ÓBUDA UNIVERSITY
JOHN VON NEUMANN FACULTY OF INFORMATICS

Institute of Applied Mathematics			Semester 2. of the curriculum 2025-26-2			
Name of the subject:	Code of the subject:	Credits:	Weekly hours:			
				lec	sem	lab
Differential equations	NMXDE1EMNF	4	full-time	2	1	0
Responsible person for the subject: Prof. Dr. TAKÁCS Márta			Classification: professor			
Subject lecturer(s): Dr. Léka Zoltán						
Prerequisites:						
Way of the assessment:	exam					

Course description	
Goal:	To provide an overview of the fundamental concepts of planar dynamical systems. Moreover, the course discusses the methods of calculus of variations with applications in mechanics, and elements of PDEs (heat and wave equations in Euclidean spaces).
Course description:	Dynamics of first and second order differential equations, stability of fixed points through linearization. Energy methods and Lyapunov direct methods. Periodic solutions, limit cycles. Calculus of variations. Hamiltonian and Lagrangian systems, Legendre transform. Elements of PDEs: method of characteristics, heat equation, wave equation.

Lecture schedule	
Education week	Topic
1.	First-order ordinary differential equations: linear, exact and separable systems
2.	Dynamics of first order autonomous differential equations, fixed points.
3.	Dynamics of second order systems: Jacobian matrix, characterization of fixed points through linearization, stability
4.	Energy methods, Lyapunov s theorems on stability
5.	Periodic solutions, limit cycles: divergence criterion, Poincaré-Bendixson theorem
6.	1st written exam
7.	Introduction to variational calculus: brachistochrone problem, Euler-Lagrange equations
8.	Calculus of variations in mechanics, Hamiltonian systems
9.	Hamiltonian and Lagrangian systems, Legendre transformation
10.	Partial differential equations: method of characteristics
11.	Second order partial differential equations, classification
12.	Laplace operator, Dirichlet energy and the heat equation
13.	2nd written exam
14.	Goursat- and Cauchy problems, the wave equation.

Mid-term requirements	
Conditions for obtaining a mid-term grade/signature	50% weekly home assignments in each actual topic, two midterms.

Assessment schedule	
Education week	Topic
7	1st midterm exam
13	2nd midterm exam
14	Resit exam

Method used to calculate the *mid-term grade* (to be filled out only for subjects with mid-term grades)

Type of the replacement	
Type of the replacement of written test/mid-term grade/signature	Resit exam on the last week
Type of the exam (to be filled out only for subjects with exams)	
Final written exam of 180 mins	
Calculation of the exam mark (to be filled only for subjects with exams)	
30 % midterms + 70 % final exam	
Final grade calculation methods:	
0-50 fail (1) 51-62 pass (2) 63-75 satisfactory (3) 76-88 good (4) 89- excellent (5)	
References	
Obligatory:	R. Kent Nagle, Edward B. Saff, Arthur David Snider: Fundamentals of Differential Equations and Boundary Value Problems, 8th Edition, Addison-Wesley, 2011.
Recommended:	D. Strogatz: Non-linear dynamics and chaos, Westview Press, 2001.
Other references:	E. Lieb, M. Loss: Analysis, Amer. Math. Soc., Providence, 2001.