



## COURSE UNIT (MODULE) DESCRIPTION

Course unit (module) title	Code
Introduction to Elementary Particle Physics II/II	

Lecturer(s)	Department(s) where the course unit (module) is delivered
<b>Coordinator:</b> dr. Thomas Gajdosik <b>Other(s):</b>	Faculty of Physics

Study cycle	Type of the course unit (module)
Primary	Optional

Mode of delivery	Period when the course unit (module) is delivered	Language(s) of instruction
Auditory work and autonomous learning	VII semester	English

Requirements for students	
<b>Prerequisites:</b> Introduction to Elementary Particle Physics I/II	<b>Additional requirements (if any):</b> English language

Course (module) volume in credits	Total student's workload	Contact hours	Self-study hours
5	135	64	71

Purpose of the course unit (module): programme competences to be developed		
<p><b>General competences to be developed:</b></p> <ul style="list-style-type: none"> <li>• Ability to plan and manage tasks.</li> <li>• Ability to think in general terms, analyse and systemize information.</li> <li>• Ability to find information in different sources.</li> </ul> <p><b>Subject-specific competences to be developed:</b></p> <ul style="list-style-type: none"> <li>• Understanding of the hadronic boundstates of the Standard model of particle physics</li> <li>• The ability to apply Feynman Rules to Feynman Diagrams</li> <li>• The ability to calculate cross sections and decay rates using Feynman Rules</li> <li>• Understanding of the construction of the Standard model</li> <li>• The ability to present a research topic</li> </ul>		
Learning outcomes of the course unit (module)	Teaching and learning methods	Assessment methods
Overview over the hadronic boundstates	lectures, exercise sessions, autonomous work	homework, examination
Application of Feynman Rules	lectures, exercise sessions, autonomous work	homework, examination
Calculation of cross sections and decay rates	lectures, exercise sessions, autonomous work	homework, examination
Construction of the Standard Model	lectures, exercise sessions, autonomous work	homework, examination
Ability to present a research topic	autonomous work, presentation	homework, presentation

Content: breakdown of the topics	Contact hours						Self-study work: time and assignments		
	Lectures	Tutorials	Seminars	Exercises	Laboratory work	Internship/work	Contact hours	Self-study hours	Assignments
1. Overview over the hadronic boundstates	2			2			4	4	Understanding the composition of quarks to form hadrons
2. Application of Feynman Rules	8			8			16	16	Drawing Feynman diagrams for processes and applying the Feynman Rules
3. Calculation of cross sections and decay rates	10			12			22	24	Calculating the cross section / decay rate from the Feynman Rules and the relativistic kinematics
4. Construction of the Standard Model	10			12			22	20	Understanding the building blocks of the Standard Model: Gauge Theories, Higgs Mechanism
5. Preparation for an exam								7	Written exam
<b>Total</b>	<b>30</b>			<b>34</b>			<b>64</b>	<b>71</b>	

Assessment strategy	Weight, %	Deadline	Assessment criteria
Homework	30	Defined, during semester	Homeworks yield cumulative mark. The maximal number of collected marks is normalized to 30% of the final grade.
Seminar presentation	20	Defined, during semester	Seminar presentations yield 20% of the final grade.
Written exam	50	End of semester	Only students who collect 50% of the possible homework and seminar presentation marks are allowed to take the exam. Theory questions will compose 25% of the final grade. Problem solving will give the 25% of the final grade.

Author	Year of publication	Title	Issue of a periodical or volume of a publication	Publishing place and house or web link
<b>Compulsary reading</b>				
D. Griffiths	2008	Introduction to Elementary Particles	2nd edition 978-3527406012, 470p.	Wiley-VCH
J. C. Romao and J. P. Silva	2012	A resource for signs and Feynman diagrams of the Standard model	International Journal of Modern Physics A, vol.27 (2012) 1230025, 30 p.	<a href="http://arxiv.org/abs/1209.6213">http://arxiv.org/abs/1209.6213</a>

<b>Optional reading</b>				
Particle Data Group		The particle adventure:		<a href="http://www.particleadventure.org/">http:// www.particleadventure.org/</a>
M. Robinson	2011	Symmetry and the standard model: Mathematics and particle physics	doi:10.1007/978-1-4419-8267-4, 327p.	Springer
P. B. Pal	2011	Dirac, Majorana and Weyl fermions	Am. J. Phys. 79 (2011) 485-498, 32p.	<a href="https://arxiv.org/abs/1006.1718">https://arxiv.org/abs/1006.1718</a>
Matthew Dean Schwartz	2014	Quantum Field Theory and the Standard Model	ISBN: 9781107034730	Cambridge, UK: Cambridge University Press, 850 p
M. E. Peskin and D.V.Schroeder	1995	An Introduction to Quantum Field Theory	ISBN13:978-0201503975	Reading, USA: Addison-Wesley, 1995, 864p
I. J. R. Aitchison and A.J.G.Hey	2013	Gauge theories in particle physics: A practical introduction: From relativistic quantum mechanics to QED	4th ed., Vol. 1, ISBN:978-1-4665-1302-0, 438p.	CRC Press
I. J. R. Aitchison and A.J.G.Hey	2013	Gauge theories in particle physics: A practical introduction: Non-Abelian Gauge Theories: QCD and The Electroweak Theory	4th ed., Vol. 2, ISBN: 978-1-4665-1310-5, 518 p.	CRC Press
A. Zee	2010	Quantum Field Theory in a Nutshell	ISBN: 9780691140346, 608p.	Princeton, UK: Princeton Univ. Pr.
F. Olness and R. Scalise	2011	Regularization, renormalization, and dimensional Analysis: dimensional regularization meets freshman E & M	Am. J. Phys. 79 (2011) 306, doi:10.1119/1.3535586, 7p.	<a href="https://arxiv.org/abs/0812.3578">https://arxiv.org/abs/0812.3578</a>
T. Gajdosik	2013	Using the path integral to derive the Feynman rules for the ABC-theory	15p.	Vilnius University, <a href="http://web.vu.lt/ff/t.gajdosik/files/2014/08/ABC-feynrules.pdf">http://web.vu.lt/ff/t.gajdosik/files/2014/08/ABC-feynrules.pdf</a>
W. Siegel	2017	Fields	1018 p.	State University of New York at Stony Brook, <a href="http://insti.physics.sunysb.edu/~siegel/Fields4.pdf">http://insti.physics.sunysb.edu/~siegel/Fields4.pdf</a>