STUDY MODULE DESCRIPTION FORM

Name of the module/subject	Code
Finite difference method (FDM)	**1010341751010349404**

Field of study	Profile of study (general academic, practical)	Year /Semester
Mathematics in Technology	**general academic**	**3 / 6**
Elective path/specialty: **-**	Subject offered in: **Polish**	Course (compulsory, elective): **obligatory**

Cycle of study:	Form of study (full-time,part-time)
First-cycle studies (Polish Qualifications Framework level six)	**full-time**

No. of hours	No. of credits
Lecture: **30** Classes: **-** Laboratory: **30** Project/seminars: **-**	**4**

Status of the course in the study program (Basic, major, other) (university-wide, from another field)

Education areas and fields of science and art	ECTS distribution (number and %)
Technical sciences	**4 100%**
Technical sciences	**4 100%**

Responsible for subject / lecturer:

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Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge**	Calculus, linear algebra, differential equations, numerical methods [K_W01 (P6S_WG), K_W06 (P6S_WG)]
2	**Skills**	Programming of digital machines in MatLab [K_U04 (P6S_UW), K_U013 (P6S_UK)]
3	**Social competencies**	Precise formulation of questions to deepen understanding of the topic [K_K01 (P6S_KK), K_K02 (P6S_KK), K_K05 (P6S_KR)]

Assumptions and objectives of the course:

This first course in mathematical programming is aimed at solving boundary problems for ordinary differential equations and boundary-initial problems for partial differential equations using finite difference method. The student after completing the course should be able to choose the appropriate differential scheme for a good approximation of the solution, and then create the appropriate software to solve the problem. The student should also understand the concepts of stability and convergence of the method and know the limitations of the methods used depending on the problem being studied.

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

Knowledge:

1. Has an extended and in-depth knowledge of different areas of higher mathematics [K_W01 (P6S_WG)]
2. Has a good IT knowledge with solid theoretic background, including numerical methods; knows at least one programming package or programming language [K_W06 (P6S_WG)]

Skills:

1. Knows how to build an algorythm of a solution for a simple ingeneering task; is able to implement it and test it in a chose programmic environment [K_U04 (P6S_UW)]
2. Knows a foreign language on a conversational level and is able to read with understanding mathematical texts, technical documents and similar [K_U013 (P6S_UK)]

Social competencies:

1. Is aware of the need to extend and deepen their knowledge in order to solve new technical problems [K_K01 (P6S_KK)]
2. Is aware of the need to extend and deepen their knowledge in order to solve new technical problems [K_K02 (P6S_KK)]
3. Is aware of their social role as a technical university graduate, is ready to pass the popular science to the society and to identify and solve basic problems related to the studied field [K_K05 (P6S_KR)]

Assessment methods of study outcomes

Numerical project

Final exam

Course description

1. Finite differences - introduction

2. Boundary-value problems for odrinary differential equations, boundary conditions, norm, normed spaces, nonlinear boundary problems

3. Explicit and implicit schemes

4. Convergence and stability

5. Boundary-value problems and initial boundary-value problems for partial differential equations.=

- finite differences for partial derivatives

- eliptic equations, Laplace equation, Piosson equation

- first order scheme, Lax scheme, Lelevier scheme, Lax-Wendorff schemes, jump scheme

- 5 and 9 points stencils

- two-dimensional polar mesh

- Jacobi and Gauss-Seidel methods for elliptic equations

- parabolic and hyperbolic equations, time-space mesh, space discretization, one dimensional diffusion and wave equations

- first order scheme, Bendera-Schimdta scheme, Crank-Nicolson scheme, Dufort-Frankl scheme, Richtmeyer-Morton scheme

- energetic method for mixed problems

6. Lax theorem

7. Fourier method for stability, von Neumanna conditio, Courant-Friedrichs-Lewy condition

8. Gerschgorina theorem

Update: 10.2018

Basic bibliography:

1. Metody Obliczeniowe Fizyki, David Potter, PWN Warszawa 1982

2. Analiza numeryczna zagadnień fizyki matematycznej, Gurij Iwanowicz Marczuk, PWN Warszawa 1983

3. Finite-difference methods for partial differential eqnations, George E. Forsythe, Wiley 1960

Additional bibliography:

1. Finite Difference Methods for Ordinary and Partial Differential Equations, Randall J. LeVeque, Society for Industrial and Applied Mathematics 2007

2. Numerical Partial Differential Equations: Finite Difference Methods, J. W. Thomas, Springer 1995

3. An Introduction to Partial Differential Equations with MATLAB, Matthew P. Coleman, CRC Press 2013

4. Numerical Methods and Modelling for Chemical Engineers, Mark E. Davis, John Wiley & Sons Canada 1984

5. A modern introduction to differential equations, Henry Ricardo, Elsevier Canada 2009

6. Beginning Partial Differential Equations, Peter V. ONeil, Wiley-Interscience 2008

Result of average student's workload

Activity	Time (working hours)
1. participation in lectures	30
2. participation in laboratory classes	30
3. participation in consultations related to the implementation of the education process, in particular laboratory exercises / project	5
4. completing (as part of your own work) reports on laboratory exercises: writing program / programs, launching and verification (time outside laboratory classes)	10
5. preparation for tests / colloquium	5
6. preparation for passing the lectures and participation in the final test	20

Student's workload		
Source of workload	**hours**	**ECTS**
Total workload	100	4
Contact hours	65	2
Practical activities	45	2