Subject code	ECTS credits
MAT6003	6

Course title in Lithuanian

DINAMINĖS SISTEMOS

Course title in English

DYNAMICAL SYSTEMS

Short course annotation in Lithuanian (up to 500 characters)

Dinaminės sistemos ir chaosas. Chaosas paprastose dinaminių lygčių sistemose. Lorenco sistema ir jos dinamika. Diskretieji modeliai. Puankare pjūviai ir vaizdai. Stabilumas ir nestabilumas. Liapunovo stabilumo teoremos. Fraktalai ir fraktalų dimensijos. Įvairūs modeliai.

Short course annotation in English (up to 500 characters)

Dynamical systems and chaos. Chaos in ordinary dynamic systems. Lorenz system and its dynamics. Discrete models. Poincaré sections and images. Stability and instability. Lyapunov‘s rate. Its numerical finding. Fractals and fractal dimension. The transition to chaos. Various models.

Prerequisites for entering the course

Algebra, Mathematical Analysis, Geometry, Differential Equations

Course aim

This course aims is to develop understanding in dynamical systems

Links between course outcomes, criteria of learning achievement evaluation, study methods and methods of learning achievement assessment

No	Course outcomes	Criteria of learning achievement evaluation	Study methods	Methods of learning achievement assessment
1.	Knowledge and understanding the purpose of Dynamical Systems	Student demonstrates the ability to understand the Dynamical Systems.	Lectures, practical works, individual work, consulting	Mid-term exam, Assessment of practical works
2.	Knowledge and understanding to solve simple dynamic equations	Student demonstrates the ability to solve simple dynamic equations.	Lectures, practical works, individual work, consulting	Mid-term exam, Assessment of practical works
3.	Understanding the concepts of qualitative theory of differential equation	Student understands the concepts of qualitative theory of differential equation.	Lectures, practical works, individual work, consulting	Final exam, assessment of practical works
4.	Understanding of the dynamic chaos	Student has understanding of the dynamic chaos.	Lectures, practical works, individual work, consulting	Final exam, assessment of practical works

Links between study programme outcomes and course outcomes

Study programme outcomes	Running number of course outcome			
	1	2	3	4
1. Deepen and expand general knowledge of mathematics and apply it in a new non-standard environment	+	+	+	+
2. Broaden and apply the knowledge of mathematical modelling for the economy and technical systems	+	+	+	+
4. Identify, select and understand the state-of-the-art literature of mathematics and apply the gained knowledge to specific scientific and practical tasks	+	+	+	+
5. Develop mathematical models integrating the knowledge from various fields and different mathematical modelling techniques, and analyse the modelling results assessing the model adequacy and accuracy	+	+	+	+
7. Analyse, understand and use mathematical methods	+	+	+	+

Content

No	Content (topics)
1.	Matrix analysis
2.	Linear autonomous systems (algebraic methods)
3.	Phase space, integral curves
4.	Nonlinear dynamic systems (qualitative approach)
5.	Chaos in ordinary dynamic systems
6.	Stability and instability. Lyapunov‘s theorems
7.	Attractors
8.	Various models

Distribution of workload for students (contact and independent work hours)

Lectures	**45 hours**
Practical work	**15 hours**
Individual students work	**100 hours**
Total:	**160 hours**

Structure of cumulative score and value of its constituent parts

Final written exam (50%), mid-term written exam (25%), and assessments of laboratory works and essay (25%).

Recommended reference materials

No	Publication year	Authors of publication and title	Publishing house	Number of copies in		
				University library	*Self study rooms*	*Other libraries*
Basic materials						
1.	*1994*	Strogatz *S.H. Nonlinear dynamics and chaos: with applications to physics, biology chemistry and engineering*	*Addison Wesley.*		1	
2.	*2003*	*Hirsch M.W.*, Smale *S., Devaney R. Differential Equations, dynamical systems, and an introduction to chaos*	*Academic Press*		1	
3.	2003	Cvitanovic P., Artuso R., Dahlqvist P., Mainieri R., Tanner G., Vattay G., Whelan N., Wizba A. Chaos – Classical and Quantum			1	http://www.cns.gatech.edu/ChaosBook
Supplementary materials						
1.	1982	D. K. Arrowsmith, C. M. Place. Ordinary differential equations a qualitative approach with applications	Chapman and Hall, London NewYork			
2.	1990	Баутин Н.Н., Леонтович Е.А. Методы и приемы качественного исследования динамических систем на плоскости.	Москва, Наука			
3.	2001	Кузнецов С. П. Динамический хаос.	Москва Физматлит	http://www.fizmatlit.narod.ru/webrary/kuzn/kuzn.htm		

Course programme designed by

Prof. habil.dr. Vytautas Kleiza