Numerical methods - course description

General information

Course name	Numerical methods
Course ID	11.9-WE-ELEKTP-NM-Er
Faculty	Faculty of Computer Science, Electrical Engineering and Automatics
Field of study	Electrical Engineering
Education profile	academic
Level of studies	First-cycle Erasmus programme
Beginning semester	winter term 2017/2018

Course information

Semester	2
ECTS credits to win	3
Course type	obligatory
Teaching language	english
Author of syllabus	• prof. dr hab. Roman Gielerak

Classes forms

The class form	Hours per semester (full-time)	Hours per week (full-time)	Hours per semester (part-time)	Hours per week (part-time)	Form of assignment
Lecture	15	1	-	-	Credit with grade
Laboratory	15	1	-	-	Credit with grade

Aim of the course

After this course, students should be able to:

• Apply standard techniques to analyze key properties of numerical algorithms performed within floating-point arithmetic regime, such as stability and convergence.

• Understand and analyze common pitfalls in numerical computing such as ill-conditioning and instability.

• Perform data analysis efficiently and accurately using data fitting method based on interpolation and approximation techniques.

• Derive and analyze numerical methods for ODEs

• Implement a range of numerical algorithms efficiently in a Matlab computing/ programming environment

Prerequisites

Foundations of Calculus, Foundations of Linear Algebra

Scope

Basics of computer arithmetic. Floating-point representations. Roundoff error. Loss of significance.

Nonlinear Equations: Bisection method. Secant method. Fixed-point based methods: Newton -Raphson method.Multidimensional Newton method.

Linear Systems: Gaussian elimination process. Gaussian elimination with scaled partial pivoting. Condition Numbers. Tridiagonal and banded systems. LU decomposition. Eigenvalues and eigenvectors. Singular value decomposition.

Interpolation and Numerical Differentiation: Polynomial interpolation schemes- Lagrange and Newton constructions . Runge effects Cubic splines construction. Estimating derivatives.

Numerical Integration: Trapezoid, Simpson's and general Newton-Cotes series rules. Gaussian quadratures.

Approximation schemes: least squares problems. Fourier series and theirs summations.

Ordinary differential equations .Initial Values Problems: Taylor series methods. Euler's method. Runge-Kutta methods.

Teaching methods

- Series of conventional lectures

- computer laboratory programming/computational exercises in Matlab environment

Learning outcomes and methods of theirs verification

Outcome description	Outcome symbols	Methods of verification	The class form
Knowledge of basic linear algebra algorithms		• a final test • an evaluation test • an ongoing monitoring during classes	• Lecture • Laboratory
Knowledge of the simplest methods of curve fitting: interpolation, approximation, Fourier discrete transformations		• a final test • an evaluation test • an ongoing monitoring during classes	• Lecture • Laboratory
Knowledge of floating-point arithmetic, its weaknesses, and the risks associated with its use		• a final test • an evaluation test • an ongoing monitoring during classes	• Lecture • Laboratory

Assignment conditions

Assignments The laboratory tests and the final test are both written individual papers with emphasis on the interpretation of the results. The problem sets are also individual assessments. These involve numerical implementation of algorithms and guided development of methodologies. As such, some problems require simple programming in Matlab.

Final grade will be formed on the basis on the laboratory activity and achievements there together with the result of final test.

Recommended reading

1. Robert J Schilling, Sandra l Harries , ” Applied Numerical Methods for

Engineers using MATLAB and C.”, 3rd edition

2. Richard L. Burden, J.Douglas Faires, “Numerical Analysis 7th edition” ,

Thomson /

3. John. H. Mathews, Kurtis Fink ,” Numerical Methods Using MATLAB 3rd

edition ” ,Prentice Hall publication

Further reading

1. Laboratory Notes

2. Matlab documentation

Notes

Modified by dr hab. inż. Radosław Kłosiński, prof. UZ (last modification: 02-05-2017 13:00)