Zał nr 4 do ZW

Faculty of Fundamental Problems of Technology

COURSE CARD

Name in polish	:	**Algebra numeryczna**
Name in english	:	**Numerical algebra**
Field of study	:	Computer Science
Specialty (if applicable)	:	
Undergraduate degree and form of	:	masters, stationary
Type of course	:	optional
Course code	:	E2_W08
Group rate	:	Yes

	Lectures	Exercides	Laboratory	Project	Seminar
Number of classes held in schools (ZZU)	30	30			
The total number of hours of student workload (CNPS)	90	90			
Assesment	pass				
For a group of courses final course mark	X				
Number of ECTS credits	3	3			
including the number of points corresponding to the classes of practical (P)		3			
including the number of points corresponding occupations requiring direct contact (BK)	3	3			

PREREQUISITES FOR KNOWLEDGE, SKILLS AND OTHER POWERS

Pass the course Scientific Computing. Learning Octave or Matlab.

COURSE OBJECTIVES

C1 Learning basic algorithms of numerical linear algebra

C2 Achievement of practical competence in applications and implementation of basic algorithms of numerical linear algebra

COURSE LEARNING OUTCOMES

The scope of the student's knowledge:

W1 Student knows QR and SVD decompositions, orthogonal transformations and their applications.

W2 Student knows parallel algorithm for systems of linear equations with banded matrices and ijk variants of Gauss elimination and Cholesky decomposition.

W3 Student knows methods for solving linear least squares problem and their properties. Student knows Savitzky-Golay method.

W4 Student knows bisection, QR method and power method for algebraic eigenvalue problem, matrix sign function and matrix equations of Sylvester and Lyapunov.

The student skills:

U1 Student is able to apply orthogonal transformations.

U2 Student is able to apply BLAS and parallel algorithms for solving systems of linear equations and comparing their costs.

U3 Student is able to choose suitable method for solving linear least squares problem and to investigate its conditioning.

U4 Student is able to implement algorithms for computing eigenvalues and eigenvectors of matrices, and for solving matrix equation of Sylvester by means of matrix sign function.

The student's social competence:

K1 Student understands role of numerical algorithms of algebra in computer science and technique.

COURSE CONTENT

Type of classes - lectures		
Wy1	BLAS, BLACS and libraries of algorithms of numerical linear algebra	2h
Wy2	ijk forms of realization of Gauss elimination and Cholesky decomposition	2h
Wy3	Orthogonal transformations, QR and SVD decompositions of matrix	2h
Wy4	Applications of decompositions of matrix	2h
Wy5	Parallel algorithms for solving systems of linear equations	2h
Wy6	Linear least squares problem with matrix of full column rank	2h
Wy7	Linear least squares problem with deficient rank matrix	2h
Wy8	Savitzky-Golay algorithm for filtering noise data	2h
Wy9	Bisection for computing eigenvalues of symmetric tridiagonal matrix	2h
Wy10	QR method for computing eigenvalues	2h
Wy11	Algorithms for computing dominant eigenvalues of large matrices	2h
Wy12	Applications of theorem of Perron-Frobenius and algorithms for computing eigenvalues and eigenvectors in PageRank method	2h
Wy13	Matrix equations of Sylvester and Lyapunov, and matrix sign function and its applications	2h
Wy14	Algorithms for computing SVD and applications of SVD to classification of handwritten digits.	2h
Wy15	Final test	2h

Type of classes - exercises		
Ćw1	Introduction to numerical linear algebra, LU decomposition.	2h
Ćw2	Selected problems of linear algebra. BLAS.	2h
Ćw3	Applications of BLAS to implementation of ijk forms of Gauss elimination and Cholesky decomposition	2h
Ćw4	Householder transformations and rotations of Jacobi, and their applications	2h
Ćw5	Algorithms for computing QR decomposition and applications of QR and SVD decompositions	2h
Ćw6	Parallel algorithms for solving systems of linear equations and their complexity in comparison to complexity of Gauss elimination	2h
Ćw7	Solving and investigation of conditioning of linear least squares problem with full rank matrix	2h
Ćw8	Algorithms for linear least squares problem with deficient rank matrix	2h
Ćw9	Test	2h
Ćw10	Transformation of symmetric matrix to tridiagonal form and implementation of bisection for computing eigenvalues of tridiagonal symmetric matrix	2h
Ćw11	QR method - properties and shifts	2h
Ćw12	Power method - convergence and deflation	2h
Ćw13	Computer home works - presentation of reports	2h
Ćw14	Properties of matrix equations and matrix sign function	2h
Ćw15	Computer home works - presentation of reports	2h

Applied learning tools

1. Traditional lecture
2. Solving tasks and problems
3. Solving programming tasks
4. Consultation
5. Self-study students

EVALUATION OF THE EFFECTS OF EDUCATION ACHIEVEMENTS

Value	Number of training effect	Way to evaluate the effect of education
F1	W1-W4, K1-K1	final test
F2	U1-U4, K1-K1	test, report, activity of student during exercises
P=30%*F1+70%*F2		

BASIC AND ADDITIONAL READING

1. A. Kiełbasiński, H. Schwetlick, Numeryczna algebra liniowa, WNT 1993.
2. D. Kincaid, W. Cheney, Analiza numeryczna, WNT 2005.
3. P. Krzyżanowski, Obliczenia inżynierskie i naukowe. Szybkie, skuteczne, efektowne, PWN 2011.
4. J. Stoer, R. Burlisch, Wstęp do analizy numerycznej, t.1 i t.2, PWN 1987.
5. L. Elden, Matrix Methods in Data Mining and Pattern Recognition, SIAM 2007.
6. C.B. Moler, Numerical Computing with MATLAB, SIAM 2004.
7. T.L Freeman, C. Phillips, Parallel Numerical Algorithms, Prentice Hall 1992.

SUPERVISOR OF COURSE

dr hab. Krystyna Ziętak

RELATIONSHIP MATRIX EFFECTS OF EDUCATION FOR THE COURSE
Numerical algebra
WITH EFFECTS OF EDUCATION ON THE DIRECTION OF COMPUTER SCIENCE

Course training effect	Reference to the effect of the learning outcomes defined for the field of study and specialization (if applicable)	Objectives of the course**	The contents of the course**	Number of teaching tools**
W1	K2_W02 K2_W04	C1	Wy1-Wy15	1 4 5
W2	K2_W02 K2_W04	C1	Wy1-Wy15	1 4 5
W3	K2_W02 K2_W04	C1	Wy1-Wy15	1 4 5
W4	K2_W02 K2_W04	C1	Wy1-Wy15	1 4 5
U1	K2_U09 K2_U10 K2_U11	C2	Ćw1-Ćw15	2 3 4 5
U2	K2_U09 K2_U10 K2_U11	C2	Ćw1-Ćw15	2 3 4 5
U3	K2_U09 K2_U10 K2_U11	C2	Ćw1-Ćw15	2 3 4 5
U4	K2_U09 K2_U10 K2_U11	C2	Ćw1-Ćw15	2 3 4 5
K1	K2_K01 K2_K13 K2_K14	C1 C2	Wy1-Wy15 Ćw1-Ćw15	1 2 3 4 5