Course Unit Descriptor

Study Programme: Applied Mathematics – Data Science

Course Unit Title: Operations research

Course Unit Code: MDS26

Name of Lecturer(s): Nataša Krejić

Type and Level of Studies: Master Academic Degree

Course Status (compulsory/elective): elective

Semester (winter/summer): Winter

Language of instruction: English

Mode of course unit delivery (face-to-face/distance learning): Face-to-face

Number of ECTS Allocated: 5

Prerequisites: Basics of linear algebra and probability

Course Aims:

Understanding of a wide range of important optimization methods in finance as well as some of the key issues related to modelling and stability of financial networks

Learning Outcomes:

- Ability to understand, implement in Mathematica and measure performance of various optimal portfolio selection models using real financial data
- Ability to comprehend key ways in which one selects, implements and validates statistical methods for measure market risk
- Ability to analyse issues related to stability of financial networks and notion of system crisis

Syllabus:

Participants shall be provided with a set of comprehensive interactive Mathematica-based lecture notes. Thus we initially provide an introduction to programming in Mathematica. After that, the following topics shall be covered:

Portfolio optimization: Markowitz approach, alternative formulation, risk-based measurement of investment performance, transaction costs, other realistic investment constraints, portfolio optimization using different risk measures, robust parameter estimation, shrinkage estimators, concepts of convex optimization, robust portfolio optimization methods, multi-period binomial tree portfolio optimization, essentials of stochastic calculus, portfolio optimization in continuous time (Bellman equation, direct optimization and martingale approach)

Market risk models: financial time series, historical and analytical VaR models, GARCH, fat tails, backtesting VaR models

An overview of concepts and papers related to stability of financial networks

Required Reading:

Selected parts of the following books:

1. Fabozzi, F., Kolm, P., Pachamanova, A., and Focardi, S., Robust Portfolio Optimization and Management, John Wiley, 2007.

2. Cvitanić, J. and Zapatero, F., Economics and Mathematics of Financial Markets, MIT Press, 2004.

3. Christoffersen, P., Elements of Financial Risk Management (2nd Edition), Academic Press, San Diego, CA, 2012.

4. Welin, P., Programming with Mathematica, Cambridge University Press, 2013.

5. Papers on financial stability and financial networks

Weekly Contact Hours:	**Lectures:** 2	**Practical work:** 2

Teaching Methods:

Lectures; revisions of the material; active students' participation in problem solving; Mathematica-based homeworks.

Knowledge Assessment (maximum of 100 points):

Pre-exam obligations	points	**Final exam**	points
Mathematica-based homeworks	50	Mathematica-based project with oral presentation	50
Practical instruction		oral exam	
Preliminary exam(s)		…….	
Seminar(s)			

The methods of knowledge assessment may differ; the table presents only some of the options: written exam, oral exam, project presentation, seminars, etc.