COURSE DESCRIPTION CARD - SYLLABUS

Course name
Difference equations [S1MwT1>E-RR]

Course

Field of study
Mathematics in Technology

Year/Semester
3/5

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
elective

Number of hours

Lecture
30

Laboratory classes
0

Other (e.g. online)
0

Tutorials
15

Projects/seminars
0

Number of credit points

4,00

Coordinators

Lecturers

Prerequisites

Basic knowledge of linear algebra and mathematical analysis

Course objective

1. To provide students with a basic knowledge of difference equations and its use in mathematical modelling. 2. To develop in students the ability to solve simple difference equations and to analyse phenomena and build their mathematical models. 3. To develop in students the ability to work in a team.

Course-related learning outcomes

Knowledge:
Student:
1. knows most of the basic definitions and theorems of the general theory of linear difference equations,
2. understands the purpose and significance of simple discrete models,
3. knows the connections of topics in the theory of difference equations with other branches of theoretical and applied mathematics.

Skills:
Student:

1. is able to solve simple difference equations,
2. is able to construct discrete mathematical models, using also tools from other branches of mathematics,
3. is able to carry out proofs, using, if necessary, also tools from other branches of mathematics,
4. is able to plan and educate himself/herself in order to improve and update his/her competences.

Social competences:
Student:
1. is ready for further education due to awareness of the limitations of his/her own knowledge,
2. has ability to co-operate within a team, to fulfil the duties assigned in the division of labour in the team, understanding the necessity of systematic work,
3. has self-reliance in searching for information in the literature, also in foreign languages,
4. has ability to act in accordance with basic ethical principles.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
Lecture: evaluation of knowledge and skills demonstrated in a written test and preparation and presentation.
Exercises: one colloquium evaluating practical skills of solving tasks and current evaluation of student"s work during classes - rewarding activity manifested in discussion and cooperation in solving practical tasks.

Programme content

LECTURES + EXERCISES:
1. basic concepts of difference calculus
2. introductory concepts: definitions of a difference equation and its solution
3. discrete dynamical systems
4. linear difference equations of higher orders
5. methods of solving nonlinear difference equations reducible to linear equations
6. periodicity of solutions of difference equations of order two
7. systems of first order linear difference equations - solution methods
8. applications of difference equations in biology
9. applications of difference equations in finance and economics

Course topics

LECTURES + EXERCISES:
1. basic concepts of difference calculus: definition of difference operator, difference of sum, product and quotient of two sequences, differences of elementary sequences, differences of higher orders; definition and properties of decreasing product; definition of indeterminate sum; indeterminate sums of sum, product and quotient of two sequences, basic formulae for indeterminate sums of sequences; definite sums, theorem of summation by parts;
2. introductory concepts: definitions of a difference equation and its solution; examples of simple recursive relations (Fibonacci model, tower of Hanoi, permutations, straight lines on the plane, capitalisation of interest); first order linear difference equation: definition, existence theorem, uniqueness and form of solution;
3. discrete dynamical systems: concept of discrete system, stationary and nearly stationary system points; definitions of stability and asymptotic stability of equilibrium points; stability criteria for one-dimensional systems (analytical and graphical - spider web method);
4. linear difference equations of higher orders: existence theorem and uniqueness of solution theorem; Casorati matrix, casoratian, fundamental system of solutions, necessary and sufficient condition for linear independence of solutions; general solution of homogeneous linear equation; homogeneous linear equation with constant coefficients, characteristic equation; determination of special solution of heterogeneous equation by prediction method; asymptotic properties of solutions of linear difference equations: Poincare"s theorem, Perron"s theorem ;
5. methods of solving nonlinear difference equations reducible to linear equations: difference equation of Riccati type; homographic type equation; homogeneous difference equation;

6. periodicity of solutions of difference equations of order two: definition of periodic solution, definition of p-cycle; discussion of periodicity of selected types of measurable difference equations;
7. systems of first order linear difference equations - solution methods: determination of the n-th power of the matrix of coefficients of the system (eigenvalue and eigenvector of the matrix, Cayley - Hamilton theorem, diagonalization of the matrix); Putzer method; elimination method;
8. applications of difference equations in biology: discrete population growth; Verhulst model; discrete predator-prey model; birth and death models; Nicholson model (parasites and their hosts);
9. applications of difference equations in finance and economics: interest capitalisation and loan repayment models; Samuelson"s national income model; demand and supply models, market equilibrium models (without storage and with storage); discrete Leontief model.

Teaching methods

Lecture:
1. lecture with multimedia presentation supplemented by examples given on the blackboard; conducted in an interactive way with formulation of questions to a group of students;
2. theory presented in connection with the current knowledge of students;
3. the activity of the students during the class is taken into account in the final assessment (preparation of papers on topics given at the beginning of the semester; topics prepared in teams of 2-3 students and referred by all members of the team).
Exercises:
1. solving sample assignments on the board;
2. continuous assessment - rewarding activity manifested in discussion and cooperation in solving practical tasks;
3. detailed review of solutions to tasks and discussion of comments;
4. initiating discussion on solutions.

Bibliography

Basic
1. D. Bobrowski, Systemy dynamiczne z czasem dyskretnym, zagadnienia deterministyczne, Wydawnictwo PP, 1994.
2. S. Elaydi, An Introduction to Difference Equations, Undergraduate Texts in Mathematics, Springer, New York, USA, 2005.
3. U. Foryś, Matematyka w biologii, Wydawnictwo WNT, 2005.
Additional
1. R. Agarwal, Discrete oscillation theory, Hindawi Publishing, 2005.
2. R. Agarwal, D. O"Regan, Infinite interval problems for differential, difference and integral equations, Kluwer Academic Publ., 2001.

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	45	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	55	2,00