

DESCRIPTION OF THE COURSE OF STUDY

Course code	0533.6.FIZ2.D.IGRAAC	
Name of the course in	Polish	Wprowadzenie do ogólnej teorii względności i zastosowań w astrofizyce i kosmologii
	English	Introduction to general relativity and applications to astrophysics and cosmology

1. LOCATION OF THE COURSE OF STUDY WITHIN THE SYSTEM OF STUDIES

1.1. Field of study	Physics
1.2. Mode of study	Stationary
1.3. Level of study	Second-cycle studies
1.4. Profile of study*	General academic
1.5. Person/s preparing the course description	prof. dr hab. Francesco Giacosa
1.6. Contact	francesco.giacosa@ujk.edu.pl

2. GENERAL CHARACTERISTICS OF THE COURSE OF STUDY

2.1. Language of instruction	English
2.2. Prerequisites*	Knowledge of classical physics and mathematics at the Bachelor's degree level.

3. DETAILED CHARACTERISTICS OF THE COURSE OF STUDY

3.1. Form of classes	Lecture (L)	
3.2. Place of classes	Institute of Physics UJK	
3.3. Form of assessment	Credit with a grade	
3.4. Teaching methods	Oral lectures, problem solving	
3.5. Bibliography	Required reading	- Sean Carroll, Spacetime and Geometry: An Introduction to General Relativity - Carlo Rovelli, General Relativity: The Essentials A. Zee, Einstein Gravity in a nutshell - Tomislav Prokopec, Lecture notes for Cosmology
	Further reading	- Quantum field theory in a nutshell, A. Zee. - J. A. Peacock, cosmological physics

4. OBJECTIVES, SYLLABUS CONTENT AND INTENDED LEARNING OUTCOMES

4.1. Course objectives (including form of classes) 1. Description of the most important features and formalism of modern special and general relativity. 2. Understanding the mathematical tools related to special and general relativity. 3. Developing skills to solve exercises and to understand the ongoing research on these topics.
4.2. Detailed syllabus (including form of classes) 1. Principles of special relativity- flat space-time geometry, time dilation, Lorentz transformations, Lorentz contraction, the principle of adding velocity 2. Mathematical aspects of STR - four vectors, four velocity, dot product, single-form, gradient, tensors, metric 3. Relativistic dynamics - four vectors of acceleration, force and energy-momentum, Faraday tensor, principle of least action 4. Curvilinear coordinate systems - curvilinear coordinates and Christoffel symbols 5. Gravity as a geometry - the principle of equivalence, clocks in a gravitational field, Newtonian gravity as the curvature of space-time 6. Curved manifolds - Riemann manifolds, parallel transport, geodesic curves, mathematical description of curvature, Riemann tensor, Ricci tensor, Einstein tensor 7. Einstein's equations 8. Spacetime around a spherically symmetric star - Schwarzschild's metric, gravitational redshift, particle orbits, trajectories of light rays 9. Gravitational collapse of bodies and black holes

10. Cosmology - structure of the Universe, expansion of the Universe, Robertson-Walker metric, Friedmann equation.

4.3 Intended learning outcomes

Code	A student, who passed the course	Relation to learning outcomes
within the scope of KNOWLEDGE:		
W01	Knows and understands the fundamental concepts and formalism of special and general relativity and their applications in astrophysics and cosmology.	FIZ2A_W01 FIZ2A_W02 FIZ2A_W03 FIZ2A_W05
within the scope of ABILITIES:		
U01	Is able to apply mathematical methods and the formalism of general relativity to solve problems in general relativity, astrophysics and cosmology.	FIZ2A_U02
within the scope of SOCIAL COMPETENCE:		
K01	Can discuss topics of general interest, such as cosmology or black holes	FIZ2A_K02

4.4. Methods of assessment of the intended learning outcomes

Teaching outcomes (code)	Method of assessment (+/-)																				
	Written and oral assessment			Test*			Project*			Effort in class*			Self-study*			Group work*			Others* e.g. standardized test used in e-learning		
	Form of classes			Form of classes			Form of classes			Form of classes			Form of classes			Form of classes			Form of classes		
	L	C	...	L	C	...	L	C	...	L	C	...	L	C	...	L	C	...	L	C	...
W01	x																				
U01	x																				
K01	x																				

*delete as appropriate

4.5. Criteria of assessment of the intended learning outcomes

Form of classes	Grade	Criterion of assessment
lecture (L)	3	51-60% of the total points available
	3,5	61-70% of the total points available
	4	71-80% of the total points available
	4,5	81-90% of the total points available
	5	91-100% of the total points available

5. BALANCE OF ECTS CREDITS – STUDENT'S WORK INPUT

Category	Student's workload	
	Full-time studies	Extramural studies
NUMBER OF HOURS WITH THE DIRECT PARTICIPATION OF THE TEACHER /CONTACT HOURS/	30	
Participation in lectures	30	
INDEPENDENT WORK OF THE STUDENT/NON-CONTACT HOURS/	20	
Preparation for the lecture	10	
Preparation for the assessment	10	
TOTAL NUMBER OF HOURS	50	
ECTS credits for the course of study	2	

*delete as appropriate

Accepted for execution (date and legible signatures of the teachers running the course in the given academic year)

.....