STUDY MODULE DESCRIPTION FORM

Name of the module/subject		Code
Dynamical systems		**1010342611010349073**
Field of study: **Mathematics**	Profile of study (general academic, practical): **(brak)**	Year /Semester: **1 / 1**
Elective path/specialty: **Modelling in applied sciences**	Subject offered in: **Polish**	Course (compulsory, elective): **obligatory**
Cycle of study: **Second-cycle studies**	Form of study (full-time,part-time): **full-time**	
No. of hours: Lecture: **30** Classes: **30** Laboratory: **-** Project/seminars: **-**		No. of credits: **4**
Status of the course in the study program (Basic, major, other): **(brak)**	(university-wide, from another field): **(brak)**	
Education areas and fields of science and art		ECTS distribution (number and %)

Responsible for subject / lecturer:

dr Jarosław Mikołajski
email: jaroslaw.mikolajski@put.poznan.pl
tel. 61 665 2712
Wydział Elektryczny
ul. Piotrowo 3A, 60-965 Poznań

Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge**	Knowledge of theory of ordinary differential and recurrence equations, as well as fied theory from first degree studies.
2	**Skills**	Solving differential and recurrence equations, drawing function graphs, using of elements of field theory.
3	**Social competencies**	Awareness of limitations of acquired knowledge and understanding the need for further education.

Assumptions and objectives of the course:

Getting to know theory and uses of continuous and discrete dynamical systems. Gaining the skills to apply the acquired knowledge to theory and practice in other fields of mathematics and physics.

Study outcomes and reference to the educational results for a field of study

Knowledge:

1. Student understands the role and importance of constructing differential and recurrence equations describing dynamic systems. - [K_W01]
2. He knows how to determine the properties of a particular problem that is a mathematical model of a given dynamic system. - [K_W03]
3. He uses phase field and rotation theories to study singular points. - [K_W04]
4. He explains the relationships between continuous and discrete systems and related equations. - [K_W07]

Skills:

1. Student is able to solve autonomous equations and their systems and define singularities. - [K_U12, K_U37]
2. He designates trajectories of such systems with singular points and separatrysas. - [K_U19, K_U22, K_U24]
3. He replaces the autonomous continuous (differential) by discrete (recurrence) equations. - [K_U29]

Social competencies:

1. Student can precisely formulate a problem in the field of dynamical systems and try to solve it. - [K_K02]
2. He understands the need to resort to intuition, both for his own understanding and for the popularization of abstract mathematics. - [K_K05]
3. It has the ability to search information in the literature and on the Internet. - [K_K06]

Assessment methods of study outcomes

Lecture

Assessment of knowledge and practical skills demonstrated in the written and oral exam.

Classes

Up-to-date: systematic control of theoretical knowledge in the form of oral and written responses, assessment of the ability to apply knowledge to solve tasks and assessment of activity in the classroom.

In the 7th and 14th week activities: tests acquired on the classes skills.

Course description

Actualization 2017/2018

1. Dynamical systems and their representation by differential or recurrence equations.
2. First order autonomous differential equations and their singularities.
3. Classification of critical points for stability.
4. Autonomous differential equations of higher order.
5. Solving the linear autonomous equations of higher order using Cardano formulas.
6. Autonomous homogeneous linear systems of two differential equations - form of solutions and trajectories.
7. Classification of singular points: stable or unstable regular node, saddle, stable or unstable focus, center, stable or unstable degenerate node, stable or unstable singular node.
8. Autonomous nonhomogeneous linear and nonlinear systems of two differential equations - singular points of a new type and separatrysas.
9. Analysis of exemplary physical dynamical systems.
10. Phase field and its use for testing types of singular points.
11. Outline of the rotation theory of vector flat field - relationship between index of singular point and trajectories.
12. Generalization of the presented theory into autonomous nonlinear systems of any number of differential equations.
13. Transition of the theory of continuous autonomous systems to discrete systems (recurrence equations).
14. Similarities and differences between continuous and discrete autonomous systems.

The applied methods of education:

- lecture led in interactive way implemented by examples on board,
- theory presented in close connection with practical tasks,
- in track of lecture formulating questions to students and initiating the discussion,
- recomendation materials for self-completion of the message,
- during classes solving on board example tasks,
- discussions on various methods of solution,
- the students activity is taken into account during the final evaluation.

Basic bibliography:

1. R. H. Martin, Elementary Differential Equations with Boundary Value Problems, McGraw-Hill Book Company, New York ? 1983.
2. R. Gutowski, Równania różniczkowe zwyczajne, WNT, Warszawa 1971.
3. J. Muszyński, A. D. Myszkis, Równania różniczkowe zwyczajne, PWN, Warszawa 1984.
4. D. Bobrowski, Systemy dynamiczne z czasem dyskretnym, Wyd. PP, Poznań 1994.

Additional bibliography:

1. W. J. Cunningham, Analiza układów nieliniowych, WNT, Warszawa 1962.
2. M. Medved?, Fundamentals of Dynamical Systems and Bifurcation Theory, Adam Hilger, Bristol ? 1991.

Result of average student's workload

Activity	Time (working hours)
1. Active participation in meetings (lectures and classes).	60
2. Active participation in consultations with posing questions.	5
3. Solving exercises designed for individual work.	20
4. Individual studying theoretical questions.	10
5. Preparing to get credits.	30

Student's workload

Source of workload	hours	ECTS
Total workload	125	4
Contact hours	65	2

Practical activities	60	2