

## COURSE OUTLINE

### (1) GENERAL

<b>SCHOOL</b>			
<b>ACADEMIC UNIT</b>	DEPARTMENT OF PHYSICS		
<b>LEVEL OF STUDIES</b>	UNDERGRADUATE		
<b>COURSE CODE</b>	106	<b>SEMESTER</b>	8
<b>COURSE TITLE</b>	Gravitation and Theory of General Relativity		
<b>INDEPENDENT TEACHING ACTIVITIES</b> <i>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</i>	<b>WEEKLY TEACHING HOURS</b>	<b>CREDITS</b>	
	4	4	
<i>Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).</i>			
<b>COURSE TYPE</b> <i>general background, special background, specialised general knowledge, skills development</i>			
<b>PREREQUISITE COURSES:</b>			
<b>LANGUAGE OF INSTRUCTION and EXAMINATIONS:</b>	Greek		
<b>IS THE COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes		
<b>COURSE WEBSITE (URL)</b>			

### (2) LEARNING OUTCOMES

<p><b>Learning outcomes</b></p> <p><i>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.</i></p> <p><i>Consult Appendix A</i></p> <ul style="list-style-type: none"> <li>• <i>Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area</i></li> <li>• <i>Descriptors for Levels 6, 7 &amp; 8 of the European Qualifications Framework for Lifelong Learning and Appendix B</i></li> <li>• <i>Guidelines for writing Learning Outcomes</i></li> </ul>
<p>After successful completion of the course students will be able to:</p> <ul style="list-style-type: none"> <li>• Calculate the Riemann curvature tensor and write Einstein's equations for a given metric of spacetime.</li> <li>• Choose the appropriate coordinate system and perform coordinate transformations.</li> <li>• Write the equations of motion for a fluid or an electromagnetic field in the presence of a gravitational field.</li> <li>• Calculate the gravitational field (by solving Einstein's field equations) in the exterior and the interior of a star with constant energy density.</li> <li>• Compute the trajectory of a material point, or a light beam within a spherically symmetrical gravitational field in vacuum and explain gravitational effects (which are not explained in the context of Newtonian theory) as the advance of Mercury's perihelion or the bending of light rays.</li> <li>• Calculate the red-shift in a gravitational field.</li> </ul>

- Write Einstein's equations for a weak gravitational field and extract from them the basic properties of gravitational waves.
- Use efficiently the tool of Tensor calculus.

**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...*  
 .....

Analysis and synthesis of data with the use of the appropriate technologies.  
 Autonomous work.  
 Promotion of creative and inductive thinking.

**(3) SYLLABUS**

Elements of Riemannian geometry. Foundations of General Relativity theory and Einstein's equations. Weak field approximation and the Newtonian limit. The Schwarzschild solution of the Einstein's equations and the experimental tests of General Relativity. The Schwarzschild solution as a Black-hole geometry. Gravitational waves. Introduction to the Robertson-Walker cosmological models.

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#### (4) TEACHING and LEARNING METHODS - EVALUATION

<b>DELIVERY</b> <i>Face-to-face, Distance learning, etc.</i>		
<b>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY</b> <i>Use of ICT in teaching, laboratory education, communication with students</i>		
<b>TEACHING METHODS</b> <i>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</i>	<b>Activity</b>	<b>Semester workload</b>
	Lectures	39
	Tutorials	13
		30
		15
	Examinations	3
	<b>Course total</b>	<b>100</b>
<b>STUDENT PERFORMANCE EVALUATION</b> <i>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.</i>	Written exams at the end of the course, which control both the knowledge of the theory and also the ability to apply it in order to solve problems.	

#### (5) ATTACHED BIBLIOGRAPHY

<p>- <i>Suggested bibliography:</i></p> <ul style="list-style-type: none"> <li>• Notes of the lectures from the teacher.</li> <li>• General Relativity, J. L. Martin, Πανεπιστημιακές Εκδόσεις Κρήτης, Ηράκλειο 2005.</li> <li>• General Relativity, Bernard F. Schutz, Εκδόσεις Κωσταράκη, Αθήνα 1994.</li> <li>• Introduction to the theory of General relativity, N. K. Σπύρου. Εκδότης Γαρταγάνης Αγις-Σάββα, 2η έκδοση 1989.</li> </ul> <p>- <i>Related academic journals:</i></p>
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