1. General characteristics of the course programme

Course title	**ASTRONOMY**
Type of programme (first cycle programme / second cycle programme / single cycle master's programme)	**First cycle programme**
Educational profile (academic/practical)	academic
Course form Full-time /part-time	**full-time**
Specification of the fields of science and scientific disciplines or fields of art and artistic disciplines to which the learning outcomes apply (including the leading discipline), and specification of percentage share of each discipline in the number of ECTS credits required to obtain qualifications corresponding to the level of education	**Natural sciences** **Disciplines: astronomy (leading discipline, 55.1%),** physical science (34.9%), mathematics (10.0%)
Professional title awarded to graduates	**Batchelor degree (licencjat)**
Scientific category held by the basic organizational unit of the university	**A**

2. Indication of the relationship between the course programme and the mission of the university and its development strategy

The University of Zielona Góra, as a university established from the merger of two previously operating academic universities in Zielona Góra, creates and shapes academic traditions in the Middle Oder region. It combines its educational and research activities with shaping the ethical values of the world of science, culture and economy. The guiding ideas of its educational activities are the truth, respect for knowledge and reliability in its spreading. In scientific research, it is guided by the search for truth and progress in science and technology. The education process at the University of Zielona Góra is organized with respect for the principle of its consistency with the conducted scientific research and the rights of students to freely develop their passions and individual talents. The University of Zielona Góra is a university open to the latest scientific and technical achievements, as well as social demand for educational services implemented in the spirit of service for the common good, taking into account the special educational needs of disabled youth.

The main goals of the faculty, in accordance with the mission of the university and its development strategy, are as follows:

- *Conducting scientific research*. The Faculty is interested in research topics related to physics and astronomy. The academic staff of the Faculty, who will support the proposed course as

tutors and scientists, conduct research in these fields. Their research is financially supported by funds from the Ministry of Science and Higher Education, the National Science Centre, the European Union, the Polish Science Foundation, and local administration;

- *Educating specialists in selected fields of science.* Specialists in physical science, in particular in astronomy and physics will be educated. The educational process will be based on the potential of employees specialising in these sciences;
- *Educating own research staff.* The Faculty of Physics and Astronomy is entitled to confer the degree of doctor of physical science in physics (2003), astronomy (2005), and physics and astronomy (2010). It is also entitled to confer the degree of habilitated doctor of physical science in astronomy (2012) and physics (2016). Between 2009 and 2017 the Faculty Council conferred the degree of doctor in physics to 21 scientists, the degree of doctor in astronomy to 11 individuals, and the degree of habilitated doctor in astronomy to 1 person.
- *Civilisation activity.* The Faculty employees actively participate in annual scientific meetings for the inhabitants of the region as part of the Festival of Science, job fairs, Wine Festival, etc.; students of the new course will also join these activities. The Faculty employees conduct classes for high school students, organized by Kepler's Science Centre in Zielona Góra, and take part in other popularizing activities conducted by this institution.

  Besides teaching students, the Faculty is involved in lifelong learning, which includes conducting regular lectures and seminars, as well as publishing books that popularize the latest scientific achievements. The Faculty organizes scientific seminars and conferences.

3. Description of competencies expected from a candidate applying for admission to the first-cycle programme, second-cycle programme or single cycle master's programme

Candidates are expected to know mathematics and physics at the level required for standard secondary school-leaving examinations.

4. Analysis of compliance of the assumed learning outcomes with the needs of the labour market

The course is aimed at educating specialists in astronomy. Graduates will also have extensive knowledge in physics, mathematics and the use of computer methods. As such, the proposed course fits into the third pillar of the European Union research and innovation programme *Horizon 2020*, in particular under the action: *spreading excellence and widening participation*, and in the thematic area *Europe in a changing world - inclusive, innovative and reflective society*. Graduates will have sufficient knowledge to conduct training and popularization activities in astronomy and related fields. In the face of increasingly frequent media information on astronomy, as well as growing interest of society in this field of science, there will be a constant demand for employees who understand, are able to interpret and explain these often very complicated issues.

Astronomy course fits into the activities of the Polish Space Agency, which in 2012 joined the European Space Agency (ESA). The space sector is one of the most innovative and technologically advanced areas, with increasing importance for the European and global economy. Supporting this industry is one of the important elements of the Strategy for Responsible Development. Long-term directions for the development of the space industry were indicated in the Polish Space Strategy, adopted in 2017 by the government of the Republic of Poland. The implementation of the long-term Polish Space Strategy will ensure that in 2030:

- Polish space sector will be able to compete effectively on the European market and its turnover will amount to at least 3% of the total turnover of this market;
- Polish public administration will use satellite data for faster and more effective implementation of its tasks, and domestic enterprises will be able to fully meet the internal demand for this type of services and export them to other markets;
- Poland will have access to satellite infrastructure that will meet its needs, especially in terms of security and defence.

The specific goals of the Polish Space Strategy include: increasing the competitiveness of the Polish space sector, increasing its share in the turnover of the European space sector, development of satellite applications - contribution to the development of the digital economy and development of capabilities in national security and defence using space technologies and satellite technologies, and - what is most important for the proposed course: building staff for the needs of the space sector. Experience in astronomy and physics (as well as basic skills in programming and computer techniques) of the course graduates will be a valuable asset in finding a job in the space sector.

Graduates will also have skills predisposing them to work in various types of projects and professions related to the design and development of computer programs and applications, data analysis, creation and maintenance of online databases, etc. Due to technological progress, these types of skills are valuable on the labour market. The administration units, with which the Faculty cooperates, participate in the preparation of educational programmes by defining the needs of the labour market and the skills that, in their opinion, graduates should possess.

The last, but not least, goal of introducing the new programme is development of academic staff in Poland, and in particular at the University of Zielona Góra. After completing the first-cycle programme, graduates will be able to continue their education joining the second-cycle programme in Physics – with specialization in computer astrophysics, and then the third-cycle programme (doctoral course), which is conducted at the Faculty in astronomy and physics. The development of the research staff is one of the strategic goals set by the university and the existence of the proposed course may significantly contribute to this. Graduates from master's courses and holders of the doctoral degree in physical sciences (including astronomy) are often employed at the University of Zielona Góra, and other academic and research institutions in Poland and Europe. The Institute of Astronomy at the University of Zielona Góra participates in numerous national and international research projects - e.g. on radio astronomy (LOFAR project), gravitational waves (LIGO/VIRGO project), X-ray and gamma radiation observations (CTA project). To ensure continuous and effective participation in these projects and to expand this participation and its measurable results, a constant supply of new scientific staff is necessary. The course will be the first step towards achieving these goals; in astronomy, the experience gained during studies is essential for the further development of a scientific career.

List of organisations cooperating within the proposed course:

- German Aerospace Centre (DLR)
- Science and Technology Park in Zielona Góra
- Kepler's Science Centre in Zielona Góra (Nature Centre and "Venus" Planetarium)
- SNaFi Physics Teachers Association
- Zielona Góra Branch of the Polish Amateur Astronomers Society
- Juliusz Słowacki's High School No 3 in Leszno
- Pomeranian Greater Poland's Nanotechnology Forum (PoWieFoNa)

- UROBORUS S.L. as part of the consortium implementing the project: Astronomy and Science Centre – The Largest Public Telescope in the World.

5. Description of methods of verifying and evaluating the learning outcomes achieved by the student throughout the education process

The general rules for completing the subject and the semester are included in the University Regulations adopted by Resolution No. 88 of the University Senate of 19 April 2017.

The description of the methods of verification and assessment of the extent of achievement of learning outcomes applicable in this course is specified in the syllabuses of individual subjects constituting Appendix 6.

The methods of verification and assessment of the extent of achievement of the assumed learning outcomes are diverse and designed to take into account the specificity of the outcome category (knowledge, skills, and social competencies category). These methods enable a reliable assessment of the extent to which the students have achieved the expected learning outcomes.

In terms of knowledge outcomes, the main evaluating methods are oral or written tests (containing both open and closed questions), as well as speeches and presentations prepared by the student.

The extent to which the student has achieved learning outcomes in the skills category is assessed by checking the computer programs written by the student, and checking the student's ability to analyse astronomical observational data using ready-made tools for data processing. This will most often be done by evaluating the prepared reports, reviews and projects.

In terms of acquiring social competencies necessary in research activities, the assessment of the achievement of the assumed learning outcomes will be based on careful observation of students during individual and teamwork as part of activities carried out during classes, laboratories and seminars.

The examinations will be written. They include multiple-choice tests with closed questions, tests with open-ended questions, essays, and open-ended questions. The exams will cover educational content described in the syllabuses of individual modules to which the exam applies. The syllabus also defines the conditions and criteria for passing individual exam papers.

Foreign language skills, including language for specific purposes, will be mastered at B2 level (1st cycle programme), and this will be verified with the following methods: oral test, written test (description, test).

The programme cycle ends with the bachelor's (in Polish: *licencjat)* exam consisting of a diploma thesis and an exam in mathematics, physics and astronomy. The details of the exam are provided in the University Regulations of 1 September 2017, Chapter 8, sections 61-65.

6. Course programme:

1.1 Description of the expected learning outcomes, with the indication of the field of science and scientific disciplines or fields of art and artistic disciplines to which the learning outcomes for this course relate.

Key:

K (before underscore) – programme learning outcomes

W – knowledge category

U – skills category

K (after underscore) – social competencies category

P6S – learning outcomes in general areas and sciences for first-cycle programmes

01, 02, 03 and next – learning outcome number

Symbol	Learning outcomes for ASTRONOMY programme After completing the first-cycle programme of ASTRONOMY :	Reference to learning outcomes in science education
	KNOWLEDGE	
K_W01	the graduate understands the civilizational importance of astronomy and its applications	P6S_WK-O2.1
K_W02	the graduate knows elementary terminology used in astronomy and understands its sources and applications within related scientific disciplines	P6S_WG-O1
K_W03	the graduate knows basic theorems and laws in studied branches of physics and astronomy	P6S_WG-O1
K_W04	the graduate knows basic theorems in studied branches of mathematics	P6S_WG-O1
K_W05	the graduate has basic knowledge of conducting experiments in physics and astronomical observations, with particular emphasis on the methods used in modern astrophysics; the graduate is able to calculate errors and measurement uncertainties	P6S_WG-01
K_W06	the graduate has elementary knowledge of the construction and operation of observational instruments used in astronomy	P6S_WG-01
K_W07	the graduate knows the fundamentals calculus of single and multiple variables and their application in physics and astronomy	P6S_WG-O1
K_W08	the graduate knows the basics of programming and computational techniques used in astronomy and understands their limitations	P6S_WG-01 P6S_UW-03
K_W09	the graduate knows at a basic level at least one software package for numerical calculations in astronomy	P6S_WG-01 P6S-UW-03
K_W10	the graduate knows English at upper intermediate level (B2)	P6S_UK-O4.3
K_W11	the graduate has elementary knowledge of occupational health and safety	P6S_WK-O2.2
	SKILLS	

K_U01	the graduate can analyse problems and find solutions applying methods used in physics and astronomy	P6S_UW-O3
K_U02	the graduate can present correct mathematical, physical and astronomical reasoning, formulate definitions, theorems and observational conclusions in an understandable way, both in speech and writing	P6S-WK-02.1 P6S_UW-O3 P6S_UO-05.1
K_U03	the graduate has elementary research skills to design and construct simple physical and astronomical research	P6S_UW-O3 P6S_UO-05.1 P6S-UU-06
K_U04	the graduate can make basic astronomical observations and interpret them, taking into account known physical and astronomical phenomena	P6S_UW-O3 P6S_UO-05.1 P6S-UU-06
K_U05	the graduate can use numerical tools and methods to solve selected problems in physics and astronomy	P6S_UW-03
K_U06	the graduate can create and analyse an algorithm in accordance with the specification and write it in the selected programming language	P6S_UW-O3
K_U07	the graduate can compile, run and test their own computer program	P6S_UW-03
K_U08	the graduate can use computer programs in data analysis	P6S_UW-03
K_U09	the graduate can talk about physical and astronomical issues in understandable, accessible language	P6S-WK-02.1 P6S_UK-04.1 P6S_KK-07.1
K_U10	the graduate can independently acquire knowledge and develop their skills, using various sources (in the native language and a foreign language) and modern technologies	P6S_UU-O6 P6S_Kk-07.2
	SOCIAL COMPETENCIES	
K_K01	the graduate is aware of the level of their knowledge and skills, understands the need for continuous training and personal development, performs self-assessment of their competencies and improves skills, sets directions for own development and education	P6S_KK-07.1 P6S_KK-O7.2
K_K02	the graduate can formulate precise questions to deepen own understanding of a topic or to find missing elements of reasoning	P6S_UU-06 P6S_KK-O7.1 PS6_KK-07.2

K_K03	the graduate can work in a team; understands the need for systematic work on all long-term projects	P6S-KK0-4.2 P6S_UO-05.1 P6S-UO-05.2 P6S-KK-07.2
K_K04	the graduate understands and appreciates the importance of intellectual honesty in their own and other people's actions; the graduate acts ethically	P^S-KK-04.2 P6S_K0-08.1, P6S-KO-08.2, P6S-KO-08.3, P6S-KR-09,
K_K05	the graduate understands the need to present selected achievements of astronomy to the public	P6S_KO-O8.1 P6S-KO-08.2
K_K06	the graduate can independently search for information in literature, also in foreign languages	P6S_UK-04.3
K_K07	the graduate can formulate opinions on basic astronomical issues	P6S_KR-09

REFERENCE TO POLISH QUALIFICATIONS FRAMEWORK LEVEL 6 DESCRIPTORS

First-cycle programme

Learning outcome category	Qualification code	Qualifications	Reference to learning outcomes
KNOWLEDGE (W)	**Knowledge: the graduate knows and understands**		
	P6S_WG-O1	The graduate has profound knowledge of selected facts, objects, phenomena, as well as methods and theories explaining the complex interrelationships between them, constituting basic general knowledge of scientific or artistic discipline and forming the theoretical basis, as well as detailed knowledge of selected issues – specific for the programme, and in the case of practical courses – the graduate knows practical applications of this knowledge in professional activity related to their field of study	K_W02, K_W03, K_W04, K_W05, K_W06, K_W07, K_W08, K_W09
	P6S_WK-O2.1	The graduate knows fundamental dilemmas of contemporary civilization	K_U02, K_U09.

SKILLS (U)	P6S_WK-O2.2	The graduate knows basic economic, legal and other conditions of various types of activities related to the given qualification, including basic concepts and principles of industrial property protection and copyright law	K_W01, K_W11
	P6S_WK-O2.3	The graduate knows basic principles of creation and development of various forms of entrepreneurship	
	Skills: the graduate can		
	P6S_UW-O3	The graduate can use their knowledge - formulate and solve complex and unusual problems and perform tasks in conditions that are not fully predictable by: − proper selection of sources and information, evaluation, critical analysis and synthesis of information, − selection and application of appropriate methods and tools, including advanced information and communication techniques	K_W08, K_W09, K_U01, K_U02, K_U03, K_U04, K_U05, K_U06, K_U07, K_U08
	P6S_UK-O4.1	The graduate can communicate with the environment using specialized terminology	K_U09
	P6S_UK-O4.2	The graduate can take part in a debate - present and evaluate different opinions and positions and discuss them	K_K02, K_K04
	P6S_UK-O4.3	The graduate can use a foreign language at B2 level of the Common European Framework of Reference for Languages	K_W10, K_K06
	P6S_UO-O5.1	The graduate can plan and organise individual and team work	K_U02, K_U03, K_U04, K_K03
	P6S_UO-O5.2	The graduate can cooperate with other people as part of teamwork (also of an interdisciplinary nature)	K_K03
	P6S_UU-O6	The graduate can independently plan and implement their own lifelong learning	K_U03, K_U04, K_U10, K_K02
	Social competencies: the graduate is ready to		
	P6S_KK-O7.1	The graduate is ready to critically assess their knowledge and received content	K_U09, K_K01, K_K02
	P6S_KK-O7.2	The graduate is ready to recognize the importance of knowledge in solving cognitive and practical problems and seek expert	K_U10, K_K01, K_K02

		opinions if the graduate is unable to solve a problem independently	K_K03
	P6S_KO-O8.1	The graduate is ready to fulfil social obligations, co-organize activities for social environment;	K_K04, K_K05
	P6S_KO-O8.2	The graduate is ready to initiate actions in the public interest;	K_K04, K_K05
	P6S_KO-O8.3	The graduate is ready to think and act resourcefully	K_K04
	P6S_KR-O9	The graduate is ready to perform professional roles, which includes being able to: − comply with the rules of professional ethics and require others to do so, − care for the achievements and traditions of the profession	K_K03, K_K07

1.2 Programme indicators

Programme indicators concerning the evaluated course	
Number of ECTS credits required to obtain qualifications corresponding to the level of education	180
Number of semesters required to obtain qualifications corresponding to the level of education	6
Number of ECTS credits assigned to classes requiring direct participation of academic teachers and students	92 (51%)
Number of ECTS credits assigned to the modules of classes related to the conducted scientific research in the field/fields of science/art corresponding the evaluated course during which the student acquires in-depth knowledge and the ability to conduct scientific research (for academic profile courses)	147 (81%)
Number of ECTS credits assigned to the modules of classes related to practical vocational preparation aimed at acquiring practical skills and social competencies by the student (for courses of practical profile)	0
Number of ECTS credits assigned to classes in humanities or social sciences (in the case of courses assigned to fields other than humanities or social sciences, respectively)	12
Number of ECTS credits assigned to elective courses/modules	54 (30%)

Number of ECTS credits assigned to internships and number of hours of internships (if the programme provides for internships)	0
Number of hours of physical education classes – for full-time first-cycle and single-cycle courses	60

Modules of classes related to conducted scientific research in the field of science or art related to the programme, aimed at gaining in-depth knowledge and skills to conduct scientific research by the student			
Module	Instructional method(s)	Total number of hours	ECTS credits
Maths-physics module	W,Ć,L	1005	83
Astronomy module	W,Ć,L	330	24
Optical astronomy/radio astronomy module module (elective)	W,Ć,L	240	21
IT module	W,Ć,L	270	19
	Total	1845	147

Academic profile *– includes classes related to scientific activity conducted at the university in the discipline or disciplines to which the programme is assigned, in the amount exceeding 50% of ECTS credits and takes into account the participation of students in classes preparing for conducting scientific activity or participation in this activity. .*

Elective classes modules			
Module	Instructional method(s)	Total number of hours	ECTS credits
Optical astronomy module*	W,Ć,L	240	21
Radio astronomy module*	W,Ć,L	240	21
General module	W,Ć,L	225	13
Undergraduate module	C,L,S	120	20
	Total:	585	54

The student is allowed to choose classes to which ECTS credits are assigned in the amount of not less than 30% of the total number of ECTS credits.

1.3 Description of subjects or groups of subjects - with learning outcomes, content, instruction forms and teaching methods ensuring the achievement of the outcomes, and

ECTS credits (syllabuses);

The syllabuses are available in electronic version.

1.4 Methods of verifying and evaluating the student's achievement of the assumed learning outcomes;

Methods of verifying and evaluating the achievement of learning outcomes are described in the syllabuses.

The general rules for completing the subject and the semester are included in the University Regulations adopted by Resolution No. 88 of the University Senate of 19 April 2017.

The description of the methods of verification and evaluation of the degree of achievement of learning outcomes is specified in the syllabuses constituting Appendix 7.

The methods of verification and evaluation of the degree of achievement of the assumed learning outcomes are diverse and designed to take into account the specificity of outcome categories (knowledge, skills, and social competencies categories). These methods enable a reliable assessment of the extent to which student has achieved the expected learning outcomes. As for learning outcomes in the knowledge category, the main testing methods are oral or written tests and quizzes (containing both open and closed questions), speeches, and presentations. In terms of learning outcomes in the skills category, they are verified by checking the correctness of computer programs written by students (in computer science classes), and by evaluating their ability to analyse astronomical observational data with ready-made tools for data processing, in the form of reports, reviews and projects. As for the social competencies category, the verification of the achievement of the assumed learning outcomes will involve careful observation of students during individual and team work as part of the activities carried out during classes, laboratories and seminars.

The exams are written. These are multiple-choice tests with closed questions, tests with open-ended questions, essays with open-ended questions. The exam topics cover the content described in the syllabuses of individual modules to which the exam applies. The syllabus also describes the requirements and criteria for passing individual exams.

Foreign language skills (level B2 for first-cycle programme), including language for specific purposes, will be verified with the following methods: speech, written test.

The cycle of education ends with a final examination consisting of a diploma thesis and an exam in mathematics, physics and astronomy. The detailed regulations on the final examination are set out in the University Regulations of 1 September 2017, Chapter 8, paragraphs 61-65.

1.5 Study programme with class modules;

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1. General Module (mandatory 225 h, 13 ECTS credits).

The module covers 225 hours of instruction for which the student can obtain 13 ECTS credits. The module contains subjects that are not directly related to the field of study, but they are necessary for the student to function properly within the university, and essential for a possible later scientific career. The module includes: learning a foreign language, subjects related to occupational health and safety, ergonomics, copyright protection, language culture, scientific methodology, philosophy of nature, and information technology. All subjects in this module are elective.

Item	Subject	Form of completing lectures	Form of completing classes/laboratories	Semester	ECTS credits	No of instruction hours		
						W	Ć	L
1	Foreign language I		ZO	II	2			30
2	Humanistic subject: Language culture	ZO		II	3	30		
3	Physical Education I		Z	II	0			30
4	Foreign language II		ZO	III	2			30
5	Physical Education II		Z	III	0			30
6	Foreign language III		ZO	IV	2			30
7	Foreign language IV		ZO	V	2			30
8	Social subject: Intellectual property protection/ occupational safety and ergonomics	ZO		V	2	15		
Total ECTS credits: 13			Hours in total: 225			45		180

Key: E - examination, ZO – grade, Z – pass, W – lecture, Ć – class, L - Laboratory

2. Maths-Physics Module (mandatory 1005 h, 83 ECTS credits)

The module covers 975 hours of instruction for which a student can obtain a total of 81 ECTS points. Subjects included in this module will be offered mainly during the first two semesters of studies. The module covers subjects related to basic sciences for astronomy, in particular mathematics and physics. In this module, the student should acquire the knowledge and skills necessary to understand astronomy subjects which are taught later. The student will also have an opportunity to learn experimental methodology, and independently conduct physical experiments as part of classes in the physics laboratory. All subjects in the module are compulsory, and the student must complete all the subjects included in it.

Item	Subject	Form of completing lectures	Form of completing classes/laboratories	Semester	ECTS credits	No of instruction hours		
						W	Ć	L
1	Introduction to higher physics and mathematics		Z	I	2		30	
2	Mathematical analysis I	E	ZO	I	8	45	75	
3	Algebraic and geometrical methods in physics	E	ZO	I	6	30	45	
4	Fundamentals of physics I - Mechanics	E	ZO	I	7	45	45	
5	Metrology	ZO	ZO	I	2	15	15	
6	Mathematical analysis II	E	ZO	II	5	30	45	
7	Fundamentals of physics II - Thermodynamics	E	ZO	II	5	30	30	
8	Physics laboratory I – Mechanics, thermodynamics		ZO	II	4			45

9	Fundamentals of physics III - Electricity and magnetism	E	ZO	III	7	30	45	
10	Mathematical methods in physics	E	ZO	III	6	30	30	
11	Physics laboratory II – Electricity and magnetism		ZO	III	4			45
12	Classical and relativistic mechanics	E	ZO	IV	6	30	30	
13	Fundamentals of physics IV - Optics, modern physics	E	ZO	IV	6	30	45	
14	Physics laboratory III – Optics, modern physics		ZO	IV	4			45
15	Electrodynamics	E	ZO	VI	5	30	30	
16	Quantum mechanics foundations	E	ZO	V	6	30	30	
Total ECTS credits: 83			Hours in total: 1005			375	495	135

Key: E - examination, ZO – grade, Z – pass, W – lecture, Ć – class, L - Laboratory

3. IT Module (mandatory 285 h, 19 ECTS credits)

The module covers 285 hours of instruction for which the student can obtain a total of 20 ECTS credits. As part of this module, the student will acquire IT skills necessary to conduct a simple professional analysis of astronomical data, and to present them. In this module, the student will learn how to write computer programs fluently in at least one programming language. Moreover, they will learn a few basic packages for data processing and their graphical presentation. The student will also acquire the skills of independent programming of simple mathematical and numerical methods commonly used in the processing of astronomical data. All subjects in the module are compulsory for all students.

Item	Subject	Form of completing lectures	Form of completing classes/laboratories	Semester	ECTS credits	No of instruction hours		
						W	Ć	L
1	Computer laboratory I - Information technologies		ZO	II	3			45
2	Fundamentals of programming	ZO	ZO	I	5			60

3	Computer data acquisition and processing		ZO	II	2			30
4	Data structures and algorithms	E	ZO	III	4	30		30
5	Scientific calculations and numerical methods		ZO	V	5		75	
Total ECTS credits: 19			Hours in total: 270			30	75	165

Key: E - examination, ZO – grade, Z – pass, W – lecture, Ć – class, L - Laboratory

4. Astronomy Module (mandatory 330 h, 24 ECTS credits)

The module covers 330 hours of instruction for which a student can obtain a total of 25 ECTS credits. In this module, the student will acquire basic information in all major fields of astronomy. The module includes subjects covering the fundamentals of astronomy and astrophysics: general astronomy, spherical astronomy, fundamentals of celestial mechanics, cosmology, astrophysics of compact objects. In the module the student will learn the fundamentals of optics, the construction and operation of radio telescopes and optical telescopes, the evolution of stars, the physics of interstellar medium. The module is compulsory for all students.

Item	Subject	Form of completing lectures	Form of completing classes/laboratories	Semester	ECTS credits	No of instruction hours		
						W	Ć	L
1	Astronomy Fundamentals	ZO		II	2	30		
2	Astronomical instruments	E	ZO	II	4	30	30	
3	The basics of spherical astronomy and astrometry	E	ZO	III	5	30	30	
4	Introduction to celestial mechanics and solar system	E	ZO	III	5	30	30	
5	Physics of stars and the scattered matter	E	ZO	V	4	30	30	
6	Star systems and the structure of the universe	E	ZO	VI	3	30	30	
Total ECTS credits: 24			Hours in total: 330			180	150	

Key: E - examination, ZO – grade, Z – pass, W – lecture, Ć – class, L - Laboratory

5. Module: Optical astronomy (elective, 240 h, 21 ECTS credits)

The elective module. It covers 240 hours of instruction for which the student can obtain 21 ECTS credits. The student must complete lectures and classes and will participate in the analysis of optical data using previously learned astrophysical and computer methods. The module is elective.

Item	Subject	Form of completing lectures	Form of completing classes/laboratories	Semester	ECTS credits	No of instruction hours		
						W	Ć	L
1	Laboratory of the fundamentals of optical astronomy		ZO	IV	4			45
2	Observational methods and data analysis in optical astronomy	ZO	ZO	IV	5	30	30	
3	Laboratory of advanced analysis of optical data		ZO	V	6			75
4	Monographic lecture	ZO		VI	4	30		
5	Introduction to the astrophysics of compact objects	E		VI	2	30		
Total ECTS credits: 21			Hours in total: 240			90	30	120

Key: E - examination, ZO – grade, Z – pass, W – lecture, Ć – class, L - Laboratory

6. Module: Radio astronomy (elective, 240h, 21 ECTS credits)

The elective module. It covers 240 hours of instruction for which the student can obtain 21 ECTS credits. The student must complete lectures and classes and will participate in the analysis of radio data using previously learned astrophysical and computer methods. The module is elective.

Item	Subject		Form of completing classes/laboratories	Semester	ECTS credits	No of instruction hours		
						W	Ć	L

		Form of completing lectures						
1	Laboratory of the fundamentals of radio astronomy		ZO	IV	4			45
2	Observational methods and data analysis in radio astronomy	ZO	ZO	IV	5	30	30	
3	Laboratory of advanced radio-astronomy data analysis		ZO	V	6			75
4	Monographic lecture	ZO		VI	4	30		
5	Pulsar Astrophysics	E		VI	2	30		
Total ECTS credits: 21			Hours in total: 240			90	30	120

Key: E - examination, ZO – grade, Z – pass, W – lecture, Ć – class, L - Laboratory

7. Undergraduate module (elective, 120h, 20 ECTS credits)

The module covers 120 hours of instruction plus writing a bachelor's thesis for which the student can earn 20 ECTS credits. The module is elective in terms of choosing the topic of the bachelor's thesis. The module includes seminar classes, during which students will learn selected issues of astrophysics, discuss them in groups, and then present them in the form of a seminar. In the undergraduate laboratory the student will learn the technical and practical aspects of preparing their bachelor's thesis, and other scientific publications in general. The module also covers the bachelor's thesis itself, with ECTS credits awarded for the work put into its creation, including interaction with the thesis supervisor.

Item	Subject	Form of completing lectures	Form of completing classes/laboratories	Semester	ECTS credits	No of instruction hours		
						W	Ć	L
1	Undergraduate seminar I		ZO	V	4		45	
2	Undergraduate Laboratory		ZO	VI	6			45
3	Undergraduate seminar II		ZO	VI	4		30	
4	Bachelor's thesis	E		VI	6			

Total ECTS credits: 20	Hours in total: 120	0	75	45

Key: E - examination, ZO – grade, Z – pass, W – lecture, Ć – class, L - Laboratory

1.6 The length, rules and form of student internships *(internships for first-cycle programmes of practical profile and single-cycle programmes last 6 months - 720h, for second-cycle programmes - 3 months - 360h. For programmes of academic profile only if the study programme includes internships)*.

Not applicable.