Riga Technical University

University of Latvia

# RTU/LU Course

***General data***

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| Code | HEP007 |
| Course title | Introduction to Particle Physics |
| Course status in the programme | Obligatory Choice |
| Course level | Doctoral Studies |
| Course type | Academic |
| Field of study | High-Energy Physics |
| Responsible instructor | Yuri Dokshitzer |
| Volume of the course: parts and credits points | 1 part, 2.0 Credit Points, 3.0 ECTS |
| Language of instruction | EN |
| Possibility of distance learning | Not planned |
| Abstract | This obligatory choice course introduces the basics of the physics of elementary particles and their interactions. Students will become familiar with relativistic kinematics, quantum scattering theory, core concepts and practical applications of relativistic quantum field theories describing electroweak and strong interactions. Special emphasis is given to the physics of high energy hadron-hadron and lepton-hadron collisions, a knowledge of which is essential for people involved in modern collider experiments.<br>This course will help students to fully benefit from the main particle physics theory course, which is an obligatory course in one of the pathways of this doctoral programme. |
| Goals and objectives of the course in terms of competences and skills | Students will learn the origin, structure and open problems of the Standard Model, properties of leptons and hadrons and their interactions, the basics of quark-gluon dynamics. They will be able to follow the derivation of selected theoretical results. The goal is to provide the students with basic understanding of modern particle physics and to equip them with necessary tools for performing simple calculations and analyses concerning, e.g., hadron quantum numbers and selection rules, estimates for cross sections of various lepton-hadron and hadron-hadron interaction processes, etc. In addition, this course will help interested students to fully benefit from the subsequent course on the theory of particle physics. |
| Structure and tasks of independent studies | The independent studies will take the form of further reading and some homework throughout the course. The students will be given problems of increasing difficulty to attempt at home with the aim of them being able to complete at least one problem in a set and attempt the rest. The further reading will be given in the form of recommendations of various sources of information, including textbooks, and material available online. |
| Recommended literature | • Goldstein, Safko, Poole, Classical Mechanics, ISBN: 9781292026558<br>• David J. Griffiths, Introduction to quantum mechanics, ISBN: 9781107179868<br>• Mandl F., Quantum Mechanics, ISBN: 9780471931553<br>• Martin B. R., Particle Physics, ISBN: 9781118912164<br>• Schwartz M. D. Quantum Field Theory and the Standard Model, ISBN: 9781107034730<br>• Okun L. B., Particle Physics: The Quest for the Substance of Substance, ISBN-10: 3718602296, ISBN-13: 978-3718602292 |
| Course prerequisites | Physics, mathematics |
| Courses acquired before | - |

***Course contents***

| Content | Full- and part-time intramural studies | | Part time extramural studies | |
|---|---|---|---|---|
| | Contact Hours | Indep. work | Contact Hours | Indep. work |
| Introduction to special relativity and quantum mechanics | 8 | 24 | | |

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|---|---|---|---|---|
| Introduction to the relativistic quantum field theory | 8 | 24 | | |
| Introduction to the Standard Model | 4 | 12 | | |
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| Total: | 20 | 60 | | |

***Learning outcomes and assessment***

| Learning outcomes | Assessment methods |
|---|---|
| Students can follow the basic concepts of relativity and non-relativistic quantum mechanics; students can perform basic calculations regarding relativistic kinematics and quantum scattering. | Examination: homework problems; oral examination. Assessment: the student will be able to attempt the homework problems and will be able to clearly explain orally the concepts learned. |
| Students can follow the basic concepts of quantum field theory, Feynman diagrams; students can perform basic calculations regarding quantum numbers and internal symmetries of leptons and hadrons, analyse amplitudes of high energy interactions and calculate corresponding cross sections. | Examination: homework problems; oral examination. Assessment: the student will be able to attempt the homework problems and will be able to clearly explain orally the concepts learned. |
| Students have a solid understanding of the fundamental concepts of leptons and hadrons, gauge symmetries, basics of the quark-gluon dynamics; students understand the structure of the Standard Model and properties of the fundamental particles that form this model. | Examination: homework problems; oral examination. Assessment: the student will be able to attempt the homework problems and will be able to clearly explain orally the concepts learned. |

***Evaluation criteria of study results***

| Criterion | % |
|---|---|
| Homework problem sets | 50 |
| Oral examination | 50 |
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| Total: | 100 |

***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 |
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