Faculty of Economics and Business Administration

COURSE UNIT (MODULE) DESCRIPTION

Course unit (module) title	Code
Further Quantitative Methods	

Academic staff	Core academic unit(s)
Coordinating: Assoc. Prof. dr. Gintautas Bareikis **Other:** Dr Povilas Lastauskas (tentative)	Faculty of Economics of Business Administration

Study cycle	Type of the course unit
First cycle	Optional

Mode of delivery	Semester or period when it is delivered	Language of instruction
Face-to-face	4 semester	English

Requisites	
Prerequisites: Mathematical methods	**Co-requisites (if relevant):**

Number of ECTS credits allocated	Student's workload (total)	Contact hours	Individual work
5	130	36	94

Purpose of the course unit
The aim of the course is to enhance students' skillset and develop students' abilities to carry out economic analysis, evaluation of economic and business decisions by means of mathematical optimization techniques, as well as to provide students with tools that are required to understand and develop rigorous theoretical models of economic processes and follow advanced courses in the third year of the program.

Learning outcomes of the course unit	Teaching and learning methods	Assessment methods
1.2 The ability to understand and develop economic processes based on rigorous mathematical arguments.	Problem-based teaching.	Open-ended questions and solution of problems in the exam, assessment of the rigour and quality of solutions to the problem sets
2.1 The ability to apply the acquired knowledge of mathematical methods, appreciate their domain of application as well as limitations.	Problem-based teaching, problem set solution.	
3.2 The ability to relate mathematically expressed arguments to the economic and social phenomena, and, vice versa, translate economic and social problems into the mathematical language.	Problem-based teaching, independent studies of literature	
5.1 Being able to work independently, while solving problem sets, and expand own understanding, knowledge and skills.	Problem-based teaching, independent studies of literature, practising mathematical methods	

Content	Contact hours							Individual work: time and assignments	
	Lectures	Tutorials	Seminars	Workshops	Laboratory work	Internship	Contact hours, total	Individual work	Tasks for individual work
1. Arithmetic of the complex numbers. Vector spaces, linear independence, basis of a vectors. Space dimension, subspaces. Linear mapping between vector spaces. Kernel and image. Matrix diagonalization. Basis transformation. Eigen value- eigen-vector decomposition.	8		4				12	12	Studies of literature, example problems
2. Function, open-closed sets in the metric spaces. Functions relations, correspondence. Convergence of a sequence in general metric spaces. Continuity in general spaces.	4		2				6	15	Studies of literature, example problems
3. Introduction to differential equations. Stability conditions.	4		4				5	11	Studies of literature, example problems. Problem set 1. SHSS chapter 2 and Appendix A
4. A differentiability in higher dimension. Taylor approximation. Static Optimization: (a) Lagrange; (b) Kuhn-Tucker; (c) Envelope Theorem.	4		2				5	12	Studies of literature, example problems. Problem set 2 SHSS chapter 3, CW chapters 12, 21.1-4, Sundaram chapters 5-6.
5. Problem of convex programming, geometrical interpretation. Non-constraint and constraint cases. Duality in convex programming. Applications.	4		1				5	12	Studies of literature, example problems. Problem set 3 Sundaram chapters 7-8, CW chapters 21.5-7
Total	28		8				36	94	

Assessment strategy	Weight %	Deadline	Assessment criteria
Exam	40	The exam session	Closed and open ended problems, with a focus on mathematical rigour and ability to apply mathematical tools to economic problems. The exhaustiveness of the answer and the ability to creatively apply mathematical methods will be given a bonus.

Colloquim (Part of exam)	40	Middle of semester	Closed and open ended problems, with a focus on mathematical rigour and ability to apply mathematical tools to economic problems. The exhaustiveness of the answer and the ability to creatively apply mathematical methods will be given a bonus.
Four problem sets, each worth 5%	20	During the semester	Rigour and depth of solutions.

Author (-s)	Publishing year	Title	Issue of a periodical or volume of a publication; pages	Publishing house or web link
Required reading				
Alpha S. Chiang, Kevin Wainwright (Referred to as CW)	2005	Fundamental Methods of Mathematical Economics		McGraw-Hill Higher Education
Knut Sydsaeter, Peter Hammond, Atle Seierstad, Arne Strom (Referred to as SHSS)	2005	Further Mathematics for Economic Analysis		Prentice Hall
Rangarajan K. Sundaram	1996	A First Course in Optimization Theory		Cambridge University Press
Recommended reading				
Michael D. Intriligator	2002	Mathematical Optimization and Economic Theory.		Prentice Hall
Lars Ljungqvist, Thomas J.Sargent	2000	Recursive Macroeconomic Theory		The MIT press Cambridge, London
Knut Sydsaeter, Peter Hammond, Arne Strom	2012	Essential Mathematics for Economic Analysis. 4th edition.		Pearson
Kelvin Lancaster	1987	Mathematical Economics.		Collier Macmillan
Richard Bellman	2010	Dynamic Programming		Princeton University Press