COURSE UNIT (MODULE) DESCRIPTION

Course unit (module) title			Code
Functional data analysis			
Lecturer(s)		**Department(s) where the course unit (module) is delivered**	
Coordinator: prof. dr. Jurgita Markevičiūtė **Other(s):**		Faculty of Mathematics and Informatics	
Study cycle		**Type of the course unit (module)**	
Second		Compulsory	
Mode of delivery	**Period when the course unit (module) is delivered**		**Language(s) of instruction**
Face-to-face	Spring semesters		English
Requirements for students			
Prerequisites: Knowledge of the basic principles of statistical inference is desirable, as well as some knowledge of the R computing environment		**Additional requirements (if any):** No	
Course (module) volume in credits	**Total student's workload**	**Contact hours**	**Self-study hours**
5	150	42	108

Purpose of the course unit (module): programme competences to be developed		
The course aims to introduce the key mathematical concepts and results that are relevant for the theoretical and practical development of the statistical analysis of data obtained from observations of stochastic processes.		
Learning outcomes of the course unit (module): after completion of the course students	**Teaching and learning methods**	**Assessment methods**
will understand both technical and conceptual aspects dealing with data treated as samples of functions, will know how to represent data as functions, will understand the role of functional data analysis to practical problems. will be able to exploit number of algorithmic approaches, with assistance of software packages, both to analyze and visualize functional data. will be able to make assessments of the type of approach that is most suitable for the problem at hand, and critically discuss the results of analysis obtained by a particular method.	theoretical lectures and seminars, applicative R sessions research examples presented in seminars	Exam Preparation and Presentation of a Project Using Real Data

Content: breakdown of the topics	Lectures	Tutorials	Computer sessions	**Contact hours**	**Self-study hours**	**Assignments**
Introduction to abstract statistics and statistics of random functions, examples and motivation (*objective is to provide students with an understanding of how functional data arises and the areas where it is commonly encountered, to present motivating examples as well as to provide a basic probabilistic structure for how functional data are enerated*)	2			**2**	**4**	To study [1, Ch. 1]; to solve homework assignments obtained during computer sessions
Smoothing and curve fitting; Registration of functional data (*objective is to demonstrate how one moves from observed vectors to functional objects, to discuss the basics of nonparametric smoothing (local polynomials, regression splines, smoothing splines, free-knot splines, wavelets), and in particular, to demonstrate how basis expansions can be used to create and store functional objects*).	2		2	**4**	**8**	To study [1,Ch. 3,4,8]; to solve homework assignments obtained during computer sessions
Clustering of functional data			2	**2**	**4**	to solve homework assignments obtained during computer sessions
Hilbert space framework for functional data (*objective is to provide a basic introduction to function spaces and operator theory, to discuss how functional objects can be modelled using this framework, and in particular, explore the basics of probability theory for function space valued objects (including distributions and other parameters)*).	4			**4**	**10**	To study [2, Ch. 3]
Descriptive statistics of of Functional Data; Dimensional reduction for functional data (functional principal component analysis, functional independent component analysis, varimax rotations) (*objective ate to learn how to estimating mean functions, covariance operators and other distributional parameters of functional data; are to introduce functional principal component analysis (FPCA) as one of the fundamental tools of FDA*).	4		4	**8**	**8**	To study [1, Ch. 6, 7]; to solve homework assignments obtained during computer sessions
Non-parametric inference for functional data (*objectives are to introduce permutational inference, global and local null hypothesis testing, functional t-test, functional ANOVA; to provide their properties*).	4		4	**8**	**10**	To study [2, Ch. 12] to solve homework assignments obtained during computer sessions

Functional linear models (*objectives are to discuss the various forms of the functional linear model, including function on function regression or function/scalar regression; to present estimation methods and properties*).	2		2	**4**	**8**	To study [1, Ch. 9, 10] to solve homework assignments obtained during computer sessions
Dependent functional data (*objectives are to discuss generalizations to dependent sequences, including functional time series*).	2		2	**4**	**8**	To study [2, Ch. 8] to solve homework assignments obtained during computer sessions
Project presentations *(Students may either investigate an FDA research paper/methodology not described in the class or to present a novel data application where they apply FDA method*s).			6	**6**	**28**	to work on a project;
Exam					**20**	Review theory and problem solutions; prepare for the exam
Total including final exam	**20**		**22**	**42**	**108**	

Assessment strategy	**Weight ,%**	**Deadline**	**Assessment criteria**
Project/Presentation *Students will work on a project in groups of 2-3 throughout the semester.* *A final report will be submitted at the end of the semester and students will give a 10-15 minute presentation based on that report.* *During the semester each group will give a 5-10 minutes' presentations about the selected data for the project and the progress on the project.* *All presentations are mandatory; without them the final project evaluation is 0.*	50%	A final report will be submitted to Moodle at the end of the semester. Three presentations during the semester. Intermediate presentations will be submitted to the Moodle just after the presentation.	Students will give a final 10-15 minute presentation based on the final report and 5-10 minutes presentations during the semester. Evaluation in 10 points scale based on quality of presentation and report. All presentations are mandatory; without them, the final project evaluation is 0.
Final exam *Written 2 hours duration exam.*	50%	during exam period	Evaluation in 10 points scale according to the tasks solved.

Evaluation strategy for extern exam			
Students must complete all the tasks : prepare the project and take the exam.	100	During session	The evaluation criteria for all the tasks are the same as for other students.

Author	Year of publication	Title	Publishing place and house or web link
Compulsary reading			
J.O. Ramsay, G. Hooker and S. Graves	2009	Functional Data Analysis with R and MATLAB	Springer
Piotr Kokoszka and Matthew Reimherr	2017	Introduction to Functional Data Analysis	Taylor & Francis group
Optional reading			
Tailen Hsing and Randall Eubank	2015	Theoretical Foundations of Functional Data Analysis, with an Introduction to Linear Operators	Wiley
L. Horvath and P. Kokoszka	2012	Inference for functional data with applications	Springer
J. Ramsay and B. Silverman	2005	*Functional Data Analysis*, Second Edition.	Springer