GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

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| Subject name and code | , PG_00052287 | | |
| Field of study | Mathematics | | |
| Date of commencement of studies | October 2022 | Academic year of realisation of subject | 2022/2023 |
| Education level | second-cycle studies | Subject group | Optional subject group<br>Subject group related to scientific research in the field of study |
| Mode of study | Full-time studies | Mode of delivery | at the university |
| Year of study | 1 | Language of instruction | Polish |
| Semester of study | 2 | ECTS credits | 4.0 |
| Learning profile | general academic profile | Assessment form | assessment |
| Conducting unit | Zakład Analizy Nieliniowej -> Instytut Matematyki Stosowanej -> Faculty of Applied Physics and Mathematics | | |
| Name and surname of lecturer (lecturers) | Subject supervisor | dr inż. Robert Krawczyk | |
| | Teachers | dr inż. Robert Krawczyk<br>dr Muhammad Riaz | |

**Lesson types and methods of instruction**

| Lesson type | Lecture | Tutorial | Laboratory | Project | Seminar | SUM |
|---|---|---|---|---|---|---|
| Number of study hours | 30.0 | 0.0 | 0.0 | 0.0 | 30.0 | 60 |

E-learning hours included: 0.0

**Learning activity and number of study hours**

| Learning activity | Participation in didactic classes included in study plan | Participation in consultation hours | Self-study | SUM |
|---|---|---|---|---|
| Number of study hours | 60 | 5.0 | 35.0 | 100 |

**Subject objectives**

The aim of the course is to familiarize students with nonlinear systems of autonomous ordinary differential equations, and more specifically to introduce the study of the behavior of solutions of such systems based on the function f in the system x '= f (x). Does it have zeros and what types of equilibrium points are they for this system?

**Learning outcomes**

| Course outcome | Subject outcome | Method of verification |
|---|---|---|
| K7_U09 | The student is able to find the equilibrium points of a system of nonlinear equations, linearize a given system at equilibrium points, apply the Hartman-Grobman theorem and draw conclusions about the qualitative structure (stability) of the equilibrium points. | [SU3] Assessment of ability to use knowledge gained from the subject |
| K7_W04 | The student knows the methods of solving ordinary differential equations and systems of linear differential equations. | [SW1] Assessment of factual knowledge |
| K7_K04 | The student is able to decide what class is the function f in the equation x '= f (x). The student is able to formulate the Lipschitz condition. | [SK5] Assessment of ability to solve problems that arise in practice |

**Subject contents**

ordinary differential equation, system of linear differential equations, system of nonlinear differential equations, stationary point of the system of differential equations, hyperbolic equilibrium point. The concept of a saddle, sink, source, center for a stationary point. Maximum lifetime of the solution. Stream and its domain. Stable and unstable variety. Hartman-Grobman theorem. Lapunov function. Basic bifurcations in differential equations.

**Prerequisites and co-requisites**

The student should know the basic concepts of the course of ordinary differential equations. Should be able to solve basic types of differential equations. He should be able to find a fundamental system for a system of linear differential equations.

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| Assessment methods and criteria | Subject passing criteria | Passing threshold | Percentage of the final grade |
| | the test | 50.0% | 50.0% |
| | an activity | 0.0% | 20.0% |
| | the presentation | 75.0% | 30.0% |
| Recommended reading | Basic literature | 1. J. Hale, H. Kocak, Dynamics and Bifurcations, Springer, 1991 | |
| | Supplementary literature | 1. J. Hale, H. Kocak, Dynamics and Bifurcations, Springer, 1991 | |
| | eResources addresses | Adresy na platformie eNauczanie:<br>Układy Nieliniowe - Moodle ID: 30967<br>https://enauczanie.pg.edu.pl/moodle/course/view.php?id=30967 | |
| Example issues/ example questions/ tasks being completed | 1. Find the maximum lifetime of the problem solution x '= x ^ 2, x (0) = 1.2. Find the stationary points of the system x '= x-y ^ 2, y' = y-y ^ 2.3. Perform linearization of the system x '= x ^ 2-y ^ 2, y' = y ^ 3-1 at the points of equilibrium.4. Check if we can apply the Hartman-Grobman theorem in the system x '= f (x) at its points of equilibrium.5. Describe the bifurcation in the equation x '= a-x ^ 2. Sketch a diagram of the bifurcation | | |
| Work placement | Not applicable | | |