COURSE UNIT DESCRIPTION

Course unit title	Code
Numerical Methods for Differential Equations	**MM110NM**

Lecturer(s)	Department(s) where the course unit is delivered
Coordinator: prof. dr. Štikonienė Olga **Other(s):**	**Faculty of Mathematics and Informatics** **Naugarduko St. 24, LT-03225 Vilnius, Lithuania**

Study cycle	Type of the course unit
second	**Optional**

Mode of delivery	Period when the course unit is delivered	Language(s) of instruction
face-to-face	**1st year, semester 1**	**Lithuanian, English**

Requirements for students	
Prerequisites: none	**Additional requirements (if any):** none

Course volume in credits	Total student's workload	Contact hours	Self-study hours
5	**130**	**32**	**98**

Purpose of the course unit: programme competences to be developed		
The aim of the course is increase knowledge of mathematical theory and methods related to theory of evolutionary differential equations and numerical methods of its solution.		
Learning outcomes of the course unit	**Teaching and learning methods**	**Assessment methods**
Understand the concepts and structure of theory of evolutionary differential equations and numerical methods of its solution	Lecture, Individual reading, seminars, solving model problems with computer	Tests (written), Exam (written), Presentation at seminars
formulate (verbally or in text) ideas, propositions and proofs of numerical methods for evolutionary differential equations using the appropriate language.		
solve mathematical problems using techniques from numerical methods for evolutionary differential equations		

Content: breakdown of the topics	Contact hours							Self-study work: time and assignments	
	Lectures	Tutorials	Seminars	Exercises	Laboratory work	Internship/work	**Contact hours**	**Self-study hours**	**Assignments**
1. Introduction. Evolutionary differential equations. Initial and boundary conditions. Advection-diffusion equation. Wave number and amplitude. Taylor's	2						**2**	**8**	Studying and problem solving [Ascher §1], preparing for seminars

theorem. Matrix norms and eigenvalues. Function spaces. Fourier transform.									
2. Well-Posed Initial Value Problems. Simple model cases. Initial-boundary value problems. Stability ideas.	2		1				**3**	**8**	Studying and problem solving [Ascher §1], preparing for seminars
3. Methods for ODEs. Multistep Methods. Runge–Kutta Methods. Convergence and 0-stability. Error Control and Estimation. Stability of ODE Methods. Stiffness. Boundary Value ODEs.	2		1				**3**	**8**	Studying and problem solving [Ascher §2], preparing for seminars
4. Finite Difference and Finite Volume Methods. Order, stability, and convergence	2		1				**3**	**8**	Studying and problem solving [Ascher §3], preparing for seminars
5. Spectral Stability. Fourier Analysis. Eigenvalue Analysis. Nonlinear Stability and Energy Methods.	2		1				**3**	**8**	Studying and problem solving [Ascher §4-5], preparing for seminars
6. Hamiltonian Systems. Splitting methods. Variational methods.	2		1				**3**	**8**	Studying and problem solving [Ascher §6], preparing for seminars
7. Dispersion and Dissipation. The Wave Equation. The KdV Equation. Spectral Methods. Lagrangian methods.	2		1				**3**	**8**	Studying and problem solving [Ascher §7], preparing for seminars
8. Parabolic Problems. Hyperbolic Problems.	2						**2**	**8**	Studying and problem solving [Ascher §8], preparing for seminars
9. Splitting Methods. Implicit methods for parabolic equations . Alternating direction implicit methods . Nonlinear problems.	2						**2**	**8**	Studying and problem solving [Ascher §9], preparing for seminars
10. Discontinuities. Godunov's scheme. Higher Order Schemes for Scalar Conservation Laws.	2						**2**	**8**	Studying and problem solving [Ascher §10], preparing for seminars
11. Nonuniform Meshes	2						**2**	**8**	Studying and problem solving [Ascher §11], preparing for seminars
Exam (written)		4					**4**	**10**	Preparation for examination
Total	**22**	**4**	**6**				**32**	**98**	

Assessment strategy	**Weight,%**	**Deadline**	**Assessment criteria**
Presentation in seminars	40	During the semester	During a seminar a student (or a small group of students) presents certain topic (selected by a lecturer and self-studied by a student) from the theory of partial differential equations, answers audience questions. Ability to understand the issue, to present it consistently and clearly is assessed.
Exam (written)	60	End of semester	Theoretical questions are set in the exam. All questions are worth the same number of points. Maximal number of points is given if the student answered the question: the student has given correct definitions, has given correct statements and their proofs. Some points are given for partial answers.

Author	**Year of publication**	**Title**	**Issue of a periodical or volume of a publication**	**Publishing place and house or web link**
Compulsary reading				
Uri M. Ascher	2008	Numerical Methods for Evolutionary Differential Equations		**SIAM**

Optional reading				
R.Čiegis	2003	Diferencialinių lygčių skaitiniai sprendimo metodai.		Vilnius: Technika