M131	**Dynamic systems**	L	P	S	ECTS
		2	2	0	6

Course objectives: Students will be introduced to basic concepts of Linear Dynamical Systems, with emphasis on models from other scientific disciplines such as economy, biology, electrodynamics, mechanics, etc. Students will be introduced to selected topics and algorithms, which have a very extensive application, using some standard mathematical tools (Python, Octave, Matlab).

Course prerequisites. Undergraduate studies in mathematics and computer science.

Syllabus.

1. Introduction. Autonomous equations. Autonomous systems. Construction of a phase space.
2. Linear systems. Linear change of variables. Phase portraits for canonical systems. Classification of all simple phase portraits. The evolution operator. Affine systems.
3. Nonlinear systems. Local and global behaviour. Linearization around a fixed point. The linearization theorem. Multiple fixed points. Stability of fixed points. Global behaviour.
4. Applications. Linear models (mechanical oscillators, electric circuits, closed and open economy models). Affine models (forced harmonic oscillator). Nonlinear models.

EXPECTED LEARNING OUTCOMES

R.b.	**LEARNING OUTCOMES**
1.	Completely understand and construct autonomous equations and systems as well as a phase space
2.	completely understand and apply knowledge of linear change of variables, phase portraits for canonical systems, classification of all simple phase portraits, the evolution operator and affine systems
3.	Analyze nonlinear systems
4.	Construct models using differential equations
5.	Analyze linear, affine, and nonlinear models
6.	Critically select, evaluate, and apply new mathematical literature

CONNECTING LEARNING OUTCOME, ORGANIZING THE TEACHING PROCESS AND ESTIMATING THE LEARNING OUTCOME

ORGANIZATION OF THE TEACHING PROCESS	**ECTS**	**LEARNING OUTCOME ****	**STUDENT ACTIVITY ***	**ASSESSMENT METHOD**	**CREDITS**	
					min	**max**
Attending lectures and exercises	1	1-6	Class attendance, discussion, teamwork, independent work on assignments and short knowledge tests	Signature lists, follow-up of classroom activities, closed-ended assignments	0	4
Homework	1	1-6	Self-Solving Programming Tasks	Checking Correct Solutions (Evaluation)	0	4
Knowledge check (Tests)	2	1-6	Preparing for a Written Assessment	Checking the correct answers (grading)	25	46

Final exam	2	1-6	Repeating the material	Oral exam	25	46
TOTAL	6				50	100

Teaching methods and student assessment: Lectures and exercises are obligatory. The exam consists of a written and an oral part. After completion of lectures and exercises students can take the exam. Acceptable mid-term exam scores replace the written examination.

Can the course be taught in English: Yes.

Basic literature:

1. L. Perko, Differential Equations and Dynamical Systems, New York: Springer - Verlag, 2001.
2. D. K. Arrowsmith and C. M. Place, Dynamical Systems: Differential Equations, Maps and Chaotic Behaviour, CRC Press, Boca Raton, 1998

Recommended literature:

1. T. A. Weber, Optimal Control Theory with Applications in Economics, MIT Press, Cambridge, Massachusetts, 2011.
2. J. Jost, Dynamical Systems: Examples of Complex Behaviour, Universitext. Springer-Verlag, Berlin, 2005