



## COURSE DESCRIPTION CARD - SYLLABUS

Course name

Numerical methods for integral equations [S2MwT1>PO2-MNRC]

### Course

Field of study

Mathematics in Technology

Year/Semester

1/2

Area of study (specialization)

Modelling in Technology

Profile of study

general academic

Level of study

second-cycle

Course offered in

polish

Form of study

full-time

Requirements

elective

### Number of hours

Lecture

30

Laboratory classes

30

Other (e.g. online)

0

Tutorials

0

Projects/seminars

0

### Number of credit points

4,00

### Coordinators

mgr inż. Marcin Stasiak

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### Lecturers

### Prerequisites

Student should have basic knowledge from calculus, linear algebra, basics of functional analysis and numerical methods.

### Course objective

The aim of the subject is presentation of a few basic methods for solving analytically and numerically integral equations. Curriculum of lectures and lab classes includes basic knowledge from Volterra and Fredholm integral equations of the first and second kind. The basic theory of multidimensional integral equations will be also presented.

### Course-related learning outcomes

Knowledge:

1. Has extended and in-depth general knowledge of various branches of higher mathematics
2. Knows advanced numerical methods and algorithms
3. Knows at least one numerical software

Skills:

1. Is able to construct and analyse complex mathematical models
2. Can construct an algorithm for solving a complex engineering task or a simple research problem and implement and test it in a selected programming environment

Social competences:

1. Is aware of the possibility of making mistakes by himself and others
2. Is ready to think and act in a creative and entrepreneurial way, taking into account safety, work ergonomics and its economic aspects
3. Is aware of the importance of intellectual honesty in own and other people's actions

### Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

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Oral exam from lecture part. Final project summary of designed algorithms.

### Programme content

1. Introduction (lecture)
  - normed spaces, operators, integral operator
  - Banach and Schauder fixed point theorem
  - Hilbert spaces,  $L_2$  space
  - continuity of integral operators
2. Linear and non-linear integral equations (lecture)
  - Fredholm and Volterra integral equations of the first and second kind, Abel equation
  - physical and technical examples of integral equations
3. Neumann method (lecture and lab classes)
4. Degenerated kernel method (lecture and lab classes)
5. The finite sum method (lecture and lab classes)
6. Collocation method (lecture and lab classes)
7. Projection methods (lecture and lab classes)
8. Multidimensional integral equations (lecture and lab classes)
9. The finite sum method for systems of integral equations (lecture and lab classes)
10. Integro-differential equations (lecture)

### Teaching methods

Lecture: traditional form given on the blackboard with discussion

Lab classes: creating and algorithms and solving numerically problems given by integral equations

### Bibliography

Basic

1. R. Grzymkowski, Wybrane metody obliczeniowe równań całkowych, WPŚ, Gliwice 2015
2. A. Piskorek, Równania całkowe, WNT, Warszawa 1980
3. J. Wolska-Bochenek, Zarys równań całkowych i równań różniczkowych cząstkowych, PWN, Warszawa 1981

Additional

1. K. Atkinson, The numerical solution of the integral equations of the second kind, CUP, Cambridge 1997
2. A. M. Wazwaz, Linear and nonlinear integral equations, Springer, Beijing 2011

### Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	60	3,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	40	1,00