M125	**Selected applications of probability**	L	P	S	ECTS
		2	0	1	4

Course objectives. To inform students about different applications of probability theory and stochastic models. To illustrate applications of theoretical concepts from probability theory and stochastic processes theory. Special focus will be on applications in other scientific areas, such as biology, economics, finance, actuarial mathematics and others.

Prerequisites. Probability.

Course content.
Each year several topics are selected by considering applications in other scientific areas. Topics are chosen from the list below or new topics are defined.

1. Extreme value distributions and applications. Heavy-tailed distributions. Limiting behaviour of partial maxima. Frechet, Gumbel and Weibull distribution. Generalized extreme value distribution. Statistical methods for analysing extreme events and parameter estimation. Applications in insurance, finance and natural sciences.
2. Insurance risk models. Claims and claim size distributions. Cramer-Lundberg model. Computing and approximating ruin probability. Distribution of ruin related quantities. Generalizations of Cramer-Lundberg model.
3. Stochastic models in sports. Modelling football match outcomes. Poisson regression. Models in other sports.
4. Dividends optimization problem. Barrier strategies- Dividend problem for Brownian motion.
5. Counterparty credit risk. Structural models (firm-value models). Intensity models. Credit value adjustment risk.
6. Stochastic models in biology. Growth models. Models for DNA sequences evolution.
7. Monte Carlo simulations. Generating pseudorandom numbers. Generating numbers from probability distributions. Monte Carlo methods. Metropolis-Hastings algorithm. Applications.

LEARNING OUTCOMES

No.	LEARNING OUTCOMES
1.	Demonstrate the properties of the models covered by the course.
2.	Recognize appropriate models for the data.
3.	Identify models and estimate parameters by using statistical estimation methods.
4.	Critically analyse model, its usefulness, possible applications and limitations.
5.	Critically study and apply new literature for stochastic modelling.
6.	Present created models and possible applications to amateurs and professionals.

RELATING THE LEARNING OUTCOMES, ORGANIZATION OF THE EDUCATIONAL PROCESS AND ASSESSMENT OF THE LEARNING OUTCOMES

TEACHING ACTIVITY	ECTS	LEARNING OUTCOME **	STUDENT ACTIVITY*	EVALUATION METHOD	POINTS	
					min	max
Attending lectures and exercises	0,5	1-6	Lecture attendance, discussion, team work and	Attendance lists, tracking activities	0	4

			independent work on given tasks			
Homework	0,5	1-6	Solving theoretical and practical problems	Evaluation	0	4
Written exam (Mid-terms)	1	1-6	Preparing for written exam	Evaluation	25	46
Final exam	2	1-6	Revision	Oral exam	25	46
TOTAL	4				50	100

Teaching methods and student assessment. Lectures and seminars are mandatory. The final exam is taken upon the completion of lectures and exercises and it consists of two parts, a written and an oral part. Acceptable mid-term exam scores replace the written examination. Students may influence their final grade by doing homework or preparing a seminar paper.

Can the course be taught in English: Yes

Basic literature:

1. P. Embrechts, C. Klüppelberg, T. Mikosch, Modelling extremal events: for insurance and finance, Springer-Verlag, Berlin, 1997.

Recommended literature:

1. J. Albert, J. Bennett, J.J. Cochran (editors), Anthology of statistics in sports. Society for Industrial and Applied Mathematics, 2005.
2. H. Albrecher, S. Asmussen, Ruin probabilities, World Scientific, Singapore, 2010.
3. T.R. Bielecki, M. Rutkowski, Credit risk: modeling, valuation and hedging. Springer Science & Business Media, 2013.
4. W.M. Bolstad, J.M. Curran, Introduction to Bayesian statistics. John Wiley & Sons, 2016.
5. D. Brigo, M. Morini, A. Pallavicini, Counterparty credit risk, collateral and funding: with pricing cases for all asset classes, John Wiley & Sons, 2013.
6. R. Durrett, Probability models for DNA sequence evolution, Springer Science & Business Media, 2008.
7. J. E. Gentle, Random number generation and Monte Carlo methods, Springer Science & Business Media, 2006.
8. H.U. Gerber, E.S.W. Shiu, Optimal dividends: analysis with Brownian motion, North American Actuarial Journal 8(2004), 1-20.