1862
RĪGAS TEHNISKĀ UNIVERSITĀTE

RTU Course "Accelerator Technologies"

04091 Augstas enerģijas daļiņu fizikas un paātrinātāju tehnoloģiju centrs

General data

Code	HEP700
Course title	Accelerator Technologies
Course status in the programme	Compulsory/Courses of Limited Choice
Responsible instructor	Toms Torims
Volume of the course: parts and credits points	1 part, 8.0 Credit Points, 12.0 ECTS credits
Language of instruction	EN
Abstract	Study course allows to experience in progressive and in-depth manner applications and limitations of different accelerator technologies. Different types of accelerators and accelerator driven systems are introduced along with the necessary electro-magnet, beam dynamics, vacuum and superconductivity theories. Applications in science, medicine and industry as well as technological challenges and required R&D is integral part of the study course. Strong emphasis is given to high-level experimental practical and lab work at CERN.
Goals and objectives of the course in terms of competences and skills	Overall goal is to provide doctoral students with comprehensive and competitive educational opportunities in the field of the accelerator technologies at large and in collaborative work at international environment. The objectives of this course are: 1. To give an insight about several types of accelerators and the principles of the particle transport. 2.To provide students with an understanding of the nature of fundamentals of accelerators and the required components and structures. 3. To allow the students to become familiar with technological components of the accelerators and beam instrumentation. 4. To provide the knowledge about the basic elements of vacuum, RF systems and power sources. 5. To allow the students to become familiar with fundamentals of superconductivity, beam power, luminosity, and efficiency. 6. To give the understanding about the principles of radiation protection, machine, and people protection. 7. To teach the skills needed for the students to be able to run relevant simulations and computation of the tracking codes. 8. To provide a hands-on experimental practical and lab work experience at CERN (if possible).
Structure and tasks of independent studies	The independent studies will take the form of further reading and some homework throughout the study 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. Individually tailor-made experimental practical and lab work programme is foreseen (if student is available to do so) at CERN; by integrating students in the work of the relevant Groups of Accelerator & Technology Sector at CERN. This work to be done under supervision of Responsible instructors or duly authorised CERN staff. Alternatively, this work can be executed by combined work at home institution premises and labs.
Recommended literature	1. Obligātā. / Obligatory 2. E.Wilson. An Introduction to Particle Accelerators Oxford Univ. Press, 2001 3. D.A. Edwards and M.J. Syphers. An Introduction to the Physics of High Energy Accelerators WILEYVCH Verlag, 2008 4. P. Strehl. Beam instrumentation and diagnostics Springer, 2006 5. A.W. Chao and M. Tigner. Handbook of Accelerator Physics and Engineering World Scientific, 2013 6. Shyh-Yuan Lee. Accelerator Physics, 3rd Ed World Scientific, 2011 7. Helmut Wiedemann. Particle Accelerator Physics Springer, 2015 8. Stephen Myers and Herwig Schopper. Particle Physics Reference Library, Volume 3: Accelerators and Colliderss Springer, 2020 9. Thomas P. Wangler. RF Linear Accelerators Wiley-VCH, 2008 10. Sören Möller. Accelerator Technology: Applications in Science, Medicine, and Industry (Particle Acceleration and Detection) Springer, 2021 11. Robert W. Hamm and Marianne E. Hamm, . Industrial Accelerators and Their Applications World Scientific, 2012 12. Samy Hanna. RF Linear Accelerators for Medical and Industrial Applications Artech House, 2012
Course prerequisites	Mechanical engineering, electrical engineering, physics.
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 accelerators, history of accelerators, overview of accelerator types	4	4	0	0
Basics of electromagnetic theory and relativity, accelerator optics, phase space and emittance	6	6	0	0

Transverse beam optics	6	6	0	0
Longitudinal beam optics	4	4	0	0
Technology components: ion sources, magnets, RF cavities	10	10	0	0
Linear accelerators	6	6	0	0
Injection, extraction, beam transfer	4	4	0	0
Synchrotron light and light sources	4	4	0	0
Collective effects, space charge	6	6	0	0
Superconductivity and accelerators	4	4	0	0
Technology components II: vacuum, RF systems, power sources, beam instrumentation	10	10	0	0
Targets and secondary beams	4	4	0	0
Figures of merit: beam power, luminosity, efficiency	4	4	0	0
Simulations and tracking codes	4	4	0	0
Types of accelerators	4	4	0	0
Advanced accelerator concepts	4	4	0	0
Radiation protection, machine and people protection issues	6	6	0	0
Medical and societal applications of accelerators	10	10	0	0
Experimental practical and lab work (if applicable - at CERN)	0	120	0	0
Total:	100	220	0	0

Learning outcomes and assessment

Learning outcomes	Assessment methods
Students are familiar with applications and limitations of different types of accelerators.	Examination: homework problems; oral examination. Assessment: the student will be able to attempt all given problems and will be able to clearly explain in writing and orally the concepts learned.
Students understand accelerator beam optics and know accelerator technological components along with the figures of merit.	Examination: homework problems; oral examination. Assessment: the student will be able to attempt all given problems and will be able to clearly explain in writing and orally the concepts learned.
Students know advanced accelerator concepts as well as medical and societal applications of accelerators.	Examination: homework problems; oral examination. Assessment: the student will be able to attempt all given problems and will be able to clearly explain in writing and orally the concepts learned.
Students are able to run relevant simulations and computation of the tracking codes.	Examination: homework problems; oral examination. Assessment: the student will be able to attempt all given problems and will be able to clearly explain in writing and orally the concepts learned.

Evaluation criteria of study results

Criterion	%
Continuous evaluation of individual work	40
Practical and lab work (if applicable - at CERN)	20
Written and oral exam	40
Total:	100

Course planning

Part	Semester			CP	ECTS	Hours per Week			Tests		
	Autumn	Spring	Summer			Lectures	Practical	Lab.	Test	Exam	Work
1.	*	*		8.0	12.0	8.0	0.0	0.0		*	