, Earth's age and heat flow; gravity field; Earth magnetic field: internal field and external field; gravimetric and magnetic anomalies; Physics of earthquakes, seismic waves.

Prerequisites

Knowledge of Physics and Mathematics at the level of 2nd Grade in Physics

Coordinator	Juan José Ledo Fernández	Dept.	FTA
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Theory/Exercises – Schedule and Teaching Staff

Group	Lecture Room	Day	Time	Professor	Period/ Dates	Hours	T/E	Dept.
B	10	Tu Th	17:00 – 18:30 16:30 – 18:00	Juan José Ledo Fernández	Alternating during the semester	12,0	T/E	FTA
				Maurizio Mattesini		12,0		
				Fco. Javier Pavón Carrasco		9,0		
				Javier Fullea Urchulutegui		7,5		

Laboratory – Schedule and Teaching Staff						
Group	**Lecture Room**	**Dates**	**Time**	**Professor**	**Hours**	**Dept.**
B	A2	27/2;19/3;24/4	17:00 - 18:30	Juan José Ledo Fernández	1.5	FTA
				Fco. Javier Pavón Carrasco	1.5	
				Javier Fullea Urchulutegui	1.5	

Office hours				
Group	**Professor**	**Schedule**	**E-mail**	**Location**
B	Juan José Ledo Fernández	We: 13.00h-16.00h Th: 09.00h-10.30h online	jledo@ucm.es	04. 214.0, 4th Fl. Central
	Maurizio Mattesini	L: 14.30h-17.30h + 3 h on-line	mmattesi@ucm.es	04. 109.0, 4th Fl. East
	Fco. Javier Pavón Carrasco	1st sem: Mo & We: 12:30h-14:00h + 3h online 2nd sem: Tu: 10:30h-12:00h Th: 12:30h-14.00h + 3h online	fjpavon@ucm.es	04. 106.0, 4th Fl. East
	Javier Fullea Urchulutegui	Tu: 10.00h-11.30h Th: 11.00h-12.30h + 3 h on-line	jfullea@ucm.es	04.236.0, 4th Fl. Central

Syllabus

1. INTRODUCTION. The age of the Earth, the Earth in the Universe. Composition and structure. Physical basis of dating methods. Ages

2. GRAVITY AND SHAPE OF THE EARTH. Gravitational potential. Rotation of the Earth. Figure of the Earth. The geoid, the ellipsoid and normal gravity.

3. GRAVITY MEASUREMENTS AND GRAVITY ANOMALIES. Gravity measurements, the gravimeter Corrections and reductions to measurements Gravimetric anomalies Isostasy. Interpretation of local, regional and global anomalies.

4. GEOMAGNETISM Sources of the Earth's magnetic field. Components of the Earth's magnetic field internal and external origin. Geodynamo. Magnetosphere.

5. EARTH'S INTERNAL AND EXTERNAL MAGNETIC FIELD. Dipole field. Geomagnetic poles and geomagnetic coordinates. Non-dipole field. International geomagnetic reference field. Temporal variation of the internal field. Origin of the internal field. Paleomagnetism. Geomagnetic and Paleomagnetic Virtual Poles. Magnetic anomalies. Origin of the external field. Structure of the magnetosphere-ionosphere. Variations of the external field: magnetic storms. Auroras

6. GENERATION AND PROPAGATION OF SEISMIC WAVES. Mechanics of an elastic medium: elastic parameters of the Earth. Seismic waves: internal and surface. Reflection and refraction of internal waves. The seismograph. Propagation of earthquake waves. Dromochrons.

7. INTERNAL STRUCTURE OF THE EARTH. Radial variation of seismic wave velocities. Reference Earth models. Physical and compositional stratification of the Earth. Density, gravity and pressure

inside the Earth. Applications: Seismic tomography.

8. EARTHQUAKES. Location and time of origin. Global seismicity in relation to plate boundaries. Size of an earthquake: intensity, magnitude, energy. Gutenberg-Richter law.

9. THERMAL STATE OF THE EARTH. Fundamentals of heat flow in the Earth. Temperature distribution in the Earth's interior. Heat sources. Heat flow. Heat transport. Applications: Calculation of ocean basin thicknesses.

10. EARTH DYNAMICS. Movement of tectonic plates. Relative velocities. Wilson cycle.

Experiences (3 sessions):

1. Gravimetry. Application of gravimetric corrections: treatment and representation of

data.

2. Paleomagnetism. Operation of a paleomagnetism laboratory. Data Analysis.

archaeomagnetic data. Use of archaeomagnetism as a dating technique.

3. Seismology.

Bibliography

Fundamental
• W. Lowrie (2007, 2ª edición). Fundamentals of Geophysics. Cambridge Univ.
• C. Clauser (2024, 1ª Edición). Introduction to Geophysics. Springer.
• Udías and J. Mezcua (1997). Fundamentos de Geofísica. Textos. Alianza Universidad

Online Resources

Campus virtual
'Lecture notes' from MIT Open Course:
Essentials of geophysics:
http://ocw.mit.edu/courses/earth-atmospheric-and-planetary-sciences/12-201-essentials-of-geophysics-fall-2004/
PDF's of class notes will be upload.

Methodology

The following training activities will be developed:
1. Theory lessons where the main concepts of matter will be explained, including real examples and applications.
2. Problems solving classes that will be combined with the theoretical lessons that complement each other appropriately.
3. Practices: three practices will be carried out.
As part of the continuous assessment, students must submit solved exercises individually.

Evaluation Criteria

Exams	Weight:	70%
The exam will consist of a series of theoretical and practical questions (of a similar level to those solved in class). The grade obtained will be Nexam.		
Other Activities	**Weight:**	30%

During the course, the student will deliver individually the problems, activities, and reports of practices, as well as questions that the professor indicates to them on the dates that he determines.
Final Mark
The final grade will be: $$CFinal = 0.7Nexam + 0.3NOtherAct,$$ Where NOtherAct is the qualification corresponding to Other Activities and Nexam the one obtained in the Final exam. The qualification of the extraordinary call of June-July will be obtained following exactly the same evaluation procedure.