COURSE DESCRIPTION CARD - SYLLABUS

Course name
Differential equations and integral transformations [N1AiR2>RRiPC]

Course

Field of study
Automatic Control and Robotics

Year/Semester
1/2

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
part-time

Requirements
compulsory

Number of hours

Lecture
20

Laboratory classes
0

Other
0

Tutorials
20

Projects/seminars
0

Number of credit points

5,00

Coordinators

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Lecturers

Prerequisites

Knowledge: A student starting this subject should have a basic knowledge of mathematical analysis, especially differential and integral calculus. Skills: The student should have the ability to obtain information from specified sources. He should also understand the need to broaden his competences / be willing to cooperate within a team. Social Competences: In the field of social competences, students must present attitudes such as honesty, responsibility, perseverance, cognitive curiosity, creativity, personal culture, and respect for other people.

Course objective

1. To provide students with basic knowledge of differential equations (Ordinary differential equation and its solution, Cauchy problem, Lipschitz condition, Examples of integer equations, Stability of solutions of differential equations (Lapunov's stability)). 2. Providing students with basic knowledge of the operator's calculus (Laplace transformation, Z transformation and Fourier transformation basics). 3. To provide students with the basics of using these transformations to solve differential and recursive (differential) equations. 4. To familiarize students with the applications of operator calculus in the study of the dynamics of analog and digital systems. 5. Developing students' teamwork skills.

Course-related learning outcomes

Knowledge:
1. student has knowledge of mathematical analysis, in particular, calculus; K1_W1
2. student has knowledge of mathematical analysis, including mathematical and numerical methods necessary to describe and analyze linear and basic properties of nonlinear dynamic and static systems, description and analysis of complex quantities, description of control algorithms and analysis of dynamic systems stability, description and analysis of signal processing in time and frequency domain; K1_W1
3. student has ordered knowledge of signal and information theory and methods of their processing in the field of time and frequency; K1_W5

Skills:
1. student is able to use the basic methods of signal processing and analysis in the field of time and frequency and extract information from the analyzed signals; K1_U9
2. student is able to obtain information from literature, technical documentation and other sources also in English; K1_U1

Social competences:
1. student understands the need and knows the possibilities of continuous training, raising professional, personal and social competences, is able to inspire and organize the learning process of others; K1_K1

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Knowledge acquired as part of the lecture is verified by a 1.5-hour exam that will take place during the exam session. It will cover 10-15 theoretical issues and 3-5 computational tasks. Passing threshold: 50% of points. Final issues on the basis of which theoretical questions are developed will be sent to students by e-mail using the university e-mail system.

The skills acquired in exercise classes are verified on the basis of two 1.5-hour credit colloquia consisting of 4-7 tasks scored differently depending on their degree of of their difficulty. Pass mark: 50% of the points.

Programme content

Basic topics in the field of differential equations; definitions and theorems of the Laplace transform; definitions and theorems of the discrete Z-transform

Course topics

The lecture and excerciseprogram includes the following topics:
1. Introduction to differential equations:
- Ordinary differential equation and its solution
- Cauchy's problem
- Lipschitz condition
- Examples of integer equations:
o Equation with separated variables
o Homogeneous equation
o Linear equation
o Bernoulli equation
o Complete equation
o Riccati equation
- Linear differential equation of n-order
- Systems of linear differential equations
- Stability of solutions of differential equations (stability in the Lapunov sense)
2. Laplace transformation:
- Properties of selected signals: Dirac delta (pulse), unit jump
- Definition of Laplace transformation
- Basic properties and theorems for Laplace transformation:
o transformationof the differential equation and integral
o transformation of the periodic function
o limit value theorem
o delay theorem, etc.

- Inverse transform: residual method, simple fractions method
- The use of Laplace transforms for algebraic solving of systems of ordinary differential equations
- Using the convolution theorem (Borel) to determine the system's response
3. Transformation Z:
- Properties of selected signals: discrete unit jump, Kronecker delta
- Basics of Z transformation - definition, basic properties, shift theorem
- Rules for making a digital circuit diagram
- Inverse transformation - decomposition into simple fractions, residual method, numerical method for determining the inverse transform by dividing polynomials
- Discrete approximation of the plexus
- Differential equations
- Determination of digital system responses using Z transformation
- Relationships of Z transformation with Laplace transformation z -> s and s -> z - exact and approximate: z = e ^ {sT}, bilinear, Euler

Teaching methods

Lecture: multimedia presentation, illustrated with examples on the board.
Exercises: calculating the tasks given by the teacher with the students - practical exercises.

Bibliography

Basic:
1. Świetlicka A., Rybarczyk A., Jurkowlaniec A., Rachunek operatorowy (Metody rozwiązywania zadań), PWN, Warszawa 2012.
2. Myjak J., Równania różniczkowe, Wydawnictwa AGH, Warszawa 2016.

Additional:
1. Bobrowski D., Ratajczak Z., Przekształcenie Laplace'a i jego zastosowania, Wyd. Uczelniane PP, skrypt No 571 (lub późniejsze wydanie).
2. Papoulis A., Obwody i układy, WKŁ, Warszawa, 1988.
3. Osiowski J., Zarys rachunku operatorowego, WNT, Warszawa, 1981.
4. Zieliński T.P., Od teorii do cyfrowego przetwarzania sygnałów, Wydział EAIiE AGH, Kraków, 2002.
5. Brigham E.O., The Fast Fourier Transform, Prentice-Hall, Englewood Cliffs, NY, 1974.
6. Oppenheim A.V., Schafer R., Cyfrowe przetwarzanie sygnałów, WKiŁ, 1979.
7. Mikusiński J., Sikorski R., Elementarna teoria dystrybucji, PWN, Warszawa, 1964.
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13. Vlach J., Singhal K., Computer methods for circuit analysis and design, Van Nostrand Reinhold Company, NY, 1983.
14. Wiliams J, Laplace Transforms, George Allen and Ugwin, London, 1973.
15. Kołodziej W., Analiza matematyczna, PWN, Warszawa, 1979.
16. Bogucka H., Dziech A., Sawicki J, Elementy cyfrowego przetwarzania sygnałów z przykładami zastosowań i wykorzystaniem środowiska MATLAB, Wyd. FPT, Kraków, 1999.

Breakdown of average student's workload

	Hours	ECTS
Total workload	125	5,00
Classes requiring direct contact with the teacher	42	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	83	3,00