Faculty of Economics and Business Administration

COURSE (MODULE) DESCRIPTION

Course title	Code
Statistical Theory	

Staff	Department
Coordinator: Dr Povilas Lastauskas and Ovidijus Stauskas (Lund University, Sweden) **Other(s):** Dr Ieva Mikaliūnaitė	Faculty of Economics and Business Administration

Study cycle	Course type
First (Bachelor's)	Compulsory

Form of implementation	Period of implementation	Language of instruction
Face-to-face and online	Semester 1 and 2	English

Requirements for student	
Prerequisites:	**Additional requirements (if any):**

Number of ECTS credits	Student's workload	Contact hours	Individual work
10	260	72	188

Purpose of the course and competences developed		
This course aims to provide theoretical knowledge of both the frequentist and the Bayesian approaches to statistics, useful for the statistical analysis of economic, financial, and social problems.		
Learning outcomes (learning outcomes of the programme)	**Teaching methods**	**Assessment methods**
To be in possession of a good grasp of the elementary tools of descriptive statistics; should understand elementary principles of probability and statistical theory; should be competent in applying basic methods of statistical inference as well as Bayesian approach to statistics. (1.2)	Lectures and lecture notes, tutorials. .	Written examination and homework.
Find relevant data, evaluate its quality, conduct statistical analysis using modern software packages and prepare a final report using scientific typesetting tools. (3.4)	Lectures and lecture notes, tutorials, labs, and independent statistical project.	
Expand own understanding, knowledge and skills working on problem sets independently (5.1)	Individual homework assignments.	
The ability to work in teams delivering an empirical project (4.1)	Group homework assignments.	

Course themes	Contact / Individual work: time and assignments								
	Lectures	Tutorials	Seminars	Practical classes	Laboratory work	Practice	Contact hours	Individual work	**Assignments due date**
FALL semester (Statistical Theory I)									
Review of Statistical Science	2						2	5	
Descriptive Statistics	2						2	5	
Probability: events, outcomes and sample space; Venn diagrams; unions, intersections and complements; simple combinatorial formulae for sampling with and without replacement; random variables	4	2					6	10	
Probability distributions: univariate discrete and continuous distributions; probability mass functions; cumulative distribution functions and probability density functions; expectations, variances and higher moments; Bernoulli trials and the Binomial distribution; Uniform and Normal distributions; Chi-squared, t and F distributions	6	2					8	20	**Problem Set 1** Emphasis on combinatorial basics of probability, probability distributions and densities. MM chapters 2-3, Appendices B and C. LM chapter 2.
Sample statistics: the concept of an estimator; unbiasedness and efficiency; sampling distributions, Law of Large Numbers and Central Limit Theorem	6						6	20	
Estimation and Inference: point and confidence interval estimation and hypothesis testing; null and alternative hypotheses; critical regions; one-tailed and two-tailed tests; Type I and Type II errors; power functions	4	2					6	15	**Problem Set 2 Group Project**
Bivariate Regression: ordinary least squares, conditional expectations function, tests of significance, sampling distributions of regression coefficients	6	2					8	20	**Problem Set 3** Work on hypothesis testing and estimation. MM chapters 12-13, 14.1-14.4. LM chapters 5-7. Time permitting: Tutorial on running simple regressions, interpreting results, conducting hypothesis testing.
SPRING semester (Statistical Theory II)									
Review of Probability: axioms, conditional probability, random variables, mean, variance.	3	2					6	20	Tutorial on R and its use for Bayesian

									inference; Individual homework 1
Discrete and Continuous random variables: Bernoulli, Bnomial, Poisson, Exponential, Gamma, Beta, Gaussian. Their properties, means, variances.	3	2					6	20	Individual homework 2
Bayesian Inference for Discrete Random variables: likelihood, prior, conjugacy, posterior and posterior predictive distributions.	6	2					4	10	Individual homework 3;
Bayesian Inference for Continuous Random Variables. Gaussian Model and Bayesian Linear regression.	6	2					12	25	Individual homework 4,5
Differences between Bayesian and Frequentist views – the big picture.	6	2					6	18	R-programming project and Individual homework 6
Total	**54**	18					**72**	**188**	

Assessment strategy	**Share in %**	**Time of assessment**	**Assessment criteria**
Fall semester (Statistical Theory I)			
Written exam	50	End of fall semester	The final exam will consist of open and mathematical questions in which students have to show their knowledge and analytical capabilities, and shorter questions testing knowledge of main concepts and statistical ideas.
Problem sets	30	Throughout semester	There will be three problem sets, which will involve problem solving and data manipulation exercises. Only one randomly picked problem set per student will be graded. However, to get a grade, all three problem sets must be submitted. All problem sets will be returned at the same time, after the last one is being covered in classes.
Group project	20	Second half of the fall semester	Presentation in class of the real-world data exercise, answering questions, and demonstrating knowledge of main statistical concepts.
Spring semester (Statistical Theory II)			

Written exam	70	End of semester	Exam questions include all topics covered in the course lectures and discussions. It is exercises based and is worth of 10 points. Each question is evaluated by 1 point using the evaluation criteria below: -1 point (excellent) evaluates the answer, giving a detailed and clear answer to a question based not only on lecture material but also on its own, substantiated reasoning. -The 0.5 point (well) evaluates the answer in detail, but not very accurately. -A score of 0.25 (weak) is considered the answer to be vague or incomplete, with several major errors. -0 points (unsatisfactory) no answer or it's completely wrong.
Programming project	30	During the course	The project evaluates students' skills in using R-program for data analysis with 3 questions. Each question is evaluated by the following criteria: correct answers, clear and readable codes, and simplicity.

Author	Published in	Title	Issue No. or Volume	Publishing house or Internet site
Required reading				
Lecture notes and slides as well as online resources will be made available to all students. Selected chapters from LM, MM and Bolstad are compulsory.				
R J Larsen and M L Marx (Referred to as LM)	2011	An Introduction to Mathematical Statistics and its Applications	5th Edition	Pearson
I Miller and M Miller (Referred to as MM)	2012	John E. Freund's Mathematical Statistics with Applications	8th Edition	Pearson
Contributors	2013	OpenStax Intro Statistics		Introductory Statistics - OpenStax

D. Diez, M. Cetinkaya-Rundel, C. Barr (Editors)	2019	Open Intro Statistics	4th Edition	OpenIntro Statistics
William M. Bolstad and James M. Curran	2017	Introduction to Bayesian Statistics (3rd edition)		Wiley
Supplementary reading (text books)				
James V Stone	2013	Bayes' Rule: A tutorial Introduction to Bayesian Analysis		Sebtel Press
D.S.Sivia and J.Skilling	2006	Data Analysis: A Bayesian Tutorial		Oxford University Press