Riga Technical University

University of Latvia

RTU/LU Course

General data

Code	HEP005
Course title	Statistical methods in data analysis
Course status in the programme	Obligatory
Course level	Doctoral Studies
Course type	Academic
Field of study	Statistics
Responsible instructor	Prof. Marcis Auzinsh
Volume of the course: parts and credits points	1 part, 2 Credit Points (3 ECTS)
Language of instruction	EN
Possibility of distance learning	Not planned
Abstract	The purpose of the course is to teach students quantitative mathematically justified techniques for analysis and processing of experimental data. Tasks of the course: Students receive an introduction in the main principles of the probability theory, based on which the mathematical justification of the data processing and testing of statistical hypotheses techniques are built. During the course, students learn the main practically used data processing techniques. This knowledge is reinforced by incorporating in lectures the solution of practical examples. The skills of practical implementation of data processing techniques are developed during practical exercises in the computer class and during independent studies. They complete processing of realistic experimental data and learn to extract from these data unknown parameters and to determine their errors.
Goals and objectives of the course in terms of competences and skills	The goal of the course is to provide a comprehensive introduction into statistical methods of data analysis and statistical testing of hypothesis in physics and engineering. After completion of the course students will acquire the following knowledge and gain the following competences and skill. They will: 1. be familiarized with key concepts of mathematical statistics, 2. gain understanding the relationship between mathematical statistics and experimental data analysis 3. be able to conduct data analysis for real experimental situations 4. to be able to formulate and test hypothesis about functional relation between variables based on statistical methods 5. to gain an ability to choose the right method to solve particular problems of data analysis
Structure and tasks of independent studies	Derivation of the Least square method formulae from the principle of maximal likelihood for linear function. Coefficients for linear regression and their dispersions in case of equally weighted data points. Derivation of the Least square method formulae from the principle of maximal likelihood for linear function. Coefficients for linear regression and their dispersions in case of unequally weighted data points. Linearization technique in data processing with least square method. Importance of error propagation in this approach.
Recommended literature	Main: Brandt, Siegmund, Data Analysis. Statistical and Computational Methods for Scientists and Engineers (4th edition), Springer 2014, 523 pages (ISBN: 978-3-319-03761-5 Further Reading: G. Cowan. Statistical Data Analysis (Clarendon Press, Oxford, 1998). D. S. Siva. Data Analysis: A Bayesian Tutorial (Clarendon Press, Oxford, 2004).
Course prerequisites	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. Typical problems of data analysis.	2	2	-	-
Concept of probability. Continuous and discrete variables.	4	6	-	-
Probability distributions of one and several variables. Error propagation. Continuous and discrete distributions Gaussian or Normal distribution. Poisson distribution. Some other distributions.	4	4	-	-
Method of maximum likelihood.	4	6	-	-
Method of least square. Covariation matrix. Polynomial regression with orthonormal polynoms.	4	6	-	-

Testing statistical hypothesis, Chi square distribution and chi square criterion. Moving average.	6	6	-	-
Function minimization methods, one and several variables.	4	6	-	-
Computer generated random numbers. The Monte Carlo method.	4	4	-	-
Total:	32	40	-	-

Learning outcomes and assessment

Learning outcomes	Assessment methods
Knowledge 1. understands the notion of a random variable and its distribution; 2. understand the concept of regression; Skills 3. is able to evaluate the parameters of the distribution of random variables and their accuracy; 4. is able to evaluate the amount and reliability of information obtained from experimental results; 5. is able to perform statistical tests for testing hypotheses based on experimental results; 6. is able to find minima of multi variable functions; 7. is able to use Monte Carlo methods; Competences 8. can choose the regression method corresponding to experimental data;	Examination; home work;

Evaluation criteria of study results

Criterion	%
Requirements for awarding credits Student's evaluation consists of: Interim assessment: - home work (10%) - 2 tests (30%); - a course project elaborated at the end of the semester (30%); Final assessment: - oral exam with 2 practical/theoretical questions (30%).	 10 30 30 30
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
1.	*													