FACULTY OF PURE AND APPLIED MATHEMATICS

SUBJECT CARD

Name of subject in Polish: Metody numeryczne w równaniach różniczkowych
Name of subject in English Numerical methods in differential equations
Main field of study (if applicable): Applied Mathematics
Specialization (if applicable): Mathematics for Industry and Commerce
Profile: academic / practical*
Level and form of studies: 2nd level/ full-time /
Kind of subject: optional
Subject code
Group of courses YES

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	90		60		
Form of crediting	Examination				
For group of courses mark (X) final course	X				
Number of ECTS points	3		2		
including number of ECTS points for practical classes (P)	2		2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1.5		1.5		

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Student has basic knowledge and abilities on mathematical analysis.
2. Student has basic knowledge concerning programming environments: Matlab/Mathematica/Mapple.

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SUBJECT OBJECTIVES

C1 Study of basic notions and knowledge in the area of numerical methods applied in differential equations
C2 Study of basic numerical techniques used in discretization of differentia equations.
C3 Acquisition of basis abilities in construing and analyzing difference schemes for differential equations

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge student:
PEK_W01 knows the most important numerical techniques used in solving problems for differential equations
PEK_W02 knows bases of construing own numerical schemes
relating to skills student:

PEK_U01 is able to analyze basic problems in differential equations with respect to application of suitable approximate methods
PEK_U02 is able to construct mathematical models used in concrete applications of mathematics, based on differential equations and their discrete forms.
…
relating to social competences:
PEK_K01 can, without assistance, search for necessary information in the literature
PEK_K02 understands necessity of systematic and individual work on the material of the course.
relating to skills:
PEU_U01
PEU_U02
…
relating to social competences:
PEU_K01
PEU_K02

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Recalling basic facts of theory of ordinary differential equations.	2
Lec 2	Explicit and implicit Euler method of approximate solving of ordinary differential equations and their systems.	2
Lec 3	Runge-Kutta type methods and other schemes of approximation of ordinary differential equations and their systems.	2
Lec 4	Multi-step methods, stability of numerical methods. Stiff problems.	2
Lec 5	Methods of approximation of boundary value problems for second order ordinary differentia equations: shooting methods and difference methods.	2
Lec 6	Methods of approximation of boundary value problems for second order ordinary differentia equations: Ritz-Galerkin method.	2
Lec 7	Difference methods for first order partial differentia equations. CFL condition.	2
Lec 8	Recalling basic facts of theory of second order partial differential equations.	2
Lec 9	Difference approximation of elliptic boundary value problems on the plane.	2
Lec 10	Variational formulation of boundary value problems for elliptic type equations.	2
Lec 11	Ritz-Galerkin and finite element methods for elliptic problems.	2
Lec 12	Difference methods for parabolic problems. Explicit and implicit schemes for heat conduction equation.	2
Lec 13	Stability of approximate method. Cranck-Nicholson scheme for equations of parabolic type.	2
Lec 14	Difference methods for the vibrating string problem and other hyperbolic problems.	4
	Total hours	**30**

Laboratory	**Number of hours**

Lab 1	Computer construction of solution of ordinary differentia equations.	4
Lab 2	Practical verifying of efficacy of automatic exactness control.	2
Lab 3	Visualization and comparison of usefulness of various methods.	4
Lab 4	Algorithms for numerical methods of solution of one-dimensional boundary value problems for elliptic equations.	4
Lab 5	Discretisation of hyperbolic first order problems. Conditions of stability and convergence of approximate methods.	4
Lab 6	Discretization of two-dimensional boundary value problem for elliptic equations.	4
Lab 7	Difference schemes of approximation of one-dimensional parabolic equation.	4
Lab 8	Difference method of discretization of the vibrating string equation.	4
	Total hours	**30**

TEACHING TOOLS USED

N1. Lecture – traditional method.
N2. Problem and computing laboratory – traditional and using computers method.
N3. Consultations.
N4. Student's personal work – preparation for the laboratory.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEK_W01 PEK_W02 PEK_K01	Presentation of given problems.
F2	PEK_U01 PEK_U02 PEK_K01	Oral presentations, tests.
P=0.5*F1+0.5*F2		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Richard L. Burden, J. Douglas Faires, Numerical Analysis.
[2] R. M. Mattheij, S. W. Rienstra, J.H.M. ten Thije Boonkkamp, Partial differential equations. Modeling, analysis and computations.
[3] Stig Larsson, Vidar Thomee, Partial differential equations with numerical methods.

SECONDARY LITERATURE

[1] L. Lapidus, G. F. Pinder, Numerical solution of partial differential equations in science and engineering, John Wiley & Sons, 1998
[2] R. J. Le Vegue, Numerical Methods for conservation laws, Birkhauser, Basel 1990
[3] J. W. Thomas, Numerical partial differential equations: conservation laws and elliptic equations, Springer, New York 1999

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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