Riga Technical University

University of Latvia

RTU/LU Course

General data

Code	
Course title	Relativity and Cosmology
Course status in the programme	Choice
Course level	Doctoral Studies
Course type	Academic
Field of study	High-Energy Physics
Responsible instructor	prof. Vyacheslavs Kashcheyevs
Volume of the course: parts and credits points	1 part, 4.0 Credit Points, 6.0 ETCS
Language of instruction	EN
Possibility of distance learning	Not planned
Abstract	The course consists two major parts: Einstein's theory of General Relativity (GR) and physical cosmology. In the first part, the concept of curved spacetime is introduced and used to develop the Einstein's geometric theory of gravitation. Non-rotating black hole metric is determined; rotating black hole metric is discussed. The GR concepts are applied to the Homogeneous Universe model, and Friedmann equations are derived and solved. Standard Model of cosmology is introduced; dark matter and dark energy components are discussed, including their possible candidates and cosmological constraints on particle physics. Alternative gravitation models and theories are briefly discussed.
Goals and objectives of the course in terms of competences and skills	The students will learn the formalism and approach of the Einstein's theory of General Relativity and become acquainted with the development and the current state of theoretical cosmology. They will also learn the current state of the astronomical observations relevant to the general relativity theory.
Structure and tasks of independent studies	The students will select a topic in modern relativity and/or cosmology for individual studies and presentation. Homework will require synthesis of previously acquired knowledge with the theory from the lectures. Some problems will require numerical solution or integration, requiring students to use the numerical computing techniques.
Recommended literature	1. P.J.E. Peebles, *Principles of Physical Cosmology*, Princeton University Press, 1993 2. C.W. Misner, K.S. Thorne, J.A.Wheeler, *Gravitation*, W.H. Freeman and Co., 1973 3. V. Mukhanov, *Physical Foundations of Cosmology*, Cambridge University Press, 2005 4. G.F.R. Ellis, R. Maartens, M.A.H. MacCallum, *Relativistic Cosmology*, Cambridge University Press, 2012 5. Y.B. Zel'dovich, I.D. Novikov, *Relativistic Astrophysics*, University of Chicago Press, 1971
Course prerequisites	Theoretical physics, special relativity, calculus
Courses acquired before	-

Course contents

Content	Full- and part-time intramural studies		Part time extramural studies	
	Contact Hours	Indep. work	Contact Hours	Indep. work
Mathematics of curved spacetime	10	40		
Einstein's General Relativity theory	15	40		
Relativistic Cosmology Models	15	40		
Topics in modern cosmology (including student presentations)	10	40		
Total:	50	160		

Learning outcomes and assessment

Learning outcomes	Assessment methods
Students understand the concept of curved spacetime, can qualitatively explain the curvature effects on the observations. They can follow the non-rotating black hole solution of the Einstein equations.	Homework problems and oral examination
Students know the observational evidences of the General Relativity theory in lab and in space, can apply theoretical notions to the cases observed in nature	Homework problems and oral examination
Students have a solid understanding of the standard model of cosmology; know its physical foundations and the observational evidences.	Homework problems and oral examination

Evaluation criteria of study results

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Criterion	%
A. Homework problems	50
B. Oral exam	50
C. Seminar presentation on a selected modern issue in relativity and/or cosmology	20
Total:	min(100, A+B+C)

Course planning

Part	Semester			CP	ECTS	Hours per Week			Tests			Tests (free choice)		
	Autumn	Spring	Summer			Lectures	Practical	Lab.	Test	Exam	Work	Test	Exam	Work
1.			*	4.0	6.0	10		-		*	*			