COURSE UNIT (MODULE) DESCRIPTION

Course unit (module) title	Code
World of Particles	

Course Summary
The course „The World of Particles“ aims to introduce the principle concepts to topics related to radiation sources and its real or perceived hazards; difference in scales of the physical world between the microcosm and the macrocosm; peculiar properties of matter at extreme conditions; the Higgs boson discovery at the Large Hadron Collider at CERN. This course presents scientific reasoning and the guiding principles for some of the forefront scientific and engineering research, as well as the historic ideas that lead to modern particle physics and the associated technologies.

Lecturer(s)	Department(s) where the course unit (module) is delivered
Coordinator: Thomas Gajdosik **Other(s): Andrius Juodagalvis, Aurelijus Rinkevičius, Albinas Plėšnys, Christoph Schäfer (TBC)**	Faculty of Physics

Study cycle	Type of the course unit (module)
First	General university studies

Mode of delivery	Period when the course unit (module) is delivered	Language(s) of instruction
Face-to-face	Autumn/ Spring	English

Requirements for students	
Prerequisites: English B1	**Additional requirements (if any):**

Course (module) volume in credits	Total student’s workload	Contact hours	Self-study hours
5	130	54	76

Purpose of the course unit (module)
The aim of the course „World of Particles“ is to present concepts, implications and applications of modern particle physics to students. The students will acquire basic knowledge and will know guiding principles about consequences of special relativity and the uncertainty principle, also about the vastness of the scales from the microcosm to the entire universe; furthermore they will understand the influence of particle physics research on current technological and societal developments. The final result of participating in this course should be, that the students are able to distinguish information that they encounter in their surrounding as being more probable or less probable using the scientific method shown and discussed in the course. This final result is usually just called critical thinking.

Learning outcomes of the course unit (module)	Teaching and learning methods	Assessment methods
- The student will be able to identify the manifestations of fundamental interactions in physical phenomena and know the fundamental constituents of matter	Lecture, seminars, tutorial, group work, and individual study	Midterm test, Final Exam, presentations, evaluating the presentations of other students
- The student will be able to critically address the paradoxes related to special relativity	Lecture, seminars, group work, and individual study	Midterm test, Final Exam, presentations, evaluating the presentations of other students
- The students will learn the scientific method of problem solving and practice its application	Lecture, seminars, group work	Midterm test, Final Exam, presentations, evaluating the presentations of other students
- The students will learn to select and use sources of information on current developments of particle physics and on technology, that is related to it, and analyze relevant examples		Midterm test, Final Exam, presentations, evaluating the presentations of other students
- The students will learn the role of fundamental research in technological and societal developments		Midterm test, Final Exam, presentations, evaluating the presentations of other students
- The students will learn team work, the application of general ethical rules, and rules of scientific research to the assigned tasks	Group work, seminars	Presentations, evaluating the presentations of other students
- The students will learn the evaluation of scientific material and to present orally complex information in a concise, clear, and reasoned manner	Group work	

Content: breakdown of the topics	Contact hours								Self-study work: time and assignments	
	Lectures	Tutorials	Seminars	Workshop	Laboratory work	placementInternship/work	E-learning	**Contact hours**	**Self-study hours**	**Assignments*** *[this is the estimated time for the student to do the assigned tasks. The tasks lead to a better under-standing of the course material, but are not necessarily used for the grade of the course!]
1. Historical motivation and Philosophical introduction; history of particle physics before accelerators, history of particle physics with accelerators, scientific method	6		4					**10**	**2**	**Answering review questions about the lecture on moodle**
2. Special Relativity; explanation of space-time diagrams, scales (microscopic/macroscopic), time dilation / length contraction, frames of reference, symmetries and conservation laws, meaning of mass	4		4					**8**	**26**	**Reading the first 6 chapters of „Special Relativity“ by D. Hogg** (in this reading the more complicated mathematical formulas and calculations can be ignored) (16 hours) **Doing homework exercises** (simple calculations and drawing space-time diagrams; the calculations and the drawing of the space-time diagrams are explained and practiced in a seminar before) (8 hours) **Answering review questions about the lecture on moodle** (2 hours)
3. Concepts of Quantum Mechanics; quantization, double slit experiment (particle-wave duality), „what is measurement?“	4							**4**	**2**	**Answering review questions about the lecture on moodle**
4. Standard Model of Particles (SM); fundamental forces, elementary particles, underlying symmetries, Higgs mechanism, detecting particles	4	2	2					**8**	**6**	**Reading the section „The Standard Model“ of „The particle adventure“ <https://www.particleadventure.org/standard-model.html>** (4 hours) **Answering review questions about the lecture on moodle** (2 hours)
5. Cosmic Rays; origin and observation of the cosmic rays	2							**2**	**1**	**Answering review questions about the lecture on moodle**
6. Technology and Society; particle physics inspired technologies that affected society, ideas about new technologies	6		6					**12**	**3**	**Answering review questions about the lecture on moodle**
7. Midterm test and Preparation for the Final Exam			4					**4**	**24**	**Individual study of the learning material to prepare for the test and the exam**

8 Student presentation sessions			6					**6**	**12**	**Preparing a presentation for seminar in the small group. Evaluating presentations of the other students.**
Total	**26**	**2**	**26**					**54**	**76**	

Assessment strategy	**Weight,%**	**Deadline**	**Assessment criteria**
2 Presentations during the seminars	**2*25**	**At the specific arranged presentation session**	• Grade from the lecturer 15%, following predefined formal criteria: ◦ logical consistency of the presentation; ◦ fitting into the assigned timeframe; ◦ answering questions to the presentation; ◦ being understandable to the audience; ◦ presenting the theme in an adequately detailed manner; • grade from students of the audience (averaged) 5%; • grade from the fellow students in the group that prepared presentation together (averaged) 5%
Evaluating the presentations of other students	**2*5**	**Within two weeks after the presentation was given.**	After the presentation was given each student has to give an evaluation on moodle. The student can give up to 5 points and has to motivate in words (with a short comment) why the presentation was worth that many points. As criteria the student can use the formal criteria that are written above.
Midterm test	**20**	**Arranged time**	Grading the multiple choice test by the computer system (Moodle). The test will consist of 40 closed questions. Full points are given only for fully and correctly answered questions.
Final exam	**20**	**Exam time**	Grading the multiple choice test by the computer system (Moodle). The exam will consist of 40 closed questions. A few questions from the Midterm test can appear again. Full points are given only for fully and correctly answered questions.
Up to 5% of bonus points can be given for students for exceptional engagement. Examples for exceptional engagement would be: the student comes with questions about the course subject outside the normal course times, the student helps other groups to prepare their presentation, the student presents the homework in a clear way that helps other students understand it better.			

Author	Year of publication	Title	Issue of a periodical or volume of a publication	Publishing place and house or web link
Compulsory reading				
D. Hogg	1977	Special Relativity	47p.	http://cosmo.nyu.edu/hogg/sr/sr.pdf
OR: Martinus J G Veltman	2018	Facts and Mysteries in Elementary Particle Physics	Revised Edition: ISBN-13: 978-9813237490 352 p.	World Scientific Publishing
Particle Data Group	© 2014	The particle adventure, section: The Standard Model		https://particleadventure.org/standard-model.html
Optional reading				
D. Griffiths	2008	Introduction to Elementary Particles	2nd edition 978-3527406012, 470p.	Wiley-VCH
T. Gajdosik	2013	Special Relativity for Particle Physics: notes on Mathematics for Physics	31p.	VU http://web.vu.lt/ff/t.gajdosik/files/2014/01/sr4wop.pdf
Particle Data Group	© 2014	The particle adventure: other sections		http://www.particleadventure.org/
CERN	2020	Accelerating science		https://home.cern/