COURSE UNIT (MODULE) DESCRIPTION

Course unit (module) title	Code
Stellar atmospheres	

Academic staff	Core academic unit(s)
Coordinating: dr. Vidas Dobrovolskas	Faculty of Physics

Study cycle	Type of the course unit
Second (Master)	Optoinal

Mode of delivery	Semester or period when it is delivered	Language of instruction
Face-to-face	Semester 1	Lithuanian / English

Requisites	
Prerequisites: Astrophysics	**Co-requisites (if relevant):** Atom physics

Number of ECTS credits allocated	Student's workload (total)	Contact hours	Individual work
5	140	64	76

Purpose of the course unit		
The aim of this subject is to familiarize students with the structure of different types of stellar atmospheres, hydrodynamic and radiation research methods of transport processes occurring in stellar atmospheres, to familiarize with principles of numerical modeling of stellar atmospheres.		
Learning outcomes of the course unit	**Teaching and learning methods**	**Assessment methods**
Ability to understand the physical processes that determine the internal structure and observed properties of stellar atmospheres.	Problem teaching, autonomous work.	Evaluations of seminars, written exam.
Understanding the internal structure and observable properties of different types of stellar atmospheres.	Problem teaching, autonomous work.	Evaluations of seminars, written exam.
Ability to understand the principles of numerical modeling of stellar atmospheres.	Problem teaching, autonomous work.	Evaluations of seminars, written exam.

Content	Contact hours							Individual work: time and assignments	
	Lectures	Tutorials	Seminars	Workshops	Laboratory work	Internship	**Contact hours, total**	**Individual work**	**Tasks for individual work**
1. Hydrodynamics of stellar atmospheres. Nature of shock waves. Propagation of finite amplitude shock waves. Rankine-Hugoniot conditions. The main equations	4		4				**8**	**8**	Preparation for seminars.

of magnetohydrodynamics. Alfvén waves.									
2. Methods of numerical solution of hydrodynamic equations. Stability of numerical methods.	4		4				**8**	**16**	Preparation for seminars.
3. Radiation processes in stellar atmospheres. Opacities of stellar atmospheres. Stellar atmosphere equation of state.	8		8				**16**	**16**	Preparation for seminars.
4. Radiation transfer equation. Formation of spectral lines in stellar atmospheres. Numerical methods of the solution of radiative transport in stellar atmospheres.	8		8				**16**	**12**	Preparation for seminars.
5. Stellar model atmospheres: 1D hydrostatic, 3D hydrodynamic models. Semi-empirical model atmospheres.	4		4				**8**	**12**	Preparation for seminars.
6. Studies of stellar atmospheres: methods of determination of parameters of stellar atmospheres and chemical composition, research of chemodynamic evolution of stellar populations.	4		4				**8**	**12**	Preparation for seminars.
Total	**32**		**32**				**64**	**76**	

Assessment strategy	Weight %	Deadline	Assessment criteria
Exam	70	During the exam session.	Understanding the main topics of the course.
Seminars	30	Regularly during the semester, during lectures intended.	Understanding of the seminar topic, ability to analyze connections between astrophysical phenomena and processes discussed in the seminar topic, perception of the wider astrophysical context related to the workshop topic.

Author (-s)	Publishing year	Title	Issue of a periodical or volume of a publication	Publishing house or web link
Required reading				
Hubeny, I., Mihalas, D.	2015	Theory of Stellar Atmospheres	-	Princeton University Press
Bodenheimer, P., Laughlin, G. P., Rozycka, M., Yorke, H. W.	2007	Numerical Methods in Astrophysics, An Introduction	-	Taylor & Francis
Recommended reading				
Gray, D. F.	2005	The Observation and Analysis of Stellar Photospheres	-	Cambridge University Press
Pradhan, A. K., Nahar, S. N.	2011	Atomic Astrophysics and Spectroscopy	-	Cambridge University Press